PART II:
ENVIRONMENTAL, SOCIAL AND HEALTH IMPACT ASSESSMENT

THE PROPOSED BALAMA GRAPHITE MINE IN THE CABO DELGADO PROVINCE IN THE DISTRICT OF BALAMA IN NORTHERN MOZAMBIQUE

Prepared for:

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DRAFT FOR REVIEW

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REVISIONS TRACK TABLE

Project Name: Proposed Balama Graphite Mine in the Cabo Delgado Province in the district of Balama in northern Mozambique

File names	Compiled by	Reviewed/edited	Date
EIA Draft 1	Lara Crous	Ted Avis	29 October 2014
EIA Final Draft			

LIST OF ACRONYMS

CES	Coastal and Environmental Services
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EMP	Environmental Management Programme
EPDA	Environmental Pre-feasibility Scoping Study
EPFI	Equator Principles Financial Institution
ESHIA	Environmental, Social and Health Impact Assessment
ESIA	Environmental and Social Impact Analysis
ESMP	Environmental and Social Management Plan
GDP	Gross Domestic Product
ha	Hectare
I&APs	Interested and Affected Parties
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
MICOA	Ministério Para a Coordenação da Acção Ambiental
MSL	Mean sea level
NGO	Non-governmental Organisation
NPO	Non-profit Organisation
PS	Performance Standards
PPP	Public Participation Process
RAP	Resettlement Action Plan
RPF	Resettlement Policy Framework
SEP	Stakeholder Engagement Plan
WWF	World Wildlife Fund

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1. INTRODUCTION

1.1 Purpose of this report

In accordance with Mozambican regulatory requirements the issuing of an environmental licence requires the preparation of an Environmental Impact Assessment (EIA). The Mozambican Ministry for Co-ordination of Environmental Affairs (MICOA) is the lead environmental agency in Mozambique, and it is MICOA who is responsible for the review and issuing of an environmental licence. The proposed project (Balama Graphite Mine), triggers an EIA and is classified as a category A project, requiring a full EIA (see Chapter 2: EIA standards, process and legislation in Mozambique).

The EIA undertaken for the Balama Graphite Mine must also meet the Equator Principles and best international practice, which is generally defined by the International Finance Corporations Performance Standards 1 to 8 (as described in Chapter 2). In order to meet these standards, and Environmental, Social & Health Impact Assessment (ESHIA) is required, and this document is henceforth therefore referred to as an ESHIA.

The key purpose of this ESHIA is to assess the environmental, social and health impacts of the proposed establishment of a graphite mine, and to provide interested and affected parties (I&APs) with an opportunity to comment on the findings of the ESHIA. The role of MICOA is to administer the ESHIA review process and issue decisions on projects submitted for review.

This ESHIA report intends to ensure that environmental and social concerns are integrated into the proposed development, and suggests ways of preventing, minimising, mitigating and/or compensating for possible adverse environmental and social impacts which may arise due to the proposed development.

It provides information about the proposed Graphite Mine and its development, the legal framework for the ESHIA, a summary of the baseline studies that have been completed to assess this project; and an outline of the ways in which I&APs can be involved in the ESHIA process (public participation). It also provides an assessment of impacts on the natural and social environment, and presents recommendations to mitigate these effects. Further detail on these recommendations will be presented in an Environmental and Social Management Plan.

1.2 Project Overview

Twigg Mining & Exploration Lda, a subsidiary of Syrah Resources Limited, proposes to develop a graphite mine in northern Mozambique, near the small town of Balama. In December 2011, Syrah acquired 100% ownership of the Balama Graphite Project and has since conducted a large diamond drilling resource definition program to establish a graphite resource with a very strong potential to be developed into a mining operation. Balama is anticipated to be a very large graphite deposit. Excluding market considerations, it has the potential to deliver a mine life of 100 years at a process rate of 1 800 000 tpa. A mining license application for a period of 25 years, at a process rate of 2 000 000 tpa will be submitted (an effective mine life of 23.5 years to allow for closure) with an option to extend for a further 25 years. The plant will operate 365 days per year.

Balama is located on a 106km^2 Prospecting Licence in northern Mozambique, within the District of Balama in the Cabo Delgado province. The project area is approximately 265 km by road (3.5 hours' drive) west of the port town of Pemba, and 515 km to the port town of Nacala, where deep water ports are strategically located (Figure 1).

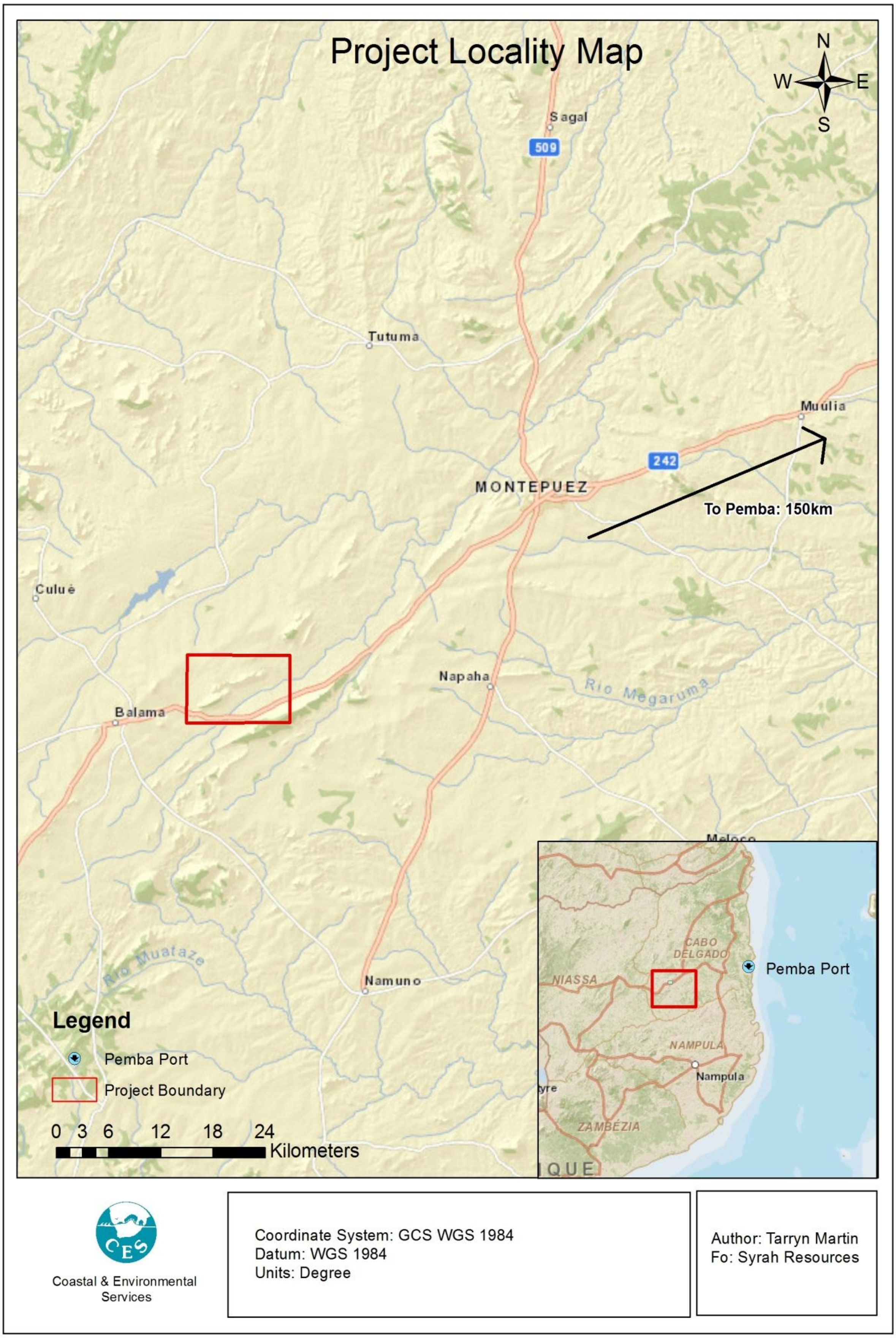

Figure 1.1: Locality map indicating the position of the proposed Balama Graphite Mine area

It is the intention that conventional open pit mining will be used to extract the ore with a baseline scenario of 2 million tonnes per annum. The extraction of the graphite will require conventional flotation processing. The Chipembe dam, located approximately 13 km northwest of the project site, will be the primary source of water for this process. It is estimated that 1 m^3 of water will be required per tonne of ore processed. This requirement of water has been discussed between Twigg (Syrah) representatives and ARA-Norte and the availability of 2 million m^3 has been confirmed (Licence no 07/2012 valid till October 2018). Water will be transferred to site via a 13 km pipeline.

Ore will be delivered from the mine onto stockpiles at the processing plant using haul trucks. The ore will then be fed into the crusher bin using. The crusher plant will consist of a primary crusher, and downstream crushers. The crushed ore will be fed via a conveyor into a mill feed silo and then milled. The ore will then undergo cleaning, flotation and regrinding. All tailings from the process facility will be transferred to a tailings storage facility, with flocculent may be added if required. The final concentrate will be pumped to final concentrate holding tanks ahead of a filter. The cake will then be dried and bagged for transport.
Once the graphite concentrate has been produced, it will be transported by road to the deep water port at Nacala and subsequently exported

Infrastructure required for the graphite mine that will be assessed as part of this ESHIA will include:

- A pipeline (±13 km) from the Chipembe dam to the project site;
- Pump houses at the dam and project site;
- Water reservoirs;
- Internal roads to enable access to various parts of the development and for transportation of materials, equipment, supplies and employees;
- Haul road;
- A diesel powered back-up electricity generation plant and bunded storage areas for diesel fuel, lubricants and waste oil; and
- An ore processing plant.

The project will also require infrastructure related to auxiliary services including the following:

- Offices and accommodation at the project site to accommodate 250 people;
- A lay-down area for construction materials and equipment. This area will continue to be used during the operational phase, although the actual area of land required may be reduced;
- Workshops for repair of equipment and machinery;
- Stores and a lay-down area(s) for equipment, spares and consumables;
- Offices for site staff;
- Ablution facilities and associated sewage treatment plants;
- Security measures

Grid power will be supplied from a 33 kVA line to the established by EDM. The power line is part of EDM's electrification programme to supply electricity to the area. A diesel generation plant will provide back-up power on site. In the event that grid power is unable to provide sufficient capacity, or has not come on line at the start of the project, the generation plant will provide the required electricity on a 24 hour, seven days a week basis. The ESIA assesses the option of 24/7 diesel powered generation in the event that EDM power is not yet available.

In addition, a Tailings Storage Facility and a waste rock dump will be required. The location of these has, as far as possible, taken into account environmental sensitivities.

1.3 Environmental Impact Assessment Team

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CES is one of the largest specialist environmental consulting firms in southern Africa. Established in 1990, and with offices in Grahamstown, East London, Cape Town, Johannesburg and Port Elizabeth in South Africa and Maputo in Mozambique, we primarily specialise in assessing the impacts of development on the natural, social and economic environments. CES's core expertise lies in the fields of environmental assessment, environmental management plans, environmental management systems, ecological/environmental water requirements, environmental risk assessment, environmental auditing and monitoring, integrated coastal zone management, social impact assessment and state of environment reporting. In addition to adhering to all relevant national legislative requirements, which we are often required to review and summarise for specific projects, acquisition of equity funding from the majority of financial institutions demands that developments must meet certain minimum standards that are generally benchmarked against the Policy and Performance Standards of the International Finance Corporation and the World Bank Operational Directives and Policies. The quality of our work during our long and extensive association with mining in Africa (we have worked on large projects in South Africa, Mozambique, Malawi, Kenya, Madagascar, Zambia and Egypt) has been acknowledged by international lenders such as the World Bank and the International Finance Corporation, and the large mining companies continue to approach us as their preferred environmental consultant for this type of project.

1.3.1 Core team members

Below are brief bio-sketches of the key EIA project team members.

Dr A.M (Ted) Avis (Director) – Project Leader
Ted is a leading expert in the field of Environmental Impact Assessments, having project-managed numerous large-scale EIAs to international standards (e.g. World Bank and International Finance Corporation). Dr Avis was principle consultant to Corridor Sands Limitada for the development of all environment aspects for the US$1billion Corridor Sands Project. This involved the completion of five Environmental Impact Assessments, as well as Environmental Management Plans for the entire project. Dr Avis has also managed EIA studies of similar scope in Kenya and South Africa. Dr Avis was instrumental in developing a professional course in Environmental Impact Assessments, based on his past experience running an honours module in EIA practice at Rhodes University. He is a Visiting Fellow in the Environmental Science Department at Rhodes University, and a certified Environmental

Assessment Practitioner. He has delivered papers and published in the field of EIA, SEA and ICZM and has been a principal of CES since its inception 22 years ago, and managing director for the past 10 years, during which time the company has grown rapidly.

Dr Chantel Bezuidenhout (Principal consultant) – Project manager
Chantel holds MSc and PhD degrees in Botany (estuarine ecology) and a BSc degree in Botany and Geography from NMMU. Chantel's main focus is estuarine ecology and she has done extensive work on 13 systems from the Orange River Mouth in the Northern Cape to the Mngazi Estuary in the Transkei. As a result she has been involved in a number of ecological reserve determination studies including the Kromme, Seekoei and Olifants systems. Chantel has been an Environmental Consultant for approximately 5.5 years and as such has been focused on environmental management and impact assessment. Chantel is well versed in environmental legislation and has been involved in number of environmental impact assessments and management plans in South Africa, Zambia and Madagascar. She is currently employed in the Port Elizabeth office of CES.

Mrs Kim Brent (Environmental consultant) – Report writing (compilation of ESHIA)
Kim holds a BSc degree with majors in Botany and Geography as well as a BSc (Hons) degree, both from NMMU. Her honours year focussed on Environmental Impact Assessments, environmental management and Geographic Information Systems. Kim’s research projects in her honours year focussed on Plant physiology and Biological factors of the Velddrif Solar Saltworks. Kim’s interests include Basic Assessments, Environmental Impact Assessments, Environmental Management Plans, Environmental auditing, Geographic Information Systems and Botanical assessments. Kim has 3 years’ experience in the consultancy environment and is currently employed in the Port Elizabeth office of CES.

Ms Carina Saranga (Administrative assistant) - **Public Participation Process Facilitation, Compilation of Reports, Quality control**
Carina holds a Bachelor’s degree in Law, with specialization in Public Law (2011), from the University of São Tomás, in Mozambique. She is presently concluding her degree research project on the topic: “Complexity of the resettlement process in Mozambique”. Carina joined CES in 2013 where she is involved in the preparation and coordination of the public participation process, as well as doing field research for a resettlement process. Prior to that, she worked as a public participation assistant, where she liaised with the various interested parties so as to ensure their participation at the public meetings.

1.3.2 Internal specialist team members

Dr Eric Igbinigie (Senior consultant)- Report writing (Waste and By-products)
Eric is a Senior Environmental Consultant and a registered Professional Natural Scientist (Pr.Sci.Nat.). Eric holds a PhD in Environmental Biotechnology and his professional interest is in Sustainable Integrated Environmental Management with a keen interest in Waste & wastewater specialist assessment, Environmental due diligence, Contamination assessment and remediation, and Environmental & Social management compliance audits. Eric has successfully conducted several related local and international environmental projects across Africa in compliance with the requirement of multinational lenders such as the IFC, SWEDFUND, DEG and AfDB, where he served as both specialist consultant and project manager. Before joining CES Eric served as a Senior Research Scientist at the Institute for Environmental Biotechnology, Rhodes University conducting postgraduate lectures and led a research group tasked with the successful beneficiation of coal spoils facilitating the re-vegetation of coal mine dump sites evident in Witbank, South Africa.

Dr Kevin Whittington-Jones (Director) – Reviewer (e.g. Waste and By-products), quality control
Kevin holds a PhD in Environmental Biotechnology and an MSc in Zoology (marine ecology) and is a Director at CES. His professional interests include environmental business risk, management systems, waste management and climate change. Prior to joining CES he held various academic posts at Rhodes University, including that of Senior Lecturer at the Rhodes Investec Business School. Kevin has undertaken environmental work at many of the ports in South Africa, including environmental risk assessments, a climate change risk assessment, strategic environmental assessments and an integrated waste management plan. Kevin has also been involved in a number of industrial EIA projects within South Africa and internationally, both as Project Manager and as a waste management specialist. More specifically, he has conducted specialist waste management studies for the Port of Mossel Bay (South Africa), two heavy mineral mining projects (Egypt and Madagascar), manganese smelters (Kalagadi and Exxaro, both in South Africa), biofuel projects (Sierra Leone and Mozambique), brewery projects (Mozambique) and the Rabai Power Station (Kenya). He is currently managing the EIA for a large biofuel development in Mozambique and the EIAs for numerous wind energy developments.

Dr Cherie-Lynn Mack (Principal consultant) – Report writing (Aquatic Impact Assessment)
Cherie-Lynn holds a PhD and MSc (with distinction) degrees in Environmental Biotechnology, with a BSc degree in Microbiology and Biochemistry. She has postgraduate research experience in industrial and domestic wastewater treatment technologies, with particular emphasis on the coal and platinum mining industries. Her interests lie in the water sector, with experience in ecological reserve determination and water quality monitoring and analysis. She has experience in water quality analysis and industrial wastewater treatment research.

Mr Bill Rowlston (Director) – Reviewer (e.g. Aquatic impact assessment), Quality Control
Bill has more than 35 years' experience in the English and South African water sectors. He spent 24 years with the Department of Water Affairs and Forestry in Pretoria, where he contributed to the development of approaches for protecting water resources, including the determination of the ecological Reserve. Bill was closely involved with the development of the National Water Policy (1997) and the National Water Act (1998), and was responsible for compiling the National Water Resource Strategy, First Edition (2005), much of which he wrote. He also supervised the development of guidelines for the preparation of sub-national catchment management strategies. He joined CES in April 2007.

Ms Tarryn Martin (Environmental consultant) – Report writing (Ecological Impact Assessment)
Tarryn holds a BSc (Botany and Zoology), a BSc (Hons) in African Vertebrate Biodiversity and a MSc with distinction in Botany from Rhodes University. Tarryn's Master's thesis examined the impact of fire on the recovery of C3 and C4 Panicoid and non-Panicoid grasses within the context of climate change. She has spent time at Rhodes University working as a research assistant and has spent many years working within the corporate tourism industry as a project manager. Her research interests include biodiversity conservation, ecotourism and climate change.

Dr Greer Hawley (Principal consultant) – Reviewer (e.g. Ecological Impact Assessment)
Greer has a BSc degree in Botany and Zoology and a BSc Honours in Botany from the University of Cape Town. She completed her PhD thesis (Microbiology) at Rhodes University. Greer has been involved in a number of diverse activities. The core academic focus has been directed in the field of taxonomy both in the plant and fungal kingdom.

Greer's research ranges from studying fresh and marine algae, estuarine diatoms, Restio species classification in the fynbos and forest vegetation and fungal species identification and ecology. Greer's study of fungi have also contributed towards an understanding of soil ecology and "below ground" ecology. Greer has focused here expertise on the study of floral biodiversity and has undertaken numerous biodiversity/ecological studies, with particular reference to the Niassa district in Mozambique. It is also worth noting that Greer undertook a number of studies for the Addax BioEnergy project in Sierra Leone, including the Ecological Impact and Carbon Stock Assessment, contributing towards the development of the biofuel development from concept to implementation. She is currently working on numerous impact assessments at the East London branch.

Mr Thomas King (Environmental consultant) – Report Writing (Traffic and transport Assessment)
Thomas holds a BSc degree with specialisation in Zoology from the University of Pretoria and an Honours degree in Biodiversity and Conservation from Rhodes University. As part of his Honours degree, Thomas was trained in Geographical Information Systems (GIS) and Community Based Natural Resource Management (CBNRM) in addition to the required biological sciences courses. His honours thesis investigated the rate at which Subtropical Thicket recovers naturally after heavy grazing by ostriches (*Struthio camelus*). His interest areas are: climate change and the investigation of possible solutions, waste management, and rehabilitation ecology.

Mr Jan Anton Hough (Social scientist) – Report Writing (Social Impact Assessment)
Anton is a social scientist in the company engaging, amongst others, in Social Impact Assessments (SIAs), social baseline studies, Social Management Plans, Relocation Action Plans (RAPs) and Public Participation Processes (PPPs). His academic qualifications and accomplishments include a Masters Degree in Sociology obtained from the University of Stellenbosch in South Africa, in addition to one published ISI-listed academic publication and two forthcoming publications. Before CES he has gained experience as a social scientist mostly in the mining and community development sector, but also the socio-environmental arena; the latter for which he has published web-based articles on socio-environmental concern in Africa.

Mr Lungisa Bosman (Senior consultant) - Report Writing (Social Impact Assessment)
Lungisa holds a Bachelor of Social Science (1993) from UCT, with majors in Public Administration & Sociology, and a Post Graduate Diploma in Organisation and Management. Lungisa has gained considerable experience in social facilitation and community education and has been involved in a number of projects where he has brought his facilitation skills to bear. These include the ADM and Chris Hani State of Environment studies.

Mr Roy de Kock (Senior consultant) -Report writing (Land, Natural resource use and Agriculture)
Roy is a Senior Consultant holding a BSc Honours in Geology and an MSc in Botany from the Nelson Mandela Metropolitan University in Port Elizabeth. His MSc thesis focused on Rehabilitation Ecology using an open-cast mine as a case study. He has been working for CES since 2010, and is based at the East London branch where he focuses on Ecological and Agricultural Assessments, Geological and Geotechnical analysis, Environmental Management Plans, mining applications and various environmental impact studies. Roy has worked on numerous projects in South Africa, Mozambique and Malawi.

1.3.3 External specialist team members

Prof W.R. Branch (Faunal Specialist)
Over the years, Prof Bill Branch has been involved in the study and research of fauna, specialising in herpetology. He is currently one of the foremost experts in faunal studies and applications to EIAs in Africa and Madagascar.

Dr Anton Bok (Ichthyology and Aquatic Faunal Specialist)
Anton Bok has a PhD in Ichthyology from Rhodes University (JLB Smith Institute of Ichthyology, now South African Institute for Aquatic Biodiversity or SAIAB) in South Africa and has over 30 years of experience in the field of fish distribution and conservation management of aquatic systems in Southern Africa. He has conducted fish ecological surveys and provided specialist input for EIA projects impacting on sensitive aquatic environments (including impacts of proposed mining operations) as a fish specialist throughout South Africa, Mozambique and the Democratic Republic of Congo.

Dr Matthew Ojelede (Digby Wells)– Report writing (Air Quality)
Matthew Ojelede holds a PhD from the University of Johannesburg. His main interest has been the public health risk posed by atmospheric dust emissions from gold mine tailings on the Witwatersrand. He has focused on economic opportunities to reprocess the legacy tailing storage facilities to extract residual gold. He has co- authored several articles on tailings. He has closely with the University of the Witwatersrand, University of Pretoria and the National Health Laboratory Service (NHLS) in looking at the “Adverse Health Impacts Associated with Dust Emissions from Gold Mine Tailings” for the Mine Health and Safety Council. At Digby Wells he is responsible for carrying out Air Quality Impact Assessments including dispersion modelling, emissions inventory and baseline assessments.

Vumile Dlamini (Digby Wells) – Report writing (Health Impact Assessment)
Vumile Dlamini is an Environmental Consultant employed within the Environmental Management Services Department, offering support to the Community Health Impact Assessment Division. She holds a Bachelor of Social Sciences (Honours) degree in Environmental Analysis and Management from the University of Pretoria. Before joining Digby Wells, Vumile has spent time as a Client Services Executive under Ernst and Young’s Climate Change and Sustainability Services Department, offering Environmental Auditing and advisory services around sustainable development strategies and frameworks. Vumile is also well versed in Environmental Impact Assessments, GIS and Remote sensing, as well as Environmental Law practices.

Francis Kom (Digby Wells) – Report writing (Geohydrology)
Francis Kom is a French and English speaking Hydrogeologist at Digbywells with over two and a half years of experience as a consultant. He holds an Honours degree in Hydrogeology obtained at the University of the Free State and a BSc Degree in Geology, minor in Chemistry obtained from the University of Buea in Cameroon. He is currently doing his MSc degree in contaminant hydrogeology at the University of Pretoria. Francis has gained lots of field experience for the past two years while working as a field Hydrogeologist in most mining projects all over Africa. His fields of expertise include hydrogeological assessments, mine dewatering management and EIA/EMP assessments, drilling supervision, groundwater contamination investigation and groundwater geophysical exploration which he has done for various mines in and outside of South Africa.

Stephen Fonkem (Digby Wells) – Report writing (Geohydrology)
Stephen Fonkem is a senior environmental consultant and hydrogeologist at Digby Wells. Stephen holds an MSc in hydrogeology from the University of the Free State. Stephen has over 6 years of experience on hydrogeological assessment for a wide range of Southern and West African mining and mineral development projects. He specialises in numerical

groundwater modelling, environmental impact assessment and groundwater resource assessment and management. Stephen is fluent in French, English and Pidgin English.

Hlayiseko Mashaba (Digby Wells) – Report writing (Closure and Rehabilitation Plan)
Hlayiseko Mashaba completed his BSc (hons) in Environmental analysis and management at the University of Pretoria in December 2012. During his honours program, Hlayiseko attended several courses which include Environmental Impact Assessments (EIA), Environmental Compliance, Environmental principles, Urban Geography of SA etc. Hlayiseko joined Digby Wells in April 2013 and is currently working as an Environmental Consultant in the Mine Closure and Rehabilitation Department. He is involved in conducting liability assessments, mine rehabilitation and closure plans.

Brett Coutts (Digby Wells) – Report writing (Closure and Rehabilitation Plan)
Brett Coutts is the unit manager of the biophysical department and has been appointed to assist with the management and co-ordination of all relevant specialist studies that are undertaken by the department. In addition he is responsible for the compilation of the Geographic Information System (GIS) component of Biodiversity Action Plans (BAP). Prior to his appointment, he gained experience as a junior project manager on environmental rehabilitation projects at Hydromulch and then was appointed by Terra Pacis as an Environmental Consultant where his roles and responsibilities included the compilation of Basic Assessment (BA) reports, S&EIR, compilation of Environmental Management Plans (EMP), GIS mapping and Biophysical Studies.

Lukas Sadler (Digby Wells) – Report writing (Noise Impact Assessment)
Lukas Sadler has a B.COM degree in Geography and Environmental Management, including short courses in Environmental Noise Assessments, Environmental Noise Control and Air Quality Management as well as local and international work experience in the environmental sciences field. This includes experience working with projects in accordance with the International Finance Corporation (IFC) and World Bank standards. Lukas has also gained experience working in Africa namely Mali, Senegal, Ghana, Sierra Leone, DRC, Liberia, Mozambique and Namibia. At Digby Wells, Lukas' core focus is working on Environmental Noise impact assessments, which includes baseline noise monitoring surveys, noise dispersion modelling and noise management programmes.

1.4 Details of the client

- Developer's name: Syrah Resources Limited
- Balama Graphite Mine, contact person and designation:
    - Name: Mr Dinis Napido
    - Email: dinis.napido@gmail.com
    - Phone: + 258 (84/82) 554 0440
- Construction will start as soon as all statutory permits and approvals are in place.

2. LEGISLATIVE REQUIREMENTS IN MOZAMBIQUE

2.1 The legislated EIA process in Mozambique

The EIA process in Mozambique is regulated by a number of key acts that include the Constitution of Mozambique as the overarching law in terms of environmental protection. The Environmental Law of Mozambique (Decree 76/98 of 29 December 1998) and the Regulations for the Environmental Impact Assessment Process (Decree No 45/2004) define the principles and actions needed in EIA respectively.

In Mozambique, an EIA process is a legal requirement under the Environmental Law (Law no. 20/97 of 1 October) for any activity which may have direct or indirect impacts on the environment. These are regulated by the Environmental Impact Assessment Regulations (Decree no. 45/2004 of 29 September and Decree no. 42/2008 of 4 November, which amends some articles of Decree no. 45/2004). Article 2 of Decree no. 45/2004 states that EIAs required for oil, gas and minerals resources related activities or developments are regulated by specific regulations.

In Mozambique, there are regulatory requirements specific for mining operations which outline the need for an EIA for mining activities. In respect of mining operations, the EIA process is set out by Mining Law 14/2002 of 26th June, Mining Law Regulation- Decree 28/2003 of June 17th and Environmental Regulations for Mining Activities -Decree 26/2004 of August 20th which together compile the environmental regulations for mining operations.

The EIA Regulations define three project categories (A, B, and C). Depending on the category, the extent of the EIA is determined by MICOA (Figure 2). Three categories of projects are defined by the new Regulations (Article 3):

- Category A: Activities presented in Annex I are considered to have significant adverse impacts on the environment and are subject to an EIA;
- Category B: Activities listed in Annex II are those for which potential environmental impacts are less adverse than those of Category A and are subject to a Simplified Environmental Assessment (SEA); and
- Category C: Activities listed in Annex III are exempt from an EIA and SEA, but still require observance of good management practices.

The Balama Graphite Mine project is a Category A project, thus full scoping and EIA reports are required.

The Ministério para a Coordenação da Acção Ambiental (Ministry for the Coordination of Environmental Affairs, or MICOA), established in 1995, paved the way for sustainable environmental management in Mozambique. MICOA is charged with the responsibility of regulating the EIA process, as set out in Regulations on the EIA Process, Decree No 45 of 2004, which replaced those of 1998.

The EIA process in Mozambique is summarised in Figure . Once the category is determined, the EIA process begins. An EIA report (and specialist reports) are prepared and disclosed to the public; these reports, together with a Public participation Report are then submitted to MICOA, who review the reports. MICOA may request clarification on some issues, after which a final set of reports must be submitted to them. The final report may be rejected, meaning the development cannot go ahead, or accepted with certain conditions. If the EIA is accepted by the authorities, the proponent must pay for the environmental license, which is then issued by MICOA.

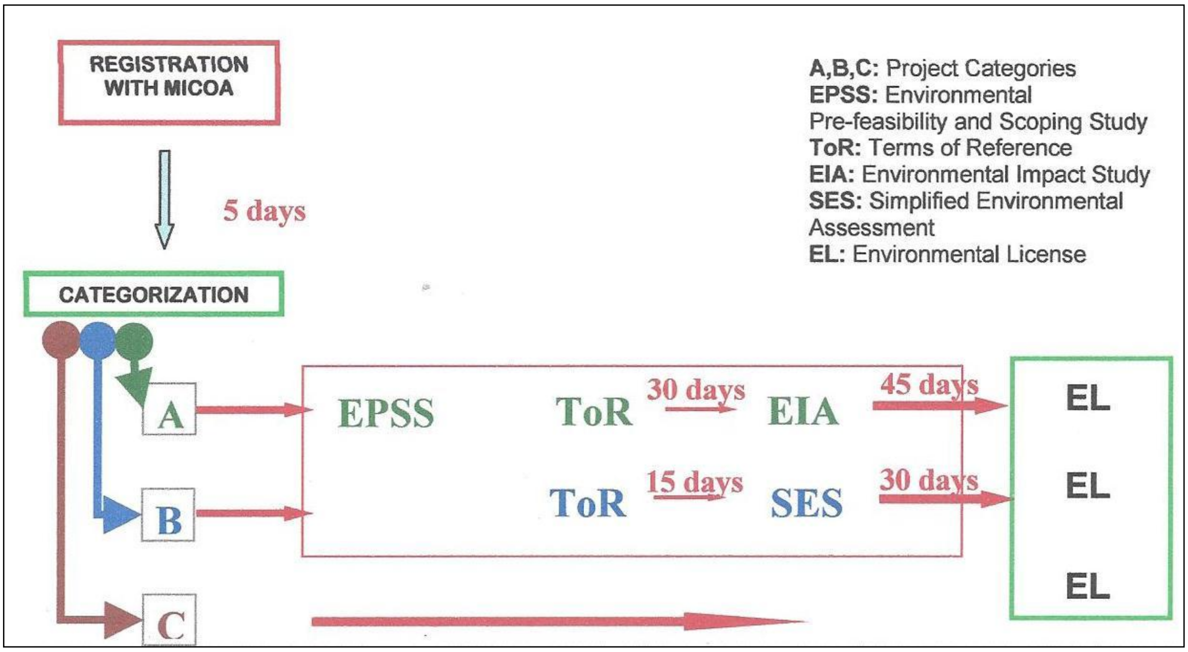

Figure 2.1: EIA process flow diagram (maximum periods allocated for report revision/approval by MICOA are indicated in red).

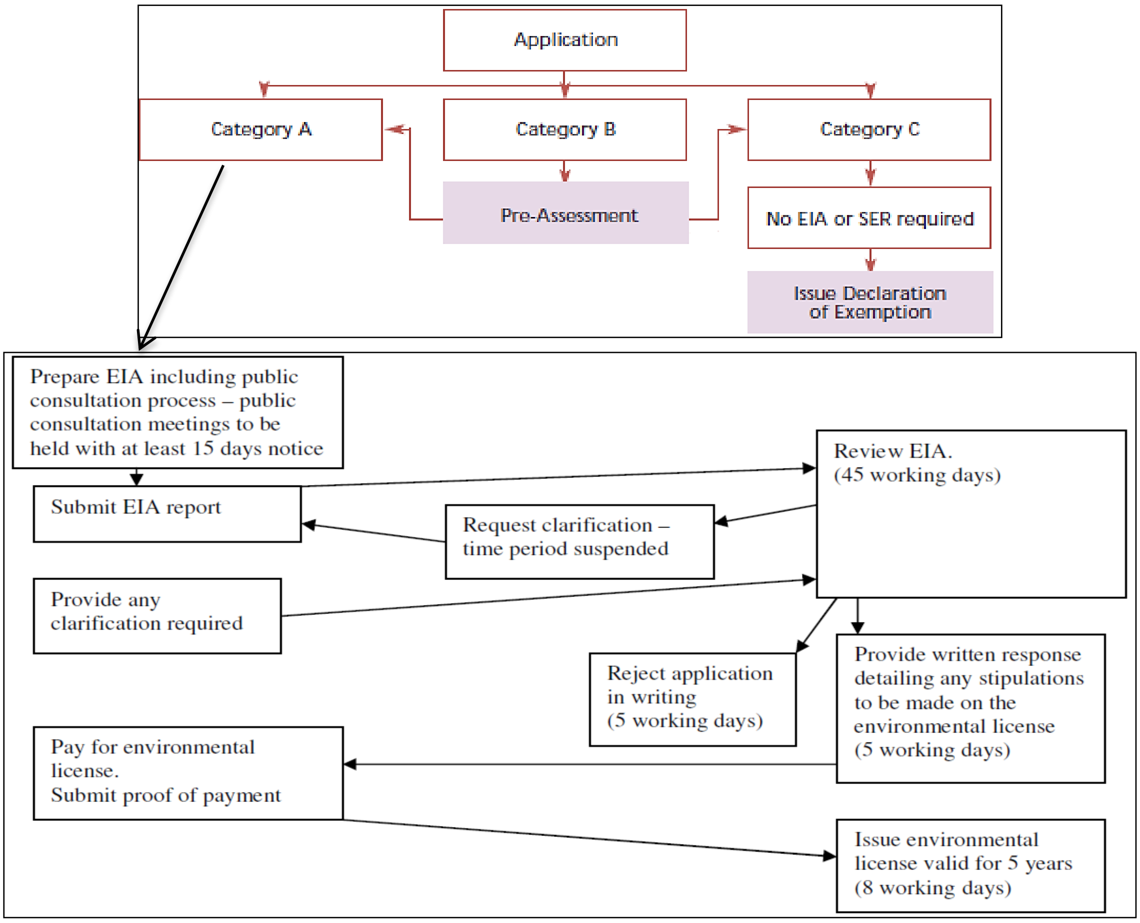

Figure 2.2: The EIA process in Mozambique

2.1.1 The Constitution of Mozambique

The Constitution of the Republic of Mozambique, November 16, 2004- Article 98.1 specifies that any natural resources located in the soil and subsoil, in domestic waterways, in territorial ocean waters, on the continental shelf and in the exclusive commercial zone are the sole property of the State. Article 102 authorizes the State to promote knowledge and inventory and assessment of natural resources and determination of the conditions for their use and enjoyment with protection of the interests of the country.

2.1.2 The Environment Law - Law nº 20/97

The Environmental Law aims to define the legal basis for the sound use and management of the environment and its components for the purpose of forming a system of sustainable development in Mozambique. The Environmental Law is applicable to all public or private activities, which may influence the environment either directly or indirectly. The law requires that activities, that by their nature, location or dimensions, are likely to cause significant environmental impacts be licensed by MICOA, based on the outcomes of an EIA process. Some of the core principles for environmental management contained in the Environmental Law and applicable to this Project are:

i. The rational management and use of environmental components that envisage the improvement of the quality of life of the citizens and the protection of biodiversity and ecosystems;
ii. The recognition and valuation of traditions and the knowledge of local communities;
iii. The priority for establishment of systems to prevent actions that are harmful to the environment;
iv. A holistic and integrated perspective of the environment;
v. The importance of public participation;
vi. The polluter pays principle; and
vii. The importance of international co-operation.

The Environment Law (Lei do Ambiente), Law nº 20/97, of 1 October is the foundation for the whole set of legal instruments regarding the preservation of the environment. This is an umbrella law for environmental matters and is an important instrument for the enactment of specific regulations. It provides the overarching principles and foundations for all forms of environmental legislation, policy and practice. Its overall objective is defined as follows:

"*Article 2: The current Act has the objective of defining the legal basis for the utilisation and correct management of the environment and its components, with a view of ensuring a system of sustainable development in this country*."

Article 8 of the Environmental Law requires that the Government creates adequate mechanisms so as to involve the various sectors of civil society, local communities and environmental protection organizations in the preparation of policies and legislation for the management of the country's natural resources.

Article 9, related to environmental pollution prohibits the production and deposit of any toxic and polluting substances on soils, sub-soils, water or atmosphere as well as the conduct of activities that will tend to accelerate erosion and desertification, deforestation or any other form of environmental degradation beyond the limits established by law.

While Article 15 and 16 give a legal basis for EIA in Mozambique, they do not provide the specific regulations and criteria needed to ensure due process. As such, supporting legislation has been promulgated.

As established in Article 2, the objective of the Environment Law is to define the legal basis for judicious utilisation and management of the environment and its components, with a view to achieving sustainable development in the country. The ambit of the Environmental Law comprises all activities public or private, which directly or indirectly may influence the environment.

Taking into account the constitutional provision for "*an ecologically balanced environment*" for all citizens, Article 4 of the Law establishes, *inter alia,* the following basic principles for environmental management:

i. Rational utilisation and management of the environment with a view to the promotion of improved quality of life of citizens and for the maintenance of biodiversity and ecosystems;
ii. Recognition of traditions and local knowledge which may contribute to the conservation and preservation of natural resources and the environment;
iii. Precaution - in the sense that activities that might harm the environment must be prevented even if there is insufficient scientific certainty on the likelihood of the occurrence of such impacts;
iv. A global, integrated vision of the environment as a grouping of interdependent ecosystems which must be managed in such a way as to maintain their functional equilibrium without exceeding their intrinsic limits;
v. Public participation;
vi. Equitable access to natural resources by all; and
vii. Commitment to minimising trans-boundary impacts.

In legal terms, principles can be defined as statements expressing the direction of the law. The above principles are central to the Environmental Law, as they contain the main policy statements regarding the environment.

The Environmental Law sets out the following:

- Chapter I General Dispositions including definitions;
- Chapter II Environmental Management Institutions;
- Chapter III Environmental Pollution;
- Chapter IV Special Measures for Environmental Protection;
- Chapter V Prevention of Environmental Damage;
- Chapter VI Citizen's Rights and Duties;
- Chapter VII Exercise of Economic Activities;
- Chapter VIII Environmental Supervision; and
- Chapter IX Final Dispositions.

Chapter V of the Environment Law refers to the Prevention of Environmental Damage. Under this clause, licensing of activities that are liable to cause significant environmental impacts is required. The issuance of an Environmental Licence is dependent on the appropriate level of EIA being completed and accepted by MICOA. Importantly, the Environment Law obliges all sectorial legislation that deals in any way with the management of components of the environment to be reviewed and revised so that it is in conformity with the new act (Article 32).

2.1.3 Licences

Article 15 of the Environmental Law states that the licensing and registration of activities which may cause a significant impact on the environment must be carried out according to the EIA regulations and that the issuance of an Environmental Licence must be based upon an approved EIA for the proposed activity. The Environmental Licence is a pre-requisite to the issuance of any other licence or permit which may be legally required. The activity for which an Environmental Licence has been issued has to start within 2 years from the date of the issue of the licence. If the developer fails to commence his activity within that period, he can request permission from MICOA to extend the licence period, in writing, no less that 90 days before the licence expires. MICOA will then decide to extend the period of validity, request new information or request a new EIA. Environmental Licences for Category A projects will be valid for a period of 5 years, renewable for an equal period. The application for renewal has to be submitted at least 180 days before the licence expires.

2.1.4 Water Law -Law no.16/1991

The National Water Policy (Resolution No.46/2007, dated October 30) and Water Law (Law no.16/1991, dated August 16), is based on the principles of environmental sustainability, the Water Law establishes the water resources that correspond to the public domain, water management principles, the need to inventory all water resources that exist in the country, the general regime for their use, general rights of users and the corresponding obligations, among other items. The Regulation regarding water licensing and concessions (Decree no. 43/2007 dated October 30), regulates the process to obtain the rights of private use and benefit of water. This regulation gives special attention to environmental issues, requesting an EIA, Environmental License or its official exemption as a condition to obtain the rights for water use. An application for a water license will be required for this project in terms of the Law.

The discharge of effluents is also subject to a specific license or concession. The surface water body or aquifer where the effluent will be discharged must be identified, or where these will be discharged on land, the following parameters are identified: the discharge point, quantity, volume and frequency, as well as the nature and composition per volume unit and the known temperature, proposed treatment methods, equipment and facilities required. The methods proposed to measure the effluents and the expected impacts on the environment as well as the methods that will be used for analysis and control shall also be included.

2.1.5 Regulation regarding Standards for Environmental Quality and Discharge of Effluent (decree no. 18/2004, dated June 2)

This Regulation defines the environmental quality and effluent emission standards for receiving bodies of water, treatment technologies, systems and methods. It governs the elimination of liquid industrial effluent into the receiving environment, which must be carried out through an appropriate entity. The final effluent must be discharged in accordance with certain emission or discharge standards. It requires that the location of the point of discharge or emission be determined during the environmental licensing process so that there is no change to water quality in the receiving body. The discharge of liquid effluent or pollutants that affects or may affect swimming areas must be controlled based on sanitary quality monitoring of the respective waterways and beaches.

This legislation was taken into account during the development of mitigation measures as part of the ESHIA and environmental management plan.

Atmospheric emissions and air quality are regulated by Decree no.67/2010, dated December 31 (amendments to Appendix I and inclusion of Appendices 1A and 1B to Decree No.18/2004, dated June 2). This Decree, among other items, amends Air Quality Standards and adds Appendices 1A and 1B which cover organic and inorganic carcinogenic atmospheric pollutants and substances with odorous properties, respectively. Parameters are set for atmospheric, water and soil pollution as well as for noise pollution. The legislation also deals with extraordinary emissions resulting from accidents or other unusual circumstances. In such cases, and in accordance with the principle of “polluter pays”, the organisation responsible for the emission is required to obtain a licence from MICOA and pay a fee.

Another regulation, Resolution no.78/2009, dated December 22, is related to the management of substances that destroy the ozone layer. This Law is intended to establish the environmental quality and effluent emission standards intended to control and maintain admissible levels of pollutant concentration in environmental components.

2.1.6 The Land Act (No.19/97 and decree No 66/98)

As people generally reside on customary land the Land Act of 1997 is applicable. The law provides the legal framework for land ownership, as well as the control of land and natural resources in Mozambique. The process of determining land rights is also explained by this law.

The law was created with the intention of encouraging the use and benefit of land, such that it contributes to the development of the national economy. The law establishes the terms under which all activities - relating to the right of land-use and benefits - operate (Article 2). It provides the basis for defining people’s land-use rights, and gives details on these rights based upon customary claims and the procedures for the acquisition of title for use and benefits by communities and individuals. The law recommends a consultation-based process that recognises customary rights as the means for identifying the claims of communities and individual members of communities without title.

Article 24 identifies that, in rural areas, local communities need to participate in:

a) The management of natural resources;
b) The resolution of conflicts;
c) The process of obtaining title as established in No. 3, of Article 13 of the Land Law; and
d) In the identification and definition of the boundaries of the land they occupy.

In the first two activities (a and b), local communities rely on, among others, customary practices.

The Land Law also defines that the right to use land may be acquired through occupation by Mozambican individuals who have been using the land in good faith for at least ten years. The law therefore recognises and protects the rights of individuals to land acquired through inheritance or occupation (customary tenure and good faith rights), except in legally defined reserves or areas where land has been legally transferred to another person or body. All citizens have equal rights and duties according to the law.

Existing rights to use land may be terminated through revocation of such rights for reasons of public interest, after the payment of fair compensation, in which case the non-removable improvements will revert to the state.

Foreign individuals or corporate persons may be holders of a right to land-use and benefit, provided they have an investment project that is approved under the investment legislation and they are established or registered under the GoM (Article 11). Total and partial protection zones are part of the public domain, and no right of land-use or benefit can be obtained in these areas (Articles 7 and 9). Total protection zones include those areas specifically intended for conservation or preservation activities, whilst partial protection zones require special licenses, which may be issued for specified activities.

For the purposes of economic activities, the right of land-use and benefit is subject to a maximum period of 50 years, which can be renewed for an additional 50 years (Article 17). The approval of an application for the right of land-use and benefit for economic activities does not preclude the need for licensing and authorisation required by:

a) The legislation relevant to the intended economic activity (e.g. tourism); and
b) Directives of land-use plans (Article 20).

Right to land-use and benefit applications are authorised by provincial governors for areas up to 1,000ha, by the Minister of Agriculture and Rural Development for areas between 1,000-10,000ha, and by the Council of Ministers for areas exceeding 10,000ha (Article 22).

Provisional authorisation is granted after the submission of application for land-use and benefit. This provisional authorisation is valid for a maximum of five years in the case of nationals, and two years in the case of foreigners (Article 25). Upon fulfilment of the exploitation plan within the provisional period, final authorisation will be given and the relevant title issued (Article 26).

2.1.7 Land Law Regulations (2003)

The Land Law Regulations (Decree 66/1998 of 8 December) apply to all areas outside of municipal jurisdiction. According to the regulations, the construction of any type of structure within the partial protection zone shall be licensed by the entities responsible for the management of inland and maritime waters (Article 8).

In accordance with Article 18, the right of land-use and benefit obtained for the fulfilment of an investment project shall have a maximum term of 50 years, renewable in accordance with the provisions of the Land Law and the terms of renewal of the authorisation. A titleholder is required to apply for renewal 12 months before the end of the term fixed in the title, demonstrating that the economic activity which the title was applied for is still being carried out.

Relevant aspects of the regulations include:

a) Where there is joint title, such title belongs to all the titleholders equally. When one of the titleholders dies, the other holders continue as the rightful titleholders;
b) Consultations between the applicants for land and the local community are mandatory before a decision to grant title use is made by the provincial governor or higher authority;
c) Good faith occupiers and local communities may apply for demarcation and title; and
d) Titleholders are required to pay a tax for authorisation of the right to use land, plus an annual tax. Family businesses and local communities are exempt from such taxes.

Article 24 states that, in order to acquire a right of land-use and benefit, an application under authorisation must be submitted including the following information:

a) Articles of association (in the case of a corporate person);
b) A sketch of the location of the land;
c) The descriptive report of the project;
d) An approximation of the nature and size (footprint) of the development the applicant proposes to undertake;
e) The opinion of the district administrator, after consultation with the local community;

f) A public notice, and verification that such a notice has been displayed in the headquarters of the relevant district and at the location itself, for a period of 30 days; and
g) A receipt of proof of payment of the provisional authorisation fee.

Additionally, where land is intended for economic activity, the application must also contain an exploitation plan and technical opinion thereof. In the case of private investment projects, the land is subject to prior identification, which must involve the Cadastre Services, the local administrative authorities, and the local community, and must be documented in the sketch and descriptive report (Article 25).

According to Article 28, in cases where the governor of the province is the competent authority, once the application process is complete, the Cadastre Services will submit the proposal to the governor of the province for a decision. In all other cases the application form will be sent to the central Cadastre Services after review by the governor of the province, who will submit it to the competent authority for decision. The authorisation granted here will be temporary, valid for five years in the case of Mozambican nationals, and two years in the case of foreigners.

Once the term of the provisional authorisation has expired, or at the request of the applicant, an inspection will be conducted to ascertain whether the proposed activity is in agreement with the approved schedule. Once this has been established, a definitive authorisation and accompanying title of the use and benefit of land will be issued (Article 31).

Lastly, Article 3 of the Technical Annex to the Land Law Regulations states that the delineation of areas occupied by local communities will not prevent economic or other activities from being conducted, provided that consent is obtained from the communities. It is essential that the local community be actively involved and consulted in the demarcation process. The Technical Annex also provides forms to be completed and submitted as part of this participatory demarcation process.

2.1.8 Decree 31/2012 - Regulations of Resettlement Process resulting from Economic Activities

Establishes the basic rules and principles governing the process of resettlement in Mozambique.

Creates a Technical Commission for the review of Resettlement Action Plans (RAP) triggered by projects causing resettlement, and defines the Commission’s responsibilities and procedures for the approval of the RAP as well as the follow-up to its implementation. This responsibility falls under the District Government.

Introduces specific procedures for the design and the implementation of the RAP. It defines the contents of the RAP and the Resettlement Implementation Action Plan, the rights of PAPs, the responsibilities of the project proponent and the implementation of the public consultation process. Introduces specific procedures for the design and the implementation of the RAP: it defines the contents of the RAP and the Resettlement Implementation Action Plan, the rights of PAPs, the responsibilities of the project proponent and the implementation of the public consultation process.

Mozambique’s Regulations on the Resettlement Process resulting from Economic Activities were passed in 2012. The regulations consist of 28 Articles which basically formulate the procedures for any resettlement in Mozambique, and especially articulate the assistance required from government during a resettlement process. These regulations require that a

Resettlement Action Plan, compliant with all 28 Articles, be prepared. A RAP, focusing on the following Articles has been prepared as Part 6:

- Articles 6 and 7: A Technical Committee

Any resettlement project in Mozambique needs to be enacted and driven through an established government resettlement committee which comprises of various representatives from a selection of government bodies.

- Articles 10 and 14: The Rights of the Affected Population and Right of Information

Article 10 lays down some basic, fundamental human rights as these pertain specifically to resettlement. These rights are elaborated upon under Article 14. Some of the most important rights include people’s rights to:

- “*Have re-established their income level, to equal or higher than that before the resettlement;*
- *Have restored their living standard to equal or higher than before the resettlement;*
- *Have space to perform their subsistence activities; and*
- *Give opinion in the whole resettlement process” (2012:p.5).*

- Article 12: Responsibilities of Central and Local Levels of Government

Article 12 delineates the responsibilities of central and local government. Some of these responsibilities include the Land-Use Planning Sector’s responsibility to provide technical assistance to the implementation in matters related to land-use planning, as well as to monitor the resettlement process.

- Articles 13 and 22: Public Participation and Consultation

Public participation is central to the success of a resettlement project. Both these articles articulate specific requirements which a RAP should adhere to.

2.1.9 The Fisheries Law No 3 of 1990

As the local population use the local river streams for subsistence and commercial fishing purposes, the Fisheries Law of 1990 is also relevant to the project. As the proposed mine may affect local fish populations and the water quality of the rivers and local streams, it triggers the regulations under this law.

2.1.10 National Heritage Protection Law of 1988

The project might affect and/or disturb areas of cultural significance, as well as gravesites and tombs. Therefore, the National Heritage Law of 1988 is applicable. The Regulations on the Protection of Archaeological Heritage Property (1994) state that the ministry must be consulted in the event where archaeological material is found.

2.1.11 Forest and Wildlife Act No 10 of 1999

One of the main objectives of the law is to assist in conserving and utilising the forests and wildlife resources for the social, ecological and economic benefits of the future generations (Development Bank of Southern Africa, 2007). The law also identifies protected areas, including cultural and heritage sites.

The law is divided into nine chapters. Of relevance to this SIA are the following chapters:

- Chapter 2 on the Protection of Forest and Wildlife Resources; and
- Chapter 3 on Sustainable Forest Resources, Exploitation Regimes and Sustainable Wildlife Conservation Regimes.

2.1.12 Land Planning Law (Law 19/2007 of 18 July)

Implemented Decree No. 23/2008 approving the Regulation on Land Use Management. The law to establish the legal framework for implementing the Government's land planning policy, its aims include promoting rational and sustainable use of natural resources, preserving a balanced environment and improving living standards and housing conditions. It introduces a land management system, sets out land planning powers at different levels and establishes citizens' rights, duties and guarantees in the land planning process.

This Law, consisting of 6 Chapters, aims at regulating the territorial planning of Mozambique, in order to guarantee the organization and sustainable use of the environment. It establishes regulations for the following sectors: General provisions (Chap. I), Territorial Management System (Chap. II), Territorial Planning Tools (Chap. III), Citizen Rights and Obligations (Chap. IV), Evaluation, Monitoring and Inspections (Chap. V).

2.1.13 Decree n.º 61/2006 of 26 December - technical Regulation on Safety and Health in Mining Activities Geologic

This decree supplies detailed rules on matters such as mine safety, worker health standards and first aid, transportation of people and ore, ventilation standards, use of electrical equipment underground, use of explosives, protection against fire and safety equipment. It also provides for inspection and fines and fines and penalties in the event of non-compliance. The Regulation on Mine Work Safety covers activity in both the exploration and (in greater detail) mining stages, covering a broad variety of circumstances.

2.1.14 Decree no 67/2010, dated December 31 (amendments to Appendix V to Decree no. 18/2004, dated June 2)

This decree amends the Standards for Receiving Entities (sea, ocean), now including Table 1 relative to potentially hazardous chemicals substances and Table 1A, relative to potentially harmful chemical substances (pesticides).

This Decree amends articles 23 and 24 and Annexes I and V of the Regulation on Environmental Quality and Effluents' Emissions, related to taxes for special authorizations and new fines and sanctions for illegal activities. Annexes IA and IB deals new standards of air quality, atmosphere polluting agents and parameters for carcinogenic Inorganic and Organic agents. Annex V lists potentially harmful chemical substances.

2.1.15 International Environmental Conventions to which Mozambique is signatory

Mozambique is a signatory to a number of international environmental conventions which are applicable to this project. Some of the more important conventions are listed in Table 2.1 below. Note that a Protocol of Signature is an instrument subsidiary to a treaty, and drawn up by the same parties. Such a Protocol deals with ancillary matters such as the interpretation of particular clauses of the treaty, those formal clauses not inserted in the treaty, or the regulation of technical matters. Ratification of the treaty will normally *ipso facto* involve ratification of such a Protocol.

When Countries become signatory to Conventions, Protocols, Treaties and Agreements; they accede to incorporate the conventions principles and standards into their legislation. Either new laws are developed or as in most cases regulations are drawn up or amended.

This is done to ensure compliance by the countries citizens and to provide measures to be able to enforce the protocols. Thus the table provides details on the conventions, however, it is noted that compliance to Mozambique legislation would ensure compliance to the conventions.

Table 2.1: International Environmental Conventions to which Mozambique is a signatory

INTERNATIONAL CONVENTIONS	
Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal	1989
African Convention on the Conservation of Nature and Natural Resources	1968
(Amended)-Revised African Convention on the Conservation of Nature and Natural Resources (Amended Version) Not yet in force. Mozambique is a party and would be bound upon entry into force	2003
Constitutive Act of the African Union	2000
Bamako Convention on the Ban of the Import into Africa and the Control of Trans boundary Movement and Management of Hazardous Wastes within Africa	1991
Convention on Biological Diversity	1992
Convention on International Trade in Endangered Species of Wild Fauna and Flora (Cites)	1973
UN Convention Concerning the Protection of World Cultural and Natural Heritage	1972
Kyoto Protocol to the UN Framework Convention on Climate Change	1998
Convention on Wetlands of International Importance Especially as Waterfowl Habitat (RAMSAR)	1971
Stockholm Convention on Persistent Organic Pollutants	2001
UN Framework Convention on Climate Change (read with Kyoto Protocol)	1992
International Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa	1994
African Charter on Human and Peoples' Rights	1981
Agenda 21	1997
UNESCO	1972

2.2 International Legislation and Guiding Principles

2.2.1 IFC Performance Standards and requirements

The IFC is a member of the World Bank Group, and one of the largest development institutions that focuses exclusively on the private sector in developing countries (IFC, 2012)[1]. The IFC was established in 1956 and works in developing countries to create job opportunities, generate tax revenue, improve corporate governance and, perhaps the most important of all, ensuring that project contribute to the upliftment of its countries' local communities. In respect of the latter, it is also the IFC's vision for people to be presented with the opportunity to escape poverty and improve their lives.

The IFC published its Performance Standards (PS) on Environmental and Social Sustainability in April 2006, and published comprehensive Guidance Notes in April 2007.

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[1] IFC. 2012. About IFC. [Online]. Available: http://www1.ifc.org/wps/wcm/connect/115482804a0255db96fbffd1a5d13d27/PS_English_2012_Full-Document.pdf?MOD=AJPERES [2012, October 26].

The PSs were revised in 2012 (cf. IFC, 2012).

The IFC's PSs are exclusively tailored for managing projects and general project requirements for IFC support. In addition to these standards, the IFC also published supporting Guidance Notes on each standard, which provides guidance to clients and the IFC staff in order for projects to effectively meet the PS.

The objectives of each of the performance standards are set out in Table 2.2 below:

Table 2.2: The International Finance Corporation Performance Standards (January 2012)

PERFORMANCE STANDARD	KEY OBJECTIVES
PS 1: Assessment and management of environmental and social risks and impacts	• Identify and assess social and environment impacts, both adverse and beneficial, in the project's area of influence; • Avoid, or where avoidance is not possible, minimise, mitigate or compensate for adverse impacts on workers, PACs and the environment; • Ensure that PACs are appropriately engaged on issues that could potentially affect them; and • Promote improved social and environmental performance of companies through the effective use of management systems.
PS 2: Labour and Working Conditions	• Establish, maintain, and improve the worker/management relationship; • Promote the fair treatment, non-discrimination and equal opportunity of workers, and compliance with national labour and employment laws; • Protect the workforce by addressing child labour and forced labour; • Promote safe and healthy working conditions; and • Protect and promote the health of workers.
PS 3: Resource efficiency and pollution prevention	• Avoiding or minimising adverse impacts on human health and the environment by avoiding or minimising pollution from project activities; and • Promoting the reduction of emissions that contribute to climate change.
PS 4: Community Health, Safety and Security	• Avoid or minimise adverse impacts on human health and the environment by avoiding or minimising pollution from project activities; and • Promote the reduction of emissions that contribute to climate change.
PS 5: Land Acquisition and Involuntary Resettlement	• Avoid or at least minimise involuntary resettlement wherever feasible by exploring alternative project designs and layouts; • Mitigate adverse social and economic impacts from land requisition or restrictions on affected persons' use of land by: (i) Providing compensation for loss of assets at replacement cost; and (ii) Ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation and the informed participation of those affected; • Improve or at least restore the livelihoods and standards of living of displaced persons; and • Improve living conditions among displaced persons through provision of adequate housing with security of tenure at resettlement sites.
PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	• Protect and conserve biodiversity; and • Promote the sustainable management and use of natural resources through the adoption of practices that integrate conservation needs and development priorities.

PERFORMANCE STANDARD	KEY OBJECTIVES
PS 7: Indigenous Peoples	• Ensure that the development process fosters full respect for the dignity, human rights, aspirations, cultures and natural resource-based livelihoods of Indigenous Peoples; • Avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not feasible, to minimise, mitigate, or compensate for such impacts, and to provide opportunities for development benefits, in a culturally appropriate manner; • Establish and maintain an on-going relationship with the Indigenous Peoples affected by a project throughout the life of the project; • Foster good faith negotiation with and informed participation of Indigenous Peoples when projects are to be located on traditional or customary lands under use by the Indigenous Peoples; and • Respect and preserve the culture, knowledge and practices of Indigenous Peoples.
PS 8: Cultural Heritage	• Protect cultural heritage from adverse impacts of project activities and support its preservation; and • Promote the equitable sharing of benefits from the use of cultural heritage in business activities.

2.2.2 IFC / World Bank Group Environmental, Health & Safety Guidelines

The overarching IFC / WBG EH&S General Guidelines is arranged under the general headings Environmental, Occupational Health & Safety, Community Health & Safety, and Construction & Decommissioning. This will be the primary source of information on Good International Industry Practice (GIIP) for the review, but the sector-specific EHS Guidelines on Mining (December 2007) and Cement and Lime Manufacturing (April 2007) will also be consulted during the review.

The IFC requires that certain issues are addressed in the ESHIA. Table 2. summarises these requirements and details where they can be found in this ESIR.

Table 2.3: IFC requirements for Environmental, Social and Health Impact Assessment Reports

ISSUE	REQUIREMENT	RELEVANT SECTION OF ESHIR
Non-technical Executive Summary	Concisely discuss significant findings and recommended actions in lay language.	Executive Summary
Policy, Legal and Administrative Framework	Discuss the policy, legal, and administrative framework within which the assessment is carried out, including host country regulations, including obligations implementing relevant international social and environmental treaties, agreements, and conventions, IFC Performance Standards, as well as any additional priorities and objectives for social or environmental performance identified by the client. Explain the environmental requirements of any co-financiers.	Chapter 2
Project Description	Concisely describe the proposed project and its geographic, ecological, social, and temporal context, including any related facilities that may be required (e.g., dedicated pipelines, access roads, power plants, water supply, housing, and raw material and product storage facilities). Include facilities and activities by third parties that are essential for the successful operation of the project. Include maps showing the project site and the project's area of influence.	Chapter 3

ISSUE	REQUIREMENT	RELEVANT SECTION OF ESHIR
Baseline Data	Assess the dimensions of the study area and describe relevant physical, biological, socio-economic, and labour conditions, including any changes anticipated before the project commences. Take into account current and proposed development activities within the project area but not directly connected to the project. Data should be relevant to decisions about project location, design, operation, or mitigation measures. The section should indicate the accuracy, reliability, and sources of the data.	Chapter 4 Chapter 5
Social and Environmental Impacts	Predict and assess the project's likely positive and negative impacts, in quantitative terms to the extent possible. Identifies mitigation measures and any residual negative impacts that cannot be mitigated. Explore opportunities for enhancement. Identify and estimate the extent and quality of available data, key data gaps, and uncertainties associated with predictions, and specify topics that do not require further attention. Evaluate impacts and risks from associated facilities and other third party activities. Examine global, trans-boundary, and cumulative impacts as appropriate.	Chapter 6 Chapter 7 Chapter 8 Chapter 9
Analysis of Alternatives	Compare reasonable alternatives to the proposed project site, technology, design, and operation in terms of their potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. State the basis for selecting the particular project design proposed and justify recommended emission levels and approaches to pollution prevention and abatement.	Chapter 10
Management Program	Should consist of the set of mitigation and management measures to be taken during implementation of the project to avoid, reduce, mitigate, or compensate for adverse social and environmental impacts, in the order of priority, and their timelines. May include multiple policies, procedures, practices, and management plans and actions. Describe the desired outcomes as measurable events to the extent possible, such as performance indicators, targets or acceptance criteria that can be tracked over defined time periods, and indicates the resources, including budget, and responsibilities required for implementation. Where the client identifies measures and actions necessary for the project to comply with applicable laws and regulations and to meet the Performance Standards, the management program will include an Action Plan, which is subject to disclosure to the affected communities and on-going reporting and updating.	Volume 3

In addition, the IFC have produced Environmental, Health and Safety (EHS) General Guidelines as well as industry sector EHS guidelines. These guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP).

Box 2.1: Environmental, Health and Safety (EHS) Guidelines:

The following general EHS guidelines are relevant:

1. Environmental
1.1 Air Emissions and Ambient Air Quality
1.2 Energy Conservation
1.4 Water Conservation
1.6 Waste Management

2. Occupational Health and Safety
2.1 General Facility Design and Operation
2.2 Communication and Training
2.3 Physical Hazards
2.4 Chemical Hazards
2.7 Personal Protective Equipment (PPE)
2.9 Monitoring

3. Community Health and Safety
3.1 Water Quality and Availability
3.2 Structural Safety of Project Infrastructure
3.3 Life and Fire Safety (L&FS)
3.4 Traffic Safety
3.6 Disease Prevention
3.7 Emergency Preparedness and Response

4. Construction and Decommissioning
4.1 Environment
4.2 Occupational Health & Safety
4.3 Community Health & Safety

2.2.3 The Equator Principles

The Equator Principles (Box 2.2) are a financial industry benchmark for determining, assessing and managing social and environmental risks to projects. There is close alignment between the Equator Principles and the IFC Performance Standards and Environmental, Health and Safety (EHS) Guidelines, and many financial institutions have committed themselves to the Equator Principles. The Principles represent a voluntary set of environmental and social guidelines for project finance lending. These principles are outlined below and are adhered to in this report.

Box 2.2: The Equator Principles

Statement of Principles
The EPFI will only provide Project Finance and Project-Related Corporate Loans to Projects that meet the requirements of Principles 1-10.

Principle 1: Review and Categorisation
When a Project is proposed for financing the EPFI will, as part of its internal environmental and social review and due diligence, categorise it based on the magnitude of its potential environmental and social risks and impacts. Such screening is based on the environmental and social categorisation process of the International Finance Corporation (IFC).
Using categorisation the EPFI's environmental and social due diligence is commensurate with the nature, scale and stage of the Project, and with the level of environmental and social risks and impacts.
The categories are:
Category A – Projects with potential significant adverse environmental and social risks and/or impacts that are diverse, irreversible or unprecedented;
Category B – Projects with potential limited adverse environmental and social risks and/or impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures; and
Category C – Projects with minimal or no adverse environmental and social risks and/or impacts.

Principle 2: Environmental and Social Assessment
For all Category A and Category B Projects the EPFI will require the client to conduct an Assessment process to address, to the EPFI's satisfaction, the relevant environmental and social risks and impacts of the proposed Project (which may include the illustrative list of issues found in Exhibit II [1]). The Assessment Documentation should propose measures to minimise, mitigate, and offset adverse impacts in a manner relevant and appropriate to the nature and scale of the proposed Project.
The Assessment Documentation will be an adequate, accurate and objective evaluation and presentation of the environmental and social risks and impacts, whether prepared by the client, consultants or external experts. For Category A, and as appropriate, Category B Projects, the Assessment Documentation includes an Environmental and Social Impact Assessment (ESIA). One or more specialised studies may also need to be undertaken. Furthermore, in limited high risk circumstances it may be appropriate for the client to complement its Assessment Documentation with specific human rights due diligence. For other Projects, a limited or focused environmental or social assessment (e.g. audit), or straightforward application of environmental siting, pollution standards, design criteria, or construction standards may be carried out.
For all Projects, in all locations, when combined Scope 1 and Scope 2 Emissions are expected to be more than

100 000 tonnes of CO_2 equivalent annually, an Alternatives Analysis will be conducted to evaluate less Greenhouse Gas (GHG) intensive alternatives. Refer to Annex A for alternatives analysis requirements

Principle 3: Applicable Environmental and Social Standards

The Assessment process should, in the first instance, address compliance with relevant host country laws, regulations and permits that pertain to environmental and social issues.

EPFIs operate in diverse markets: some with robust environmental and social governance, legislation systems and institutional capacity designed to protect the people and the natural environment; and some with evolving technical and institutional capacity to manage environmental and social issues.

The EPFI will require that the Assessment process evaluates compliance with the applicable standards as follows:

1. For Projects located in Non-Designated Countries, the Assessment process evaluates compliance with the then applicable IFC Performance Standards on Environmental and Social Sustainability (Performance Standards) and the IFC / World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines) (Exhibit III [2]).
2. For Projects located in Designated Countries, the Assessment process evaluates compliance with relevant host country laws, regulations and permits that pertain to environmental and social issues. Host country laws meet the requirements of environmental and/or social assessments (Principle 2), management systems and plans (Principle 4), Stakeholder Engagement (Principle 5) and, grievance mechanisms (Principle 6).

The Assessment process will establish to the EPFI's satisfaction the Project's overall compliance with, or justified deviation from, the applicable standards. The applicable standards (as described above) represent the minimum standards adopted by the EPFI. The EPFI may, at their sole discretion, apply additional requirements.

Principle 4: Environmental and Social Management System and Equator Principles Action Plan

For all Category A and Category B Projects the EPFI will require the client to develop or maintain an Environmental and Social Management System (ESMS).

Further, an Environmental and Social Management Plan (ESMP) will be prepared by the client to address issues raised in the Assessment process and incorporate actions required to comply with the applicable standards. Where the applicable standards are not met to the EPFI's satisfaction, the client and the EPFI will agree an Equator Principles Action Plan (AP). The Equator Principles AP is intended to outline gaps and commitments to meet EPFI requirements in line with the applicable standards.

Principle 5: Stakeholder Engagement

For all Category A and Category B Projects the EPFI will require the client to demonstrate effective Stakeholder Engagement as an on-going process in a structured and culturally appropriate manner with Affected Communities and, where relevant, other stakeholders. For Projects with potentially significant adverse impacts on Affected Communities, the client will conduct an Informed Consultation and Participation process. The client will tailor its consultation process to: the risks and impacts of the Project; the Project's phase of development; the language preferences of the Affected Communities; the decision-making processes; and the needs of disadvantaged and vulnerable groups. This process should be free from external manipulation, interference, coercion and intimidation.

To facilitate Stakeholder Engagement the client will, commensurate to the Project's risks and impacts, make the appropriate Assessment Documentation readily available to the Affected Communities, and where relevant other stakeholders, in the local language and in a culturally appropriate manner.

The client will take account of and document the results of the Stakeholder Engagement process, including any actions agreed resulting from such process. For Projects with environmental or social risks and adverse impacts disclosure should occur early in the Assessment process, in any event before the Project construction commences, and on an on-going basis.

EPFIs recognise that indigenous peoples may represent vulnerable segments of project-affected communities. Projects affecting indigenous peoples will be subject to a process of Informed Consultation and Participation, and will need to comply with the rights and protections for indigenous peoples contained in relevant national law, including those laws implementing host country obligations under international law. Consistent with the special circumstances described in with adverse impacts on indigenous people will require their Free, Prior and Informed Consent (FPIC).

Principle 6: Grievance Mechanism

For all Category A and, as appropriate, Category B Projects, the EPFI will require the client, as part of the ESMS, to establish a grievance mechanism designed to receive and facilitate resolution of concerns and grievances about the Project's environmental and social performance.

The grievance mechanism is required to be scaled to the risks and impacts of the Project and have Affected Communities as its primary user. It will seek to resolve concerns promptly, using an understandable and transparent consultative process that is culturally appropriate, readily accessible, at no cost, and without retribution to the party that originated the issue or concern. The mechanism should not impede access to judicial or administrative remedies. The client will inform the Affected Communities about the mechanism in the course of the Stakeholder Engagement process.

Principle 7: Independent Review

Project Finance

For all Category A and, as appropriate, Category B Projects, an Independent Environmental and Social Consultant, not directly associated with the client, will carry out an Independent Review of the Assessment Documentation including the ESMPs, the ESMS, and the Stakeholder Engagement process documentation in order to assist the EPFI's due diligence and assess Equator Principles compliance.

The Independent Environmental and Social Consultant will also propose or opine on a suitable Equator Principles AP capable of bringing the Project into compliance with the Equator Principles, or indicate when compliance is not possible.

Project-Related Corporate Loans

An Independent Review by an Independent Environmental and Social Consultant is required for Projects with potential high risk impacts including, but not limited to, any of the following:

- Adverse impacts on indigenous peoples
- Critical habitat impacts
- Significant cultural heritage impacts
- Large-scale resettlement

In other Category A, and as appropriate Category B, Project-Related Corporate Loans, the EPFI may determine whether an Independent Review is appropriate or if internal review by the EPFI is sufficient. This may take into account the due diligence performed by a multilateral or bilateral financial institution or an OECD Export Credit Agency, if relevant.

Principle 8: Covenants

An important strength of the Equator Principles is the incorporation of covenants linked to compliance.

For all Projects, the client will covenant in the financing documentation to comply with all relevant host country environmental and social laws, regulations and permits in all material respects.

Furthermore for all Category A and Category B Projects the client will covenant the financial documentation:

a) To comply with the ESMPs and Equator Principles AP (where applicable) during the construction and operation of the Project in all material respects; and

b) To provide periodic reports in a format agreed with the EPFI (with the frequency of these reports proportionate to the severity of impacts, or as required by law, but not less than annually), prepared by in-house staff or third party experts that (i) document compliance with the ESMPs and Equator Principles AP (where applicable), and (ii) provide representation of compliance with relevant local, state and host country environmental and social laws, regulations and permits; and

c) To decommission the facilities, where applicable and appropriate, in accordance with an agreed decommissioning plan.

Where a client is not in compliance with its environmental and social covenants, the EPFI will work with the client on remedial actions to bring the Project back into compliance to the extent feasible. If the client fails to re-establish compliance within an agreed grace period, the EPFI reserves the right to exercise remedies, as considered appropriate.

Principle 9: Independent Monitoring and Reporting

Project Finance

To assess Project compliance with the Equator Principles and ensure on-going monitoring and reporting after Financial Close and over the life of the loan the EPFI will, for all Category A and, as appropriate, Category B Projects, require the appointment of an Independent Environmental and Social Consultant, or require that the client retain qualified and experienced external experts to verify its monitoring information, which would be shared with the EPFI.

Project-Related Corporate Loans

For Projects where an Independent Review is required under Principle 7 the EPFI will require the appointment of an Independent Environmental and Social Consultant after Financial Close, or require that the client retain qualified and experienced external experts to verify its monitoring information which would be shared with the EPFI.

Principle 10: Reporting and Transparency

Client Reporting Requirements

The following client reporting requirements are in addition to the disclosure requirements in Principle 5.

For all Category A and, as appropriate, Category B Projects:

- The client will ensure that, at a minimum, a summary of the ESIA is accessible and available online.
- The client will publicly report GHG emission levels (combined Scope 1 and Scope 2 Emissions) during the operational phase for Projects emitting over 100,000 tonnes of CO_2 equivalent annually. Refer to Annex A for detailed requirements on GHG emissions reporting.

EPFI Reporting Requirements

The EPFI will report publicly, at least annually, on transactions that have reached Financial Close and on its Equator Principles implementation processes and experience, taking into account appropriate confidentiality considerations. The EPFI will report according to the minimum reporting requirements detailed in Annex B.

2.3 Key Policy and Legal Institutions

2.3.1 Ministry for Co-ordination of Environmental Affairs (MICOA)

In 1995, Mozambique adopted a National Environmental Management Programme (NEMP) comprised of a National Environmental Policy, an Environmental Framework Law, and an Environmental Strategy. The Ministry for Co-ordination of Environmental Affairs (MICOA) has the mandate to co-ordinate, supervise and monitor environmental management. The Environmental Law gives more precision on the role and powers of this government institution, with a little more emphasis on the natural resources management.

In terms of natural resources management, MICOA has two directorates, namely the National Directorate for Natural Resources Management and the Directorate of Territorial Planning, with the latter also being linked to integrated land use planning. The National Directorate for Natural Resources Management oversees environmental impact assessment studies and monitors environmental sustainability. The Directorate of Planning manages the coastal strip and urban zones, sets standards for planning at district levels and promotes integrated development plans for regional, provincial and district levels.

The responsibility could well overlap with other institutions, such as the Regional Planning Directorate of the Institute of Rural Development (INDER) and the National Institute of Physical Planning (INPF).

2.4 Stakeholder engagement activities

2.4.1 Introduction and requirements

The Stakeholder Engagement process has been carried out to comply with the International Finance Corporation (IFC) requirements for projects of this nature and to satisfy the requirements as entrenched in Mozambican law.

According to International Guidelines the process of community engagement is an on-going process involving disclosure of information. The engagement process includes consultation with all parties that may be affected by risks or adverse impacts from a project. The relevant stakeholders are not limited to the local communities, but also include organisations (such as NGO's and NPO's), and other interested parties. The purpose of community engagement is to build and maintain, over time, a constructive relationship with these communities, and consultation should begin at an early stage in the EIA process, be based on the prior disclosure of relevant and adequate information, including draft documents and plans, and focus on the social and environmental risks and adverse impacts, and the proposed measures and actions to address these. In essence the consultation process must ensure free, prior, and informed consultation with stakeholders and facilitate their informed participation (IFC, 2007).

Both the Mozambican Constitution and Environment Law establish the rights of citizens to have information concerning a project, and to participate in decision-making about activities which may affect them and the environment. A Public Participation Process identifies and consults with interested and affected parties (Partes Interessadas e Affectadas – PI&As), and is a compulsory activity for all Category A projects. A Stakeholder Engagement Process[2] must also be carried out whenever the proposed activity implies the permanent or

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[2] A Public Participation Process (PPP) and a Stakeholder Engagement Process (SEP) are the same, except that the term PPP is used in Mozambique and the term SEP is the preferred international term.

temporary relocation of people or communities, and the relocation of goods or assets or restrictions on the use of or access to natural resources. Article 14 of the EIA Regulations defines the Public Participation Process as an activity that involves public hearings and consultation. For detailed information on the requirements and contents of a Public Participation process the reader should refer to MICOA's Directive for the Public Participation Process published as Ministerial Diploma 130/2006 of 19 July.

The Public Participation Process implies:

- Delivery of information regarding projects to all directly and indirectly affected and interested parties;
- Responding to public requests for explanations on the project; and
- The formulation of suggestions for the project.

The process of public participation includes public consultation and a public enquiry which must be carried out in compliance with directives issued by MICOA. In Mozambique the PPP is divided into two phases, the first one running between the application for pre-assessment of the activity and the submission of the EIA report to MICOA, and the second running between the review of the EIA by MICOA and the issuing of the environmental license. The first phase is the responsibility of the applicant and the second is MICOA's responsibility. However, to comply with international requirements the ESHIR will be disclosed for public review for one month (30 days).

Public participation provides the opportunity for stakeholders to learn more about the proposed project and provide their opinions. These need to be incorporated into the ESHIA process and should be used to guide further phases and help mitigate potential conflict situations early on in the planning process. It must be noted that effective stakeholder engagement is an on-going process and it is not the intention of the ESHIA Stakeholder Engagement Process to achieve the above objectives in their entirety (IFC, 2007c).

2.4.2 Stakeholder Engagement activities to date

Stakeholder engagement is an integral part of socio-economic impact assessment, as the socio-economic impacts of a proposed project are directly linked to the society in which the proposed project exists. Issues and concerns of the potential project-affected population must be considered. Table 2.4 below summarises the stakeholder activities conducted to date. A comprehensive and detailed Public Participation Report is available as Volume IV.

Table 2.4: Stakeholder Engagement Planned Activities

PERIOD	ACTION	PURPOSE	STATUS
Issues gathering phase	Stakeholder Identification	Identify all interested and affected parties	Complete
Issues gathering phase	Stakeholder Consultation	Introduction of the various stakeholders and identification of primary issues	Complete
EPDA phase	Stakeholder Public Meetings	Discussion and presentation of project and its potential impacts, as presented in the Draft EPDA.	Complete
EPDA phase	Stakeholder Consultations	Disclosure of EPDA	Complete
EIA Phase	Stakeholder Public Meetings	Presentation of the Draft ESHIA and discussion of positive and negative impacts.	In Progress
MICOA Phase	Stakeholder Public Meetings/Hearings (if required)	Presentation of the EIA by MICOA and discussions on the issuing of the environmental license.	Pending

Table 2.5: Summary of Stakeholder Engagement Activities for the Scoping Phase of the Project

STAKEHOLDERS	TIME	DATE	LOCATION	PARTICIPANTS
LOCAL COMMUNITIES				
Ncuide Community	10:00	04/03/2013	Nquide	150
Ntete Community	14:00	04/03/2013	Ntete	100
Maputo Community	10:00	05/03/2012	Maputo	80
Pirira Community	14:00	05/03/2012	Pirira	40
FOCUS GROUPS				
Ncuide Youth	16:00	06/03/2013	Nquide	40
Maputo Women	10:00	11/03/2013	Maputo	40
Pirira Women	14:00	11/03/2013	Pirira	30
Maputo Youth	10:00	12/03/2013	Maputo	60
Pirira Youth	14:00	12/03/2013	Pirira	30
Ncuide school teacher	10:00	13/03/2013	Nquide Primary	4
Traditional healers	14:00	13/03/2013	Nquide	5

2.5 Deliverables and specialist scope of work

The EIA requires the preparation of the volume documents:

Part 1: Executive Summary
Part 2: Environmental Impact Assessment Report
Part 3: Environmental & Social Management and Monitoring Programme
Part 4: Public Participation Document
Part 5: Specialist Studies Volume
Part 6: Resettlement Action Plan

The section below defines the terms of reference for all the specialist studies conducted for the Balama Graphite ESHIA in response to the risks identified in the EPDA. A list of specialist studies conducted is presented below:

1. Vegetation Assessment
2. Terrestrial Fauna Assessment
3. Land, Natural Resource Use and Agriculture Assessment
4. Surface Water and Aquatic Assessment
5. Socio-Economic Impact Assessment
6. Waste Management Assessment
7. Traffic, Transport and Visual Assessment
8. Health Impact Assessment
9. Air Quality Assessment
10. Hydrogeology
11. Noise Impact Assessment
12. Closure and Rehabilitation Plan

Wet and dry season surveys are:
- Vegetation Assessment
- Terrestrial Fauna Assessment
- Surface Water and Aquatic Assessment
- Initial baseline socio-economic survey
- Air Quality (dust) Assessment
- Hydrogeology

Dry season surveys are:
- Land, Natural Resource Use and Agriculture Assessment

- Traffic, Transport and Visual Assessment
- Health Impact Assessment
- Noise Impact Assessment

In addition to the specific Terms of Reference (ToR) for each specialist study presented below in Table 2.6, all the studies also include the following:

1. Address all issues and concerns raised by IAPs during the scoping phase.
2. Identify and assess the significance of the impacts of the construction and operation and closure of the mine.
3. Provide practical and realistic recommendations to mitigate impacts.
4. Work in consultation with other specialists to ensure that the linkages between the various systems are understood.

Table 2.6: Terms of Reference for the Specialist Studies undertaken in the EIA Phase of the Balama Graphite Mine Project

SPECIALIST STUDY	TERMS OF REFERENCE
Vegetation Assessment	• Describe and map different vegetation units and ecosystems (e.g. grassland, savannah, riverine etc.) in the mining area. • Describe the floral biodiversity and record the plant species that occur in each vegetation type. • Determine habitat units that perform critical ecosystem functions (e.g. erosion control, hydrological service etc.). • Utilise stratified random approach for plot based botanical surveys in order to describe biodiversity and ecological state of each vegetation unit. • Describe and map rare, endangered or threatened ecosystems. • Define and delineate any wetlands in the study area. • Establish and map sensitive vegetation areas and species of special concern (IUCN Red Data list). • Identify alien plant species, assess the invasive potential and recommend management procedures. • Identify and assess the impacts of the mining and associated infrastructure on the natural vegetation in terms of habitat loss and fragmentation and degradation of key ecosystems.
Terrestrial Faunal Assessment	• Start of wet season and dry season: seasonal, breeding and migration trends. • Identify and list all species of terrestrial vertebrates and selected indicator groups of invertebrates occurring in the mining area, based on the literature, published specimens or site records, and likely occurrences. • Record species of fauna identified in the mining area list by: active searching, opportunistic siting and specimen collection. • Describe any new species or occurrences. • Assess the habitat preference of fauna and use these habitat preferences to assess the presence and abundance of faunal species. • Identify species of Special Concern using reference to the IUCN Red Data List. • Define and map faunal habitats that are sensitive and require conservation. These may need to be defined as No-Go or Restricted Development areas. • Describe current land use impacts on faunal groups. • Identify and assess the impact that mining will have on the different faunal groups and specific species would be significantly affected by the mining proposal.
Land & Natural Resource Use and Agricultural Assessment	The terms of reference for the soil assessment: • Characterise the soil and distribution of soil types. • Characterise land use and capability (including in the new settlement areas). • Develop recommendations for soil management and mitigation measures for soil degradation. • Estimate soil potential linked to current land use.

SPECIALIST STUDY	TERMS OF REFERENCE
	• Identify appropriate crops types and yields, extrapolated from soil and climatic conditions. Terms of reference for the Natural Resource Use and Agriculture Assessments: • To provide a report on the status quo with reference to land use and agricultural activity. • Determine GIS locations of important agricultural areas in proposed mine infrastructure and mine prospect locations. • Develop a land use management plan for mining closure, incorporating conservation and agricultural objectives. • To find ways and means to help the local people to improve their agriculture in mitigation against the loss of the soils resource. • Evaluate the land capability of the area based on the broad soil and climatic analysis and comment on the potential of the area for agriculture and other land uses. • Determine mechanisms of restoring the potential of the mined surface area or previously cropped areas affected by the mine path or footprint. • Engage with the social scientists to ensure that questions related to land use are asked during the social impact assessment, to clarify the complexities associated with current land use and natural resource utilisation. • Identify the most widely used natural resources in the project area and determine whether any of these are spatially limited to certain locations where proposed mining areas will be located. • Identify the main fuel wood trees and assess their abundance and replaceability. • Determine whether any grazing land falls within proposed mine infrastructure and mining areas and map these areas. • Identify and assess the significance of impacts on soils, land and natural resource use that could result from the mining operation.
Surface Water and Aquatic Assessment	• Establish the baseline status of the ecological state and general health of the Chipembe Dam in terms of: o Invertebrate indicator species; o Water and sediment chemistry (metals, nutrients, physical parameters and field measurements); o Fish species; o Riparian Vegetation. • Determine the ecological importance of the dam and any river systems and set minimum indicator thresholds for water quality monitoring. • Identify upstream and downstream water users. • Identify risks of surface water pollution from mining activities.
Socio-economic Impact Assessment	• Describe the local social environment, with particular reference to the communities that will be directly affected by the project. • Determine the number of households (and people) that will need to be resettled as a result of the project. • Determine the current land use of the development area and the areas outside of the development boundary that are likely to be affected. • Assess the significance of potential environmental and social impacts on the local populace and the district. • Evaluate how the project could contribute to community upliftment programmes. • Establish a baseline understanding of current state of livelihoods, income sources, education levels and food security. • Investigate possible effects on livelihoods, income levels, education levels, food security and other factors relevant to the affected communities. • Describe and investigate possible effects on traditional structures and cultural and religious customs.

SPECIALIST STUDY	TERMS OF REFERENCE
	• Consultation with stakeholders should be done in such a way as to contribute to the formulation of a Resettlement Action Plan (RAP). • Develop a monitoring programme to ensure effective implementation of the recommended mitigation measures.
Waste Management Study	• Compile an inventory (identify, describe and, where possible, quantify) of the various waste streams to be generated by sources. This will not require the analysis of solid waste samples. • Briefly describe the processes giving rise to the waste streams and the anticipated volumes and tonnages of waste streams. • Identify and describe the possible impacts of any solid and liquid wastes on the quality of surface and groundwater. • Assess the risks to the health and safety of workers on the mine and processing plants, and residents within the project's area of influence. • Provide recommendations on the most feasible options for the disposal of solid and liquid wastes. • Describe the levels of hazardous waste on-site, paying particular attention to any material that might be regarded as radioactive, and make recommendations for the disposal and/or recycling of these materials. • Relate levels of any potentially toxic waste to recognised international standards, and ensure that any waste management strategy is in line with these standards.
Traffic, Transport and Visual Assessment	The terms of reference for the traffic and transport study: • Describe the mining process with particular reference to traffic and transport issues including a quantification of traffic expected to be generated. • Describe the road route from the mine site to Pemba and Nacala and identify sensitive areas such as bridges, intersections, villages close to the road and potential bottleneck or hazardous areas. The road condition will also be described. • Describe the port with details on: current activities, infrastructure and layout, and ability of the port to accommodate product export. • Review Mozambican legislation pertaining to traffic and transport issues. The terms of reference for the visual assessment: • Identify visually sensitive areas (VSAs) within a pre-selected radius or distance from mining activities and associated infrastructure. • Conduct a site reconnaissance visit and photographic survey of the proposed project to survey natural and cultural features, protected areas, view-sheds and landscape, view sites, and scenic routes. • Conduct a desktop mapping exercise and develop a Digital Elevation Model to establish visual sensitivity. • Produce photomontage images from VSAs in order to provide a description of the potential visual impact. • Determine from the VSAs, the significance of potential visual impacts. • Recommend feasible and reasonable mitigation measures in order reduce visual impacts received by VSAs.

Health Impact Assessment	• Desktop literature review in order to:
	    o Outline the country and community health profile from a desktop perspective including a literature review.
	• A field visit in order to:
	    o Collect primary participatory data in the form of semi-structured focus group discussions with men and women in the different project affected communities.
	    o Gather additional information that was not available in the public domain during the desktop review. This includes collection of information from health facilities, from the national health information management system, as well as from unpublished

SPECIALIST STUDY	TERMS OF REFERENCE
	reports and documents. o Identify key informants and conduct interviews using a semi-structured questionnaire; o View the standards of the local health facilities and functionality of the health management information system. o Visualise the project and location of communities in relation to planned project activities. • Impact assessment process which will: o Consider the potential future health impacts that the proposed project will have on the health of these respective communities. o Determine the existing health needs of the community based on health strategies, infrastructure, programmes, service priorities, delivery plans and challenges. o Based on the existing evidence rank the likelihood and consequence of difference health impacts to outline their significance and prioritisation for mitigation. A confidence ranking will be applied based on the available evidence. o Develop evidence-based recommendations to avoid/mitigate negative and enhance positive impacts resulting from the project at the relevant project stage.
Air Quality Assessment	• Compilation of a baseline assessment based on a desktop study of available climatic data, modelled data and published reports (weather station was commissioned in November of 2012) at the site; • Emissions Inventory based on the mining, processing and ancillary activities at the mine; • Development of a dispersion model based on atmospheric conditions, the emission inventory and measured data; and • Impact assessment of baseline and proposed developments at the mine site.
Hydrogeology	The terms of reference for the ground water assessment: • The aquifer characteristics and potential sustainable yield. • Potential changes in groundwater levels and quality in the surrounding area. • Potential surface water-groundwater interaction. • Groundwater inflow volumes into the mining area over time. • Predict contaminant migration through the area. The terms of reference for the geochemical assessment: • Geochemically characterise the waste rock, ore, tailings and the exposed material on the walls of the proposed pit; • Predict the potential risk of acid, metal and salt precipitation and the quality of leachate from the waste rock dump(s) (WRD), ore stockpile(s), tailings storage facility (TSF), and pit walls over time; • Advise on project design optimisation and assist in the development of mitigation and management measures to avoid or reduce degradation of water quality downstream of the project during construction, operation and post closure; and • Assess the need for, and suitability of, waste materials to be used as an acid neutralising resource; as construction materials, and as WRD covers and a substrate for re-vegetation.
Noise Impact Assessment	• Determine ambient/baseline noise levels at all potential noise sensitive areas (NSAs) such as potential villages close to the mining site and transport routes. • Predict, using models, the impact of noise on NSAs and assess whether the noise levels will be acceptable in terms of relevant national and international threshold limits. • Where possible and practical, recommend mitigation measures that may reduce the negative impacts.
Conceptual Closure and	The framework closure plan includes the following: • A description of the closure objectives and how these relate to the mine

SPECIALIST STUDY	TERMS OF REFERENCE
Rehabilitation Study	operation and its environmental and social setting. • A plan showing the land or area considered for closure. • A summary of the regulatory requirements and conditions for closure. • A summary of the results of the environmental risk report and details of identified residual and latent impacts. • A summary of the results of progressive rehabilitation undertaken. • A description of the methods to decommission each mining component and the mitigation or management strategy proposed to avoid, minimize and manage residual or latent impacts. • Details of any long-term management and maintenance expected. • Details of a proposed closure cost and financial provision for monitoring, maintenance and post closure management. • A plan drawn on an appropriate scale describing the final and future land use proposal and arrangements for the site. • Technical appendices. The rehabilitation plan includes: • Specific actions to be undertaken during construction, operation, decommissioning and closure phases of the mining operation. • Soil and overburden materials handling, to ensure that materials favourable to plant establishment, as well as potential problem materials (such as high metal level, saline soils or potentially dispersive material), are placed in the correct sequence. • Topsoil and subsoil handling procedures, especially those designed to conserve plant, nutrients and soil biota. • Soil amelioration techniques to create conditions favourable for growth, such as the application of lime or gypsum. • Any techniques for conserving and reusing vegetation, including mulch, brush matting for erosion protection and introduction of seed and log piles for fauna habitat. • Landscaping procedures, including the construction of erosion control and water management structures. • Vegetation establishment techniques. • Weed control measures prior to and following rehabilitation. • Fertilizer application. • Follow-up planting and maintenance programs.

3. PROJECT DESCRIPTION

3.1 Introduction

This section provides a detailed project description for the proposed Balama Graphite Mine project in Mozambique.

Twigg Mining & Exploration Lda, a subsidiary of Syrah Resources Limited, has proposed the development of a graphite mine in northern Mozambique, approximately 7 km east from the small town of Balama. The Syrah Balama Project (SBP) is located on a 106 km^2 Prospecting Licence in northern Mozambique, within the District of Balama in the Cabo Delgado province. The project area is approximately 265 km by road (3.5 hours' drive) west of the port town of Pemba, and 515 km to the port town of Nacala, where deep water ports are strategically located (refer to Figure 3.1).

Balama is accessed by a good quality asphalt road from Pemba to Montepuez, a regional town, and then via a 45 km unsurfaced road which is in the process of being upgraded by the Government. An existing unsurfaced road currently links Nquide and Ntete with Balama via a circuitous northern route.

In December 2011, Syrah acquired 100% ownership of the Balama Graphite Project and has since conducted a large diamond drilling resource program to define a graphite resource with a very strong potential to be developed into a mining operation. Syrah aim to produce a high purity graphite concentrate (between 90-99% total graphite content - TGC), with a requirement to preserve flakes. Balama is anticipated to be a very large graphite deposit and excluding market considerations, has the potential to deliver a mine life of 100 years at a process rate of 2 million tpa. A mining license application for a period of 25 years will be submitted (an effective mine life of 23.5 years to allow for closure) with an option to extend for a further 25 years. The plant will operate 365 days per year.

Conventional open pit mining will be used to extract the ore with a base case scenario of 2 million tonnes per annum. Graphite extraction requires a conventional flotation process. The Chipembe dam, located approximately 13 km northwest of the project site, will be the primary source of water for this process.

Infrastructure required for the graphite mine includes:

- A pipeline (±13 km) from the Chipembe dam to the project site;
- Pump houses at the dam and project site;
- Water reservoirs, for process and waste water;
- Internal roads to enable access to various parts of the development and for transportation of materials, equipment, supplies and employees;
- An access road to regional road 242 at Balama, for product transport by road to Nacala port;
- A diesel powered electricity generation plant, inclusive of bunded storage areas for diesel fuel, lubricants and waste oil; and
- An ore processing plant.

The project will also require infrastructure related to auxiliary services including the following:

- Offices
- Accommodation at the project site for approximately 250 people;
- A lay-down area for construction materials and equipment. This area will continue to be used during the operational phase, although the actual area of land required may

be reduced;

- Workshops for repair of equipment and machinery;
- Stores and a lay-down area(s) for equipment, spares and consumables;
- Offices for site staff;
- Ablution facilities and associated sewage treatment plants;
- Security measures

3.2 Syrah Balama Pit and Waste Rock Dump

According to Syrah Resources (2012), the Balama graphite deposit comprises 3 small hills and a ridge that contain graphitic schists (**Error! Reference source not found.**). The apped strike distance of the graphitic schists is over 7 km. The highest grade of graphite is located in east and west target zones (**Error! Reference source not found.**) and it is nticipated that mining will commence in these two areas first.

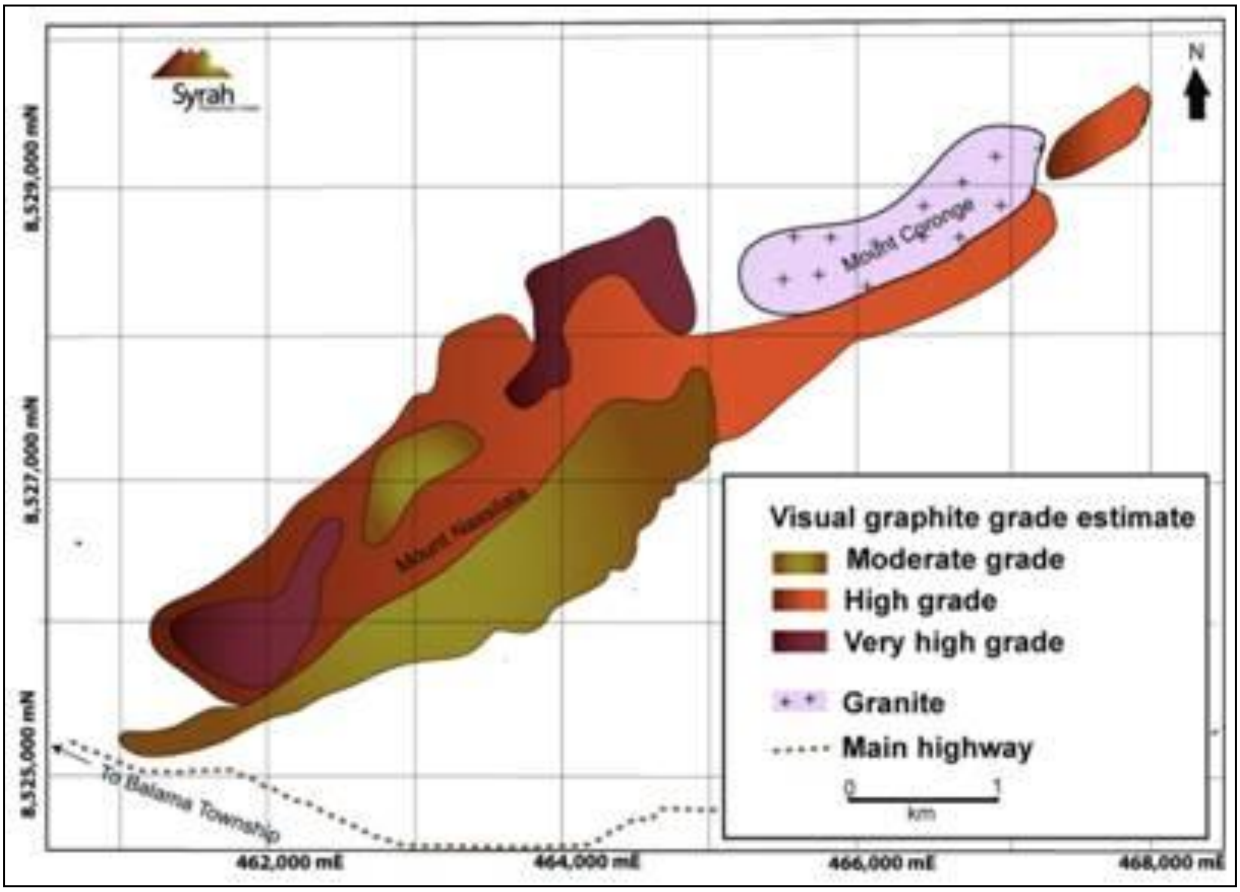

Figure 3.1: Balama Graphite Deposit
(Source: Syrah Resources)

The mine will consist of two open pits, Balama East and Balama West. Balama East is located approximately 1 km east of the process plant, whereas Balama West is located approximately 2.5 km south west of the processing plant.

Both open pits are designed for a maximum depth from surface of less than 50 m. Geotechnical investigation has been completed and the mine pits are designed to have overall wall angles of 55 degrees.

Balama East has effectively no overburden to be stripped initially, but during the life of the mine may have some in pit internal waste rock to be stripped. This will be stockpiled in a waste rock dump adjacent to and north of the Balama East open pit. The waste dumps are constructed by dumping waste rock in layers and once complete, pushing the rock down to result in final slopes of 30 degrees. They will have to be sloped to avoid runoff and surface drains will be designed around the dumps.

Lower grade ore present within the mine has been identified and it may be stockpiled between the open pit and the ROM pad for later processing.

Balama West has waste overburden to be stripped, and during the life of the mine may also have some in-pit internal waste rock. This will also be stockpiled in a waste rock dump adjacent to and north of the Balama West open pit.

Initial mining will be in weathered materials, which have low levels of sulphur. It is sulphur content that dictates, to a large extent, the potential for acid leachate developing and causing acid rock drainage, also called acid mine drainage. Thus, with low levels of sulphur the potential for formation of acid in the waste is reduced. Furthermore, the mined waste will contain carbonates that will neutralise sulphur minerals. The investigations to date have indicated that the resulting mined rock stockpiles will have a low potential for acid drainage, but further work will be completed to quantify this potential. If the potential for acid formation is identified then measures will be put in place to manage these waste rock dumps. This aspect has been investigated in the ESHIA and is reported on Chapter 4 (description) and 8 (impacts).

3.3 Mining Method

Conventional open pit mining techniques have been proposed for the project. Effectively, this will involve the removal of blocks of ore, dug from the open pit of the deposit, for further processing to extract the graphite contained in the ore. During the mining process, the surface of the land is excavated, forming a deeper and deeper pit until the mining operation terminates. The final shape of this open pit is determined before the mining operation begins.

The open pit area will be cleared and any topsoil which will be stockpiled for later rehabilitation. Mining is expected to be completed initially by ripping with dozers to loosen the ore. Drilling and blasting will not be required, as the mine plan indicates that “free dig” material will be mined for the first 25 years. Later in the mine life when mining proceeds below the zones of oxidised rock (about 50 m deep) it may necessary to drill and blast, but this aspect is not covered in this ESIA.

As a safety measure an abandonment bund will be constructed around the open pit to prevent inadvertent access by people into the open pit.

Mining equipment will commence initially with smaller 40t trucks loaded with 40 t excavators to provide suitable equipment for training of local operators. In later stages larger 100t capacity trucks loaded with 100t excavators may be used to load ore onto trucks and to haul it to the ROM pad. Ancillary equipment required to support the mining operation include graders and water trucks to maintain the mine road, and a service truck to provide fuels and lubricant top ups to the equipment.

Minor maintenance of equipment will be completed in the open pit and more major maintenance will be completed in a maintenance workshop located adjacent to the processing plant and offices.

Mobile equipment used is expected to be:

- Wheel loaders
- Excavators
- Dump trucks
- Crawler-tractors (bulldozers)
- Motor graders
- Water truck

The expected fuel usage and carbon emissions are shown in the table below:

Item	**Equipment**	**Utilisation**	**Qty**	**Fuel Usage**		
		%		L/hr	L/shift	L/day
1.0	Light Vehicles	20	8	4	96	192
2.0	Excavator 100t	90	1	85	918.0	1,836
3.0	Dump Truck 777D	80	4	66	2,534.4	5,068.8
4.0	Service Truck	30	0	10		
5.0	Track Dozer D10T	30	1	68	244.8	489.6
6.0	Motor Grader 14H	30	1	17	61.2	122.4
7.0	Drill Rig CHA1100	50	0	20	-	-
8.0	Water Cart 777	50	1	66	396.0	792.0
9.0	Loader 988	90	1	48	518.4	1,036.8
10.0	LT Vehicles	30	10	10	360.0	720.0
11.0	Lighting Tower Generators - Cat C1.1	50	4	4	96.0	192.0
	TOTAL					10,258
	Contingency 15%					1,539
	TOTAL WITH CONTINGENCY L/day					**11,796**
	CO2 Generation t/a					**11,366**

3.4 Mining Method and Processing

The following process description is provided to give a general understanding of the present key operational components. Syrah reserves the right to alter components or process steps in the interests of optimising and simplifying the process.

The main stages in the operation are:

1. Run of mine handling
2. Crushing
3. Milling
4. Flotation
5. Regrinding
6. Thickening

7. Drying and graphite product handling
8. Reagent storage
9. Dust emissions and handling
10. Tailings disposal

These processes are explained more fully below, and the proposed process flow diagram is presented in Figure 3.2.

3.4.1 Run of Mine (ROM) Handling

The ROM pad will be an area of about 200 m x 200m and will be able to store sufficient ore to allow blending of ore of different grades and provide for times when mining is interrupted.

Multiple stockpiles on the ROM pad have been proposed to allow for blending of different ore grades. ROM ore with a top size of 600 mm will be delivered by haul truck from the open pit to the ROM pad stockpile, located close to the crusher.

The ore will be either direct dumped from haul trucks or extracted from the stockpile using front end loaders and fed to the ROM bin. The tipping area will be in close proximity to the stockpiles.

A rock breaker will be used to break oversize material that would otherwise be fed to the crusher.

3.4.2 Crushing

The ROM Ore will be extracted from the bin by a feeder and fed to a primary crusher. Product from the primary crusher is fed to a further screen and crusher. The final crushed and screened rock is conveyed to a coarse ore bin.

3.4.3 Milling

Crushed ore is fed from the coarse ore bin, by feeders, onto a conveyor which in turn feeds the primary mill. The feed rate is controlled by a weight-o-meter installed on the primary mill feed conveyor. The weight-o-meter is also used to measure total ore milled, for monthly accounting purposes.

The feed ore is conveyed to the crusher product screen. The coarse screen oversize material is conveyed to the secondary crusher to reduce the size of the ore. The secondary crusher discharge is returned to the primary mill feed screen. The primary mil feed screen undersize is conveyed to the primary classifier to which water is added. The primary mill operates in closed circuit with a primary classifier. The returning coarse stream from the classifier is fed to the primary mill.

Slurry exits the primary mill and gravitates to a hopper. The mill product is pumped from the hopper to join the primary mill feed screen undersize in the primary classifier. The primary classifier floatation feed product is passed over a trash screen for the removal of oversize, and the undersize discharged into the rougher conditioner tank.
Rods will be used as grinding media for the primary mill. A storage area for the rods will be located in close proximity to the mill.

The mill area will be contained in a sloped bunded concrete containment area to facilitate ease of removal of coarse settled solids by a small front end loader. The area will have a spillage sump and pump. Milling area spillage will be reintroduced to the mill product sump.

3.4.4 Flotation/Secondary Grinding

The primary mill circuit product will be fed into the rougher flotation circuit. A slurry sampling station will be located ahead of the rougher flotation cells. This sample will be used for metallurgical accounting purposes.

The flotation feed gravitates to the first of the rougher cells, and then flows from one cell to another until it reaches the last cell. Tailings are collected from the last cell of the roughers and fed to the secondary classifier in the secondary grinding circuit.

The rougher concentrate is fed to the first of the cleaning stages via a regrind step.

A secondary mill operates in closed circuit with a secondary classifier. The returning coarse stream from the classifier is fed to the secondary mill. The slurry exits the secondary mill and gravitates into a hopper. The mill product is pumped from the hopper to the secondary classifier. The secondary classifier product is fed to the first cell of the scavengers bank of flotation cells.

The scavenger bank consist of scavenger 1 cells and scavenger 2 cells. Scavenger 1 concentrate will be fed to the first of the cleaning stages. The scavenger 1 tails will feed the scavenger 2 flotation cells. The tailings from the scavenger 2 cells are discarded as final tailings, whilst scavenger 2 concentrate is recycled back to the first cell of scavenger 1 for further upgrading.

Tailings from the first cleaning stage are recycled back to the secondary milling circuit, whilst concentrate is fed to the second cleaning stage, via the second regrind step. Tailings from the second cleaning stage are recycled back to the first regrinding circuit whilst concentrate is fed to the third cleaning stage, via the third regrind step.

Tailings from the third stage cleaning step are recycled back to the second stage regrinding circuit whilst concentrate is fed to the fourth stage cleaner. Tailings from the fourth stage cleaning step are recycled back to the third stage whilst final concentrate is taken through a dewatering step.

3.4.5 Regrinding

Concentrate regrind stages in the circuit will be incorporated to provide further size reduction. The regrind stages are arranged in closed circuit. The regrind mill discharge is fed to the classifier, where the coarse stream is fed to a regrind mill, and the ground product feeds into the next cleaning step.

3.4.6 Thickening

Scavenger 2 tailings are transferred to the tailings dam where it will settle and separate from the process water. A return water pump at the tailings dam will collect water and return it to the process pond for reuse. A standby tailings pump will be installed, to ensure sufficient capacity to discard tails. Process water will be recycled to the mill for reuse.

3.4.7 Drying and Graphite Product Handling

Graphite concentrate from the last cleaning stage is pumped to screens ahead of the final concentrate holding tanks. A two stage sample cutter will be installed ahead of the storage tanks for accounting purposes.

Filters are proposed to produce a filter cake of different size fractions at around 10% moisture. The filter cake is then fed to a drier. The drier further serves to reduce the moisture of the cake to less than 1% moisture. The drier will be heated by a diesel or gas boiler. Waste heat recovery from the power station may also be used for drying.

The dry graphite product will then be classified into various size classes before being bagged and dispatched. Dried product will be stored in a warehouse on site. Product will be bagged in 1 tonne bulk bags and loaded into containers for transport.

3.4.8 Reagent Storage

The reagent storage facility will be contained in a sloped, bunded concrete containment area. The area will have a spillage sump and pump. The spillage will be pumped to the tailings dam.

Sodium silicate can be delivered as a liquid of solid. Bulk liquid delivery or solis sodium silicate will be in bulk containers or bags supplied by the manufacturer. Bulk liquid sodium silicate will be dosed directly from the bulk tank to the respective process areas via an appropriately sized pump. Solid sodium silicate will be mixed with water using a vendor supplied mixing facility.

The liquid reagents, collector (kerosene and paraffin) and frother (Dowfroth200 or pine oil) will be delivered in containers supplied by the manufacturers. These will be dosed directly from the bulk tanks to the respective process areas via an appropriately sized pump.

The off-loading area will be clearly demarcated and sufficient provision will be made to contain the entire contents of the bigger of the containers plus 10%, in case of an accident event.
If necessary electrical equipment will be rated for operation in hazardous areas which may arise from the storage and dosing of reagents.

Flocculant will be delivered in bags. Mixing will be conducted using a vendor supplied mixing facility. The bags will be lifted into a hopper/bin, and the bag contents then fed through a screw feeder.

The hopper will be fitted on loads cells, and only the required mass will be transferred into the mixing tank. The reagent mixing area must be properly ventilated and equipped with fume extraction, if required

3.4.9 Dust Emissions and Handling

There are two main sources of dust in the plant, namely crushing and drying, and dust minimisation has been provided for both.

In the crushing section, dust suppression will be provided through water spray. The plant's process water will be used for this purpose. Only a thin mist of water will be supplied in order to minimize the water significantly affecting the ore moisture.

The drying and product handling section will be equipped with a dust extraction system, complete with ducting; extraction fan; a cyclone to remove the dust from the stream; and a bag filter for collection of particulate material. Water vapour will be released to the atmosphere.

3.4.10 Plant Area Containment

A plant area containment pond will collect any water from around the immediate plant area and the water will be pumped to the plant process water pond. This pond and its drainage will provide a second level of containment to that provided by the bunding immediately around the plant.

By using this double containment system the chances of errant water releases from the site have a very low probability, thereby ensuring minimal chances of any downstream runoff.

3.4.11 Tailings Disposal

The TSF will comprise paddock type storage in a 3 cell arrangement with Cell 1 constructed first and cells 2 and 3 later in the mine life. Each cell will be formed by a multi-zoned perimeter earth-fill embankments, comprising a total footprint area (including the basin area) of approximately 62 ha for the Cell 1 TSF (initial cell only) increasing to 265 ha for the final TSF. The three TSF cells are designed to accommodate a total of 72 Mt of tailings and a life of 40 years.

Preliminary water balance modelling indicates the TSF has sufficient storm water storage capacity for all design storm events and rainfall sequences.

The TSF embankments will be constructed in annual raises to suit storage requirements. It has been assumed that upstream raise construction methods will be utilised after the second stage of embankment construction.

The TSF basin area will be cleared, grubbed and topsoil stripped, and a 300 mm thick low permeability soil liner, constructed over the entire TSF basin area, should geotechnical and permeability tests indicate that the TSF must be lined.

Tailings Material

Typically tailings from a graphite ore deposit will be reddish-orange in colour (due to the natural oxidation of the iron in the ore body) and have the texture of coarse sand. The tailings are expected to be benign, as toxic chemicals are not used in the process of extracting graphite from the ore reserve.

The assumed density of the tailings is 1.38 t/m^3, due to the presence of mica in the ore body.

Tailings Deposition

Only one cell of the TSF will be operated at any given time.

The deposition of tailings into the TSF will be sub-aerially from the perimeter embankment to locate the supernatant pond centrally within the facility. The tailings distribution line will run along the deposition areas.

Deposition will occur from multiple spigots inserted along the tailings distribution line. The deposition location(s) will be moved progressively along the distribution line as required to control the location of the supernatant pond. After initial establishment of the tailings beaches, a suitable cycle time will be determined in order to evenly deposit the tailings around the TSF, thereby maintaining the supernatant pond at a suitable location and maintaining the formation of the tailings beach. Supernatant water will be recovered from the TSF and returned to the process facility.

Tailings Management

The sub-aerial technique for tailings deposition allows for the maximum amount of water removal from the facility by the formation of a large beach for drying and draining. Together with keeping the pond size down, sub-aerial deposition should increase the settled density of the tailings, and hence improve the storage potential and efficiency of the facility. During the early stages of operation the deposition plan will be modified to improve the return water efficiency. This will be achieved by using relatively thick tailings layers on the beach to reduce the evaporation. Whilst this will result in lower settled densities initially it should help to reduce water loss from the beaches during the early stages of operation.

The tailings will generally be deposited from along the distribution pipeline in such a way as to encourage the formation of beaches over which the slurry will flow in a laminar non-turbulent manner. The solids will settle as deposition continues and water will be released to form a thin film on the surface of the tailings. This water will flow to the supernatant pond from where it will be removed from the facility by means of decant pumps and returned to the process facility for reuse.

The tailings will initially be deposited in the TSF (cell 1) from the western embankment at the low point of the TSF basin in such a way as to encourage the formation of beaches over which the slurry will flow in a laminar non-turbulent manner, and allow the supernatant pond to migrate up the valley. The solids will settle as deposition continues and water will be released to form a thin film on the surface of the tailings. A degree of segregation of the tailings will occur against the embankment, promoting de-watering of the tailings through the toe drain and thus enhancing stability, consolidation and reducing basin drainage. Tailings deposition will then be moved either side of this initial point to line the basin area whilst controlling the location of the supernatant pond.

Deposition of tailings will be carried out on a cyclic basis with the tailings being deposited over one area of the storage until the required layer thickness has been built up. Deposition will then be moved to an adjacent part of the storage to allow the deposition layer to dry and consolidate. This will facilitate optimum storage to be achieved over the whole area.

After deposition on a particular area of beach ceases and settling of the tailings has been completed, further de-watering will take place due partly to drainage into the underdrainage system but mainly due to evaporation. As water evaporates and the moisture content drops, the volume of tailings will reduce to maintain a condition of full saturation within the tailings. This process will continue until interaction between the tailings particles hinders volume reduction.

During construction and operation, exposed loose soil will be prone to erosion due to wind or water. This will be controlled by localised structures and by management procedures to minimise sediment creation.

Typical management practices will include:

- Minimising exposed areas and maintaining vegetation cover where practically possible.
- Construction during the dry season and using of water sprays to minimise dust.
- Installation of water management structures and erosion protection before commencement of the wet season.
- Continuous rehabilitation.

Tailings Return Water

The TSF design incorporates an underdrainage system to reduce pressure head acting on the soil liner, reduce seepage, increase tailings densities, and improve the geotechnical stability of the embankments. The underdrainage system drains by gravity to a collection tower located at the lowest point in the TSF basin of each cell. In addition, a groundwater collection system will be installed beneath the low permeability soil liner.

Supernatant water will be removed from the TSF via submersible pumps and solution recovered from the decant system will be pumped back to the plant for re-use in the process circuit.

An operational emergency spillway will be available at all times during TSF operation, constructed in the embankment abutment in order to protect the integrity of the constructed embankments in the event of emergency overflow. The preliminary water balance modelling indicates that the TSF design has sufficient freeboard to cater for all design storm events and rainfall sequences thus the operational emergency spillway will not be utilised in these events.

The closure spillway will be constructed to ensure all rainfall runoff from the TSF will safely discharge after operation ceases.

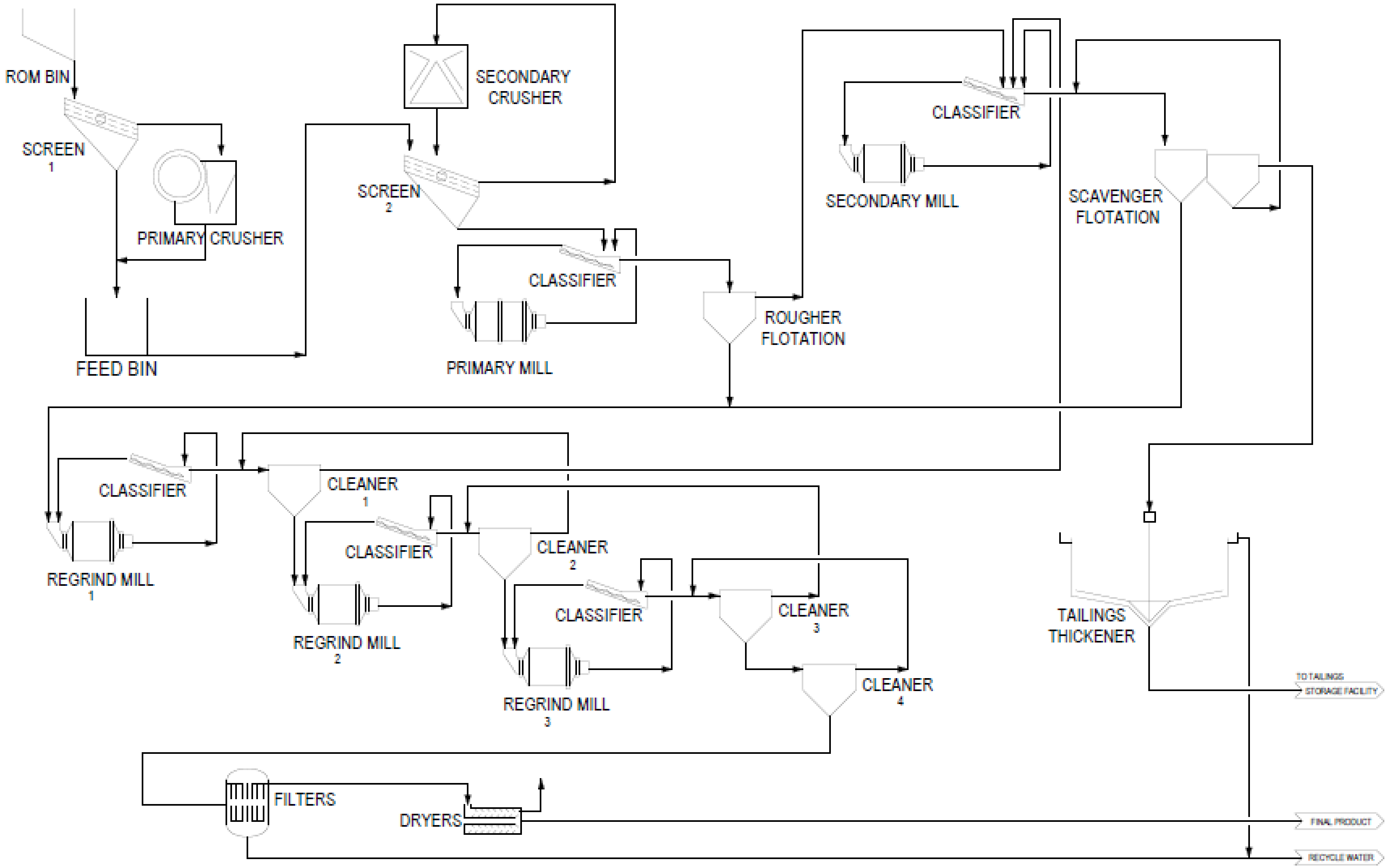

Figure 3.2: Proposed process flowsheet for the Balama Graphite Plant
(Source: Metallicon, 2013)

3.5 Infrastructure

3.5.1 Raw and Potable Water

Chipembe Dam is located approximately 12km from the project site. Completed in 1985 the dam covers approximately 7.1km^2 and has a capacity of close to 24 million m^3. The primary water use was intended to be irrigation, but the planned irrigation scheme has largely failed. This will be the primary source of water during the operational phase of the project. It is estimated that 1 m^3 of water will be required per tonne of ore processed, thus resulting in the minimum water requirements of 2 million m^3 per annum, which is less than 8.5% of the dams volume at full supply level. This requirement of water has been discussed between Twigg (Syrah) representatives and ARA-Norte and the availability has been confirmed (Licence no 07/2012 valid till October 2018). Water will be pumped to site with a pump station located adjacent to the dam via a 13km above-ground pipeline where it will be stored in a raw water storage pond to provide local storage in the event of pipeline maintenance.

Water will be pumped from this pond to a 300 m^3 tank at the offices and a second 300 m^3 tank located at the accommodation village, to be used in the process plant. These tanks will provide water for general use and for fire water storage for fire fighting. Water will be distributed via a pump and piped reticulation system for general use and to a potable water treatment facility that will make potable water to be stored in a potable water tank, and reticulated for use in the office complex, change houses and tea room.

Process water

Tailings return water is pumped to the process water tank. This is to be used for a variety of process applications. Storm water and a portion of the water used for general washing applications will be collected in process water ponds from where it will be pumped to the process water tank.

Process water will be circulated through the plant in a ring main. Each required take off will be fitted with an isolation valve. The mill discharge, flotation feed, scavenger tails and tailings pumps will have flushing water connected to the suction line. The flushing points will be manually operated.

Reagent mixing water, fire water, sample cutter rinse water and gland service water will be supplied from a raw water tank.

Mine dewatering

The mine is not expected to generate large quantities of water. Water in the mine will be collected in sumps and either pumped into water trucks for dust suppression on the mine haul roads or pumped to the process water pond to be used for processing.

3.5.2 Power

A 33 kV, three phase, single circuit power supply, connected to the national grid, runs near to the mine site. The capacity and reliability of this supply is not confirmed, and it may not have the capacity to provide the entire mine site power requirement. Additionally, as a single circuit supply, the reliability of supply may be unacceptable for the mine sites base load supply. Consequently a back-up, diesel powered supply will be provided. This back-up will be capable of providing 100% of mine site requirements on a continuous basis. High voltage power will be reticulated around the mine with the reticulation voltage to be determined from the results of final power studies.

The power supply requirements for the proposed mine site are as follows:

Usage Area	Connected Load kW	Maximum Demand MVA	Average Drawn Power kW
Process Plant	7,813	7.4	5,332
Mine Infrastructure	100	0.12	103
Administration & Village	850	1.05	876
Total	8,763	8.54	6,311

From the above it is proposed to install seven (7) (six in duty and one in standby) 1,200 kW (continuous electrical) rated diesel fuelled generator sets. The following tabulation sets out the expected fuel burn rate and CO_2 generated for the proposed installation. Where practical the available grid power will be used, supplemented by diesel generated power.

Amount of Grid Power Used kW	Amount of diesel generated power used kW	Diesel fuel burn L/h	Diesel fuel burn kL/a	CO_2 Generated t/a
0	6,311	1,650	13,042	34,430
500	5,811	1,497	11,832	31,236
1,000	5,311	1,370	10,828	28,586
2,000	4,311	1,113	8,797	23,224

A 400 kL diesel storage facility is proposed, made up of 4 x 100,000 l self bunded tanks providing fuel for 7 days operation.

3.5.3 Roads

Mine site roads will consist of the following:

- A partial upgrade of 3km of the road meeting the main road at Piriri and running to Ntete village;
- A new road approximately 2.5 km from the provincial road (No. 242) the mine office, workshop and processing area;
- A new road approximately 2.5 km from the mine office, workshop and processing area to the accommodation village;
- Mine haul road from the Balama East open pit to the ROM pad;
- Mine haul road from the Balama West open pit to the ROM pad;

3.6 Ancillary Infrastructure

3.6.1 Construction and Operation Accommodation

A permanent rural village has been proposed by Syrah Resources, as part of the Balama Graphite mining operations. This village will become an important contributor to the local economy and an opportunity to enhance the welfare and opportunities of many of the local residents. The village will be located on existing rural land in close proximity to the existing Ntete and Nquide villages as well as the proposed Balama Graphite mine. The village will be situated at the base of a 100 m high granite ridgeline. The location and design of the village has been selected based on areas with the least visual impacts and most suitable land in terms of environmental parameters to showcase the best global practices in mine workers' accommodation. Currently an existing gravel road links the Nquide and Ntete Villages with Balama. A new road network is planned to connect the mine to the existing villages as well as the proposed agricultural and rural village. Accommodation at the village will accommodate approximately 250 people, mainly workers, and will not include families or children. The local production of food will be integrated to supply the local food requirement with the possibility of export.

The village will be structured to include the following:
- A residential area consisting of clusters of living pods;
- A recreational building, gym and barbeque courtyard (serving as an outdoor cinema as well);
- A mess hall, senior staff accommodation and visitor accommodation buildings;
- An administration building (office space, storage space);
- A medical clinic with a small pharmacy;
- A housekeeping area (e.g. laundry, linen stores, cleaning stores and parking house);
- A village hub (e.g. service area, barber shop, hairdresser, stationary store, small grocer, clothing store and guesthouse);
- A soccer field and basketball court adjacent to the hub;
- Bicycle paths running parallel to the main road; and

The construction of the following infrastructure will be required:
- Roads and paths for access (bitumen paved/spray sealed);
- Substation and generating plant;
- Electricity supply;
- Sewerage system;
- Water supply will be via a branch line from the main pipeline from the Chipembe reservoir to the raw water distribution system;
- Small water treatment plant;

Locally sourced materials and labour will be used where possible.

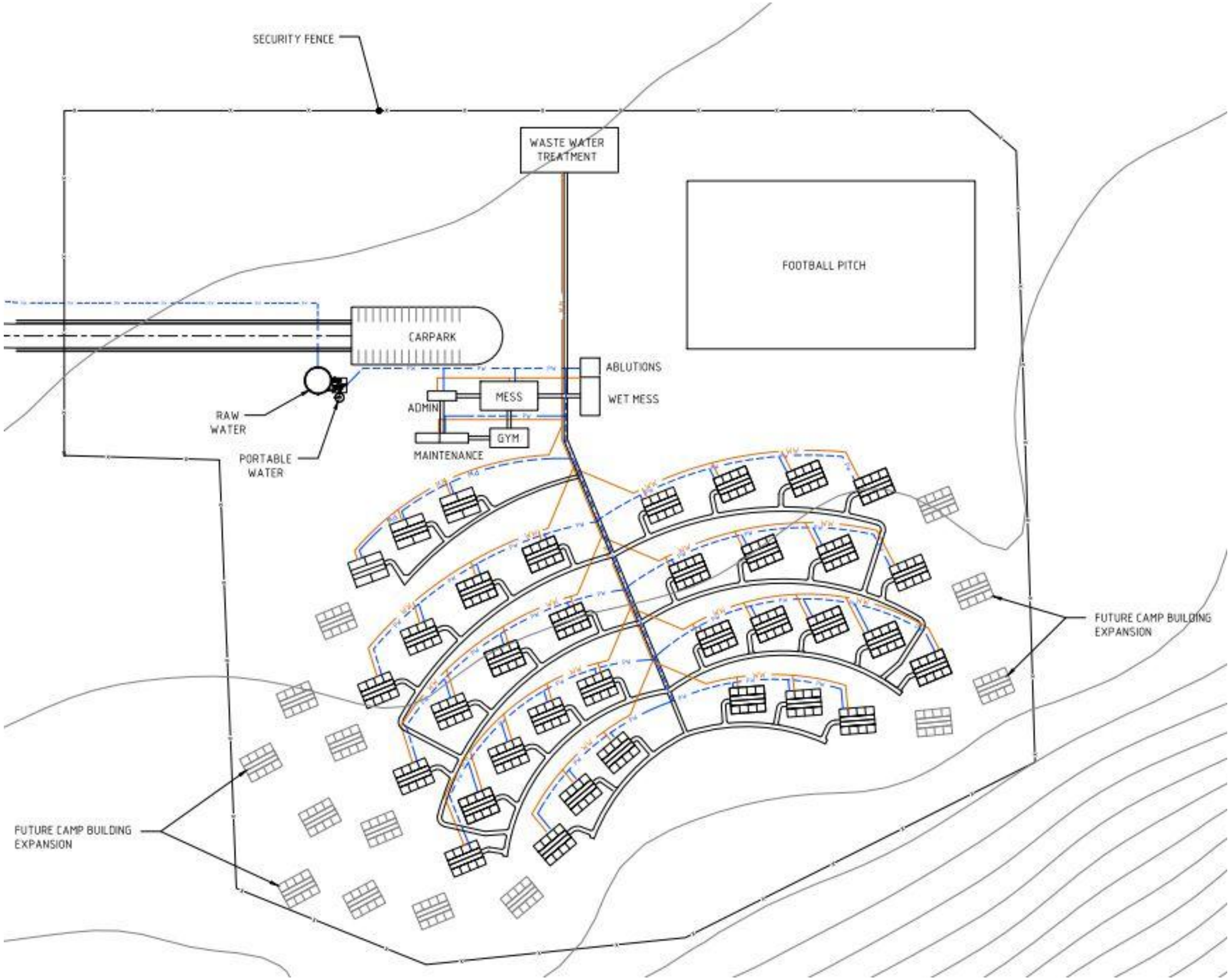

Figure 3.3: Proposed village Masterplan ***(Source: Equinox, 2013)***

3.6.2 Sewage System

The construction and operational phases' workforce of approximately 250 individuals (at peak period) will generate sewage and wash water that will need to be managed.

Table 3.1 shows the summary of the anticipated general sewage and domestic wash water effluent streams associated with the construction and operational phases of the Syrah Balama Graphite project.

Table 3.1: Anticipated Wastewater Streams Associated with the Construction and Operational Phases of the Syrah Balama Graphite Project

Phase	Waste Type	Estimated Quantity	Management & Disposal
Construction/ Operational	Sewage / domestic wash water	~5m^3/day (conservative scenario) and ~40m^3/day (worst case scenario)	A packaged sewage treatment plant will be utilised for the treatment of sewage and domestic wash water and the treated effluent discharged into the environment during the construction phase. During the operational phase, the treated effluent would be channelled to the process water dam for recycling. Lined Ventilated Improved Pit (VIP) latrines would need to be considered for field operations, particularly near the mine pit.

Packaged sewage plant specification
Based on the calculated estimate of generated sewage and domestic wash water during the construction and operational phases of the project, a packaged sewage treatment plant with the capacity of treating ~40m^3 of domestic effluent per day is required for installation.

3.6.3 Landfill Site

The design and construction of the Syrah Balama Graphite general waste landfill site should be in accordance with international best practice as described in EPA (2000), details of which have been provided in the Minimum Requirements for Waste Disposal by Landfill, 3rd ed. (DWAF, 2005).

Mozambique has no specific requirement for the siting, design and construction of a general waste landfill site. According to Article 7(I) of Decree No. 13/2006, of 15 June (Regulations on Waste Management) "*All public or private entities carrying out activities related to solid waste management should prepare their waste management plan, prior to entering into business, which should contain at least, information required in Annex I and/or Annex II, in case it is, respectively, a landfill or another waste management operation".*

The size of the landfill site depends on the daily rate of waste deposition. To take time and growth into account, disposal sites are classified using the 'Maximum Rate of Deposition' or 'MRD'. This is simply the projected maximum average annual rate of waste deposition, expressed in tonnes[3] per day, during the expected life of the site. To calculate the MRD:

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[3] 1 ton = 1.016tonne. NEMA WA refers to "Ton" while the DWAF 2005b refers to Tonnes. For the purpose of this report 1tonne has been equated to 1ton.

- Establish the 'Initial Rate of Deposition' or 'IRD'. This is the measurement of the existing waste stream in tonnes per day.
- Then, escalate the IRD at a rate that is usually based on the projected population growth for the estimated or design life of the disposal site.
- The maximum average daily rate of deposition, which usually occurs in the final years of the operation, then represents the MRD.

The calculated IRD for the Syrah project is based on the following assumptions:
Construction solid waste = 100kg (0.1 tonnes) / day
Operational solid waste = 100kg (0.1 tonnes) / day

Using the formula $MRD = (IRD)(1 + d)^t$

Where
d = the expected (constant) annual increase in the rate of deposition and would usually be based on the anticipated population growth rate. In this case the anticipated population growth will be 1% since the number of employees will not increase throughout the life of the mine.
t = the period or planned life of the site expressed in years. 51 years (including the 8 - 12 months construction phase).

The MRD = $(0.1)(1 + 1\%)^{51}$
$= (0.1)(1 + 0.01)^{51}$
$= 0.1 \times 1.66$

= <u>0.166 tonne per day</u>

The disposal site size classification according to DWAF 2005, based on the above calculation, is a Communal Landfill Site C with a MRD of <25 tonnes/day.

The estimated total waste disposal to landfill per year = 0.166 tonne/day x 260 d = 43.16 tonnes/yr, and the total waste disposal to landfill during the life of mine = 43.16 tonnes x 51 yrs = 2201.16 tonnes. As such, the total capacity of the proposed landfill should be in excess of 2201.16 tonnes but not exceeding 25000 tonnes.

As ambient climate is the major uncontrollable cause of significant leachate generation at a landfill, a Climatic Water Balance is used as the first step in determining the potential for significant leachate generation. In essence, storm water generation would be expected to be high during the wet season (November to March) and highest in December each year and the site would be expected to generate leachate during this time of year. It is recommended that the proposed landfill site be rated as having potential for sporadic leachate generation and as such the engineering design should include a suitably designed leachate management system. This will include the installation of under-liners, drains and removal system to avert the potential contamination of water resource and in particular, ground water.

A disposal site selection must be undertaken to ensure that:

- The site to be developed is environmentally acceptable and that it provides for simple, cost-effective design, which in turn provides for good operation.
- The site is also socially acceptable.

4. DESCRIPTION OF THE BIOPHYSICAL ENVIRONMENT

4.1 Introduction

This chapter provides a description of the natural environment that could potentially be impacted by the proposed development. The descriptions are based on the assessments presented by the various specialists who undertook baseline studies for this project. These specialist studies are presented as a separate volume, entitled Part IV: Specialist Volume.

4.2 Physical Environment

4.2.1 Climate

Mozambique experiences predominantly a maritime climate, largely determined by offshore warm waters of the Agulhas current and tropical cyclones which typically pass from the north to the south. Maritime climates generally are fairly humid, accompanied by considerable amounts of precipitation, since the main moisture source is from the ocean.

Annual rainfall follows a strong seasonal pattern, as well as geographical position. Regions north of the Zambezi River are influenced by the equatorial low pressure zone with a north-east (NE) monsoon in the warm season. Regions south of the Zambezi River receive the influence of the subtropical anti-cyclonic zone. Hence, the winds in the northern part of Mozambique are influenced by the monsoon system. Regions of central and southern Mozambique experience the south-east (SE) trade winds.

Rainfall

As shown in Table 4.1 below, the three year (2010-2012) annual total rainfall maximum and average for the Balama site are 1 342 mm and 746 mm respectively. The highest total monthly precipitation (392 mm) was observed in January. The rate decreases down to 6 mm in June. The maximum total rainfall and averages observed for each month over the three year period under survey are depicted in Figure 4.1 below.

Table 4.1: Average monthly precipitation
(Source: Digby Wells Air Quality Assessment, 2013)

Precipitation (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annul Total
Total Monthly Rainfall (Max).	392	140	232	38	16	6	23	8	103	96	84	203	1342
Average Total Monthly	196	100	121	26	14	5	11	5	52	37	52	127	746

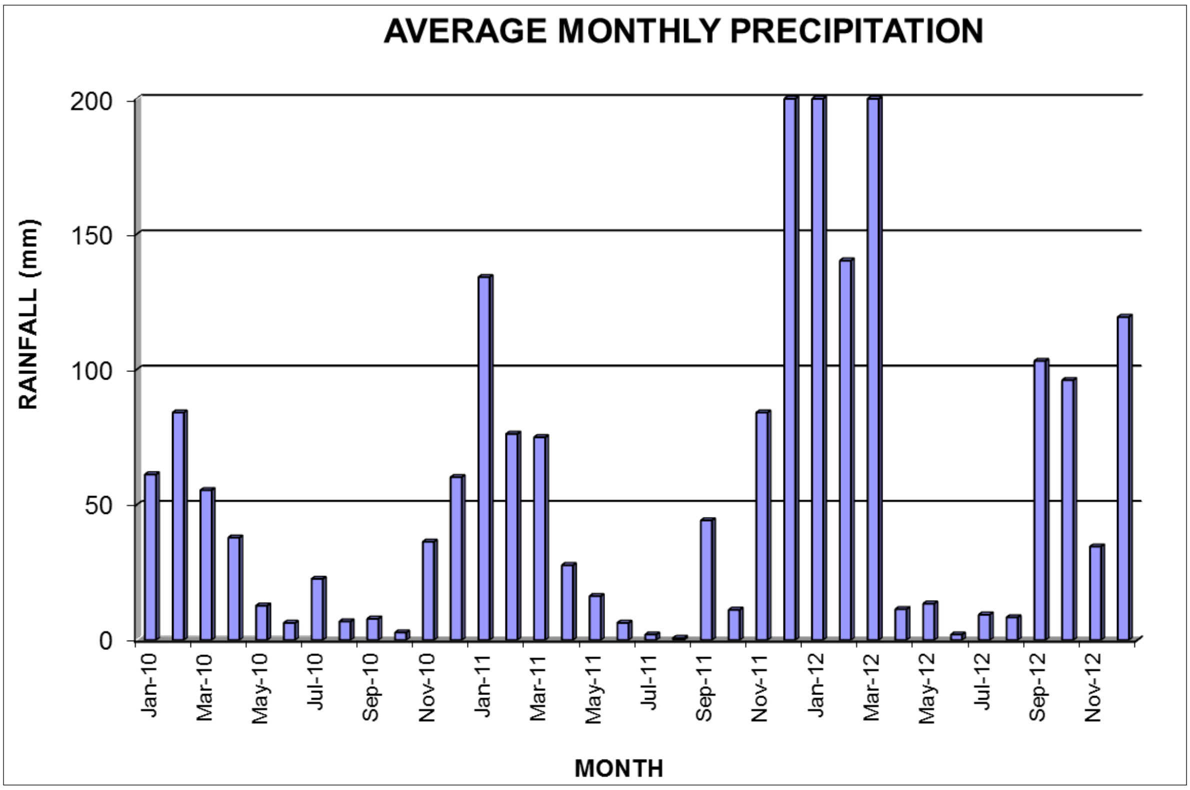

Figure 4.1: Average monthly precipitation
(Source: Digby Wells Air Quality Assessment, 2013)

Temperature

Annual mean temperatures for Balama area are given as 20.1°C. The average daily maximum temperatures ranges from 17.5°C in July to 24.9°C in December, with daily minima ranging from 16.6°C in July to 23.1°C in January (refer to Table 4.2 and Figure 4.2).

Table 4.2: Average monthly temperature
(Source: Digby Wells Air Quality Assessment, 2013)

Temperature (deg °C)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Monthly Max.	24.2	24.6	21.5	20.6	18.6	18.1	17.5	18.9	20.4	21.5	22.9	24.9	21.1
Monthly Min.	23.1	21.5	21.1	20.2	17.4	17.4	16.6	17.8	18.4	20.4	21.1	20.6	19.6
Monthly Mean	23.6	22.8	18.0	20.4	18.2	17.7	17.0	18.3	19.5	21.0	21.8	23.0	20.1

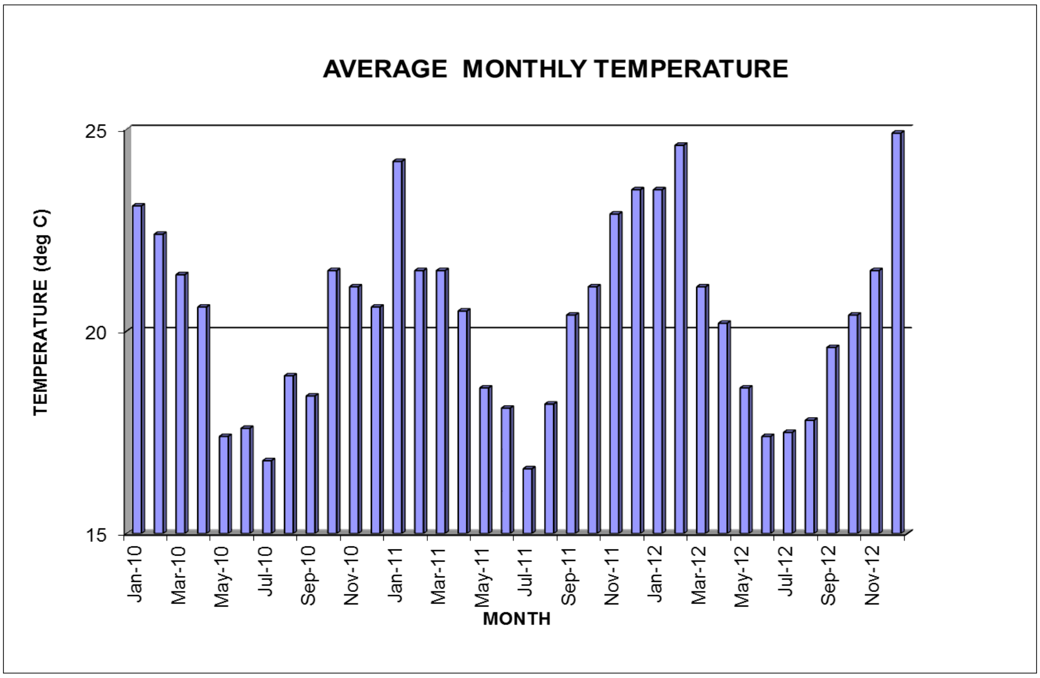

Figure 4.2: Average monthly temperature
(Source: Digby Wells Air Quality Assessment, 2013)

Wind

The spatial and annual variability in the wind field for the Balama site is clearly evident in Figure 4.3. The predominant winds come from the northeast (12.13%), south southeast (12.27) with the strongest and most frequent from the south (13.37). Calm conditions (wind speeds < 0.5 m/s) occurred for 3.9 % of the period.

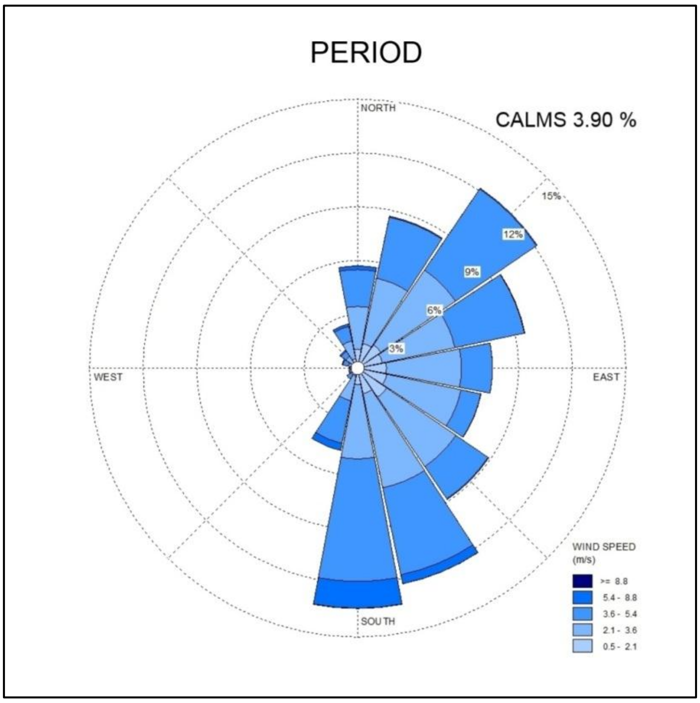

Figure 4.3: Wind Rose
(Source: Digby Wells Air Quality Assessment, 2013)

Relative Humidity

The annual maximum, minimum and mean relative humidity values are given as 79%, 77% and 79%, respectively. The daily maximum relative humidity remains above 70 % for most of the year (with the months from April to September above 80%, reaching 87% in June and July). The daily minimum on the other hand was 68% (January), with the highest value of 85% observed in the months of June and July. The monthly values observed in relative humidity for the three year period (2010-2012) are depicted in Figure 4.4 below.

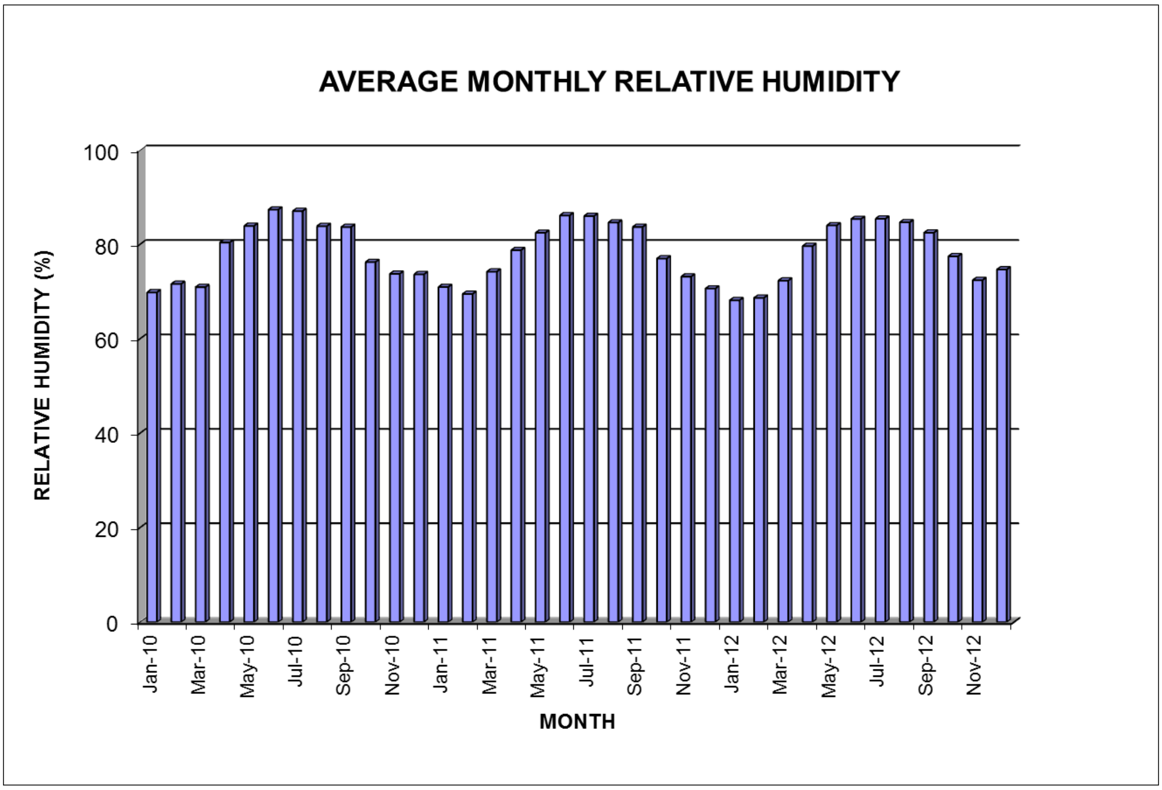

Figure 4.4: Average monthly relative humidity
(Source: Digby Wells Air Quality Assessment, 2013)

4.2.2 Topography

Mozambique's topography consists of coastal plains, mountains, and plateaus. About 44% of the country are coastal lowlands, and the terrain rises toward the west to a highland that ranges from 150 to 610 metres above mean sea level. In some sections elevations the highlands reach 550 to 910 m, with mountains reaching a height of nearly 2 440 m. Regional topography of the wider Balama project area shows elevations of 200 m above mean sea level, up to 1 440 m.

The local topography of the Study Area is dominated by ground surface elevation which ranges from about 540 m to 678 m above mean sea level, with a NE-SW trending ridge. Elevation declines gradually to the northwest and southeast of the ridge (Figure 4.5).

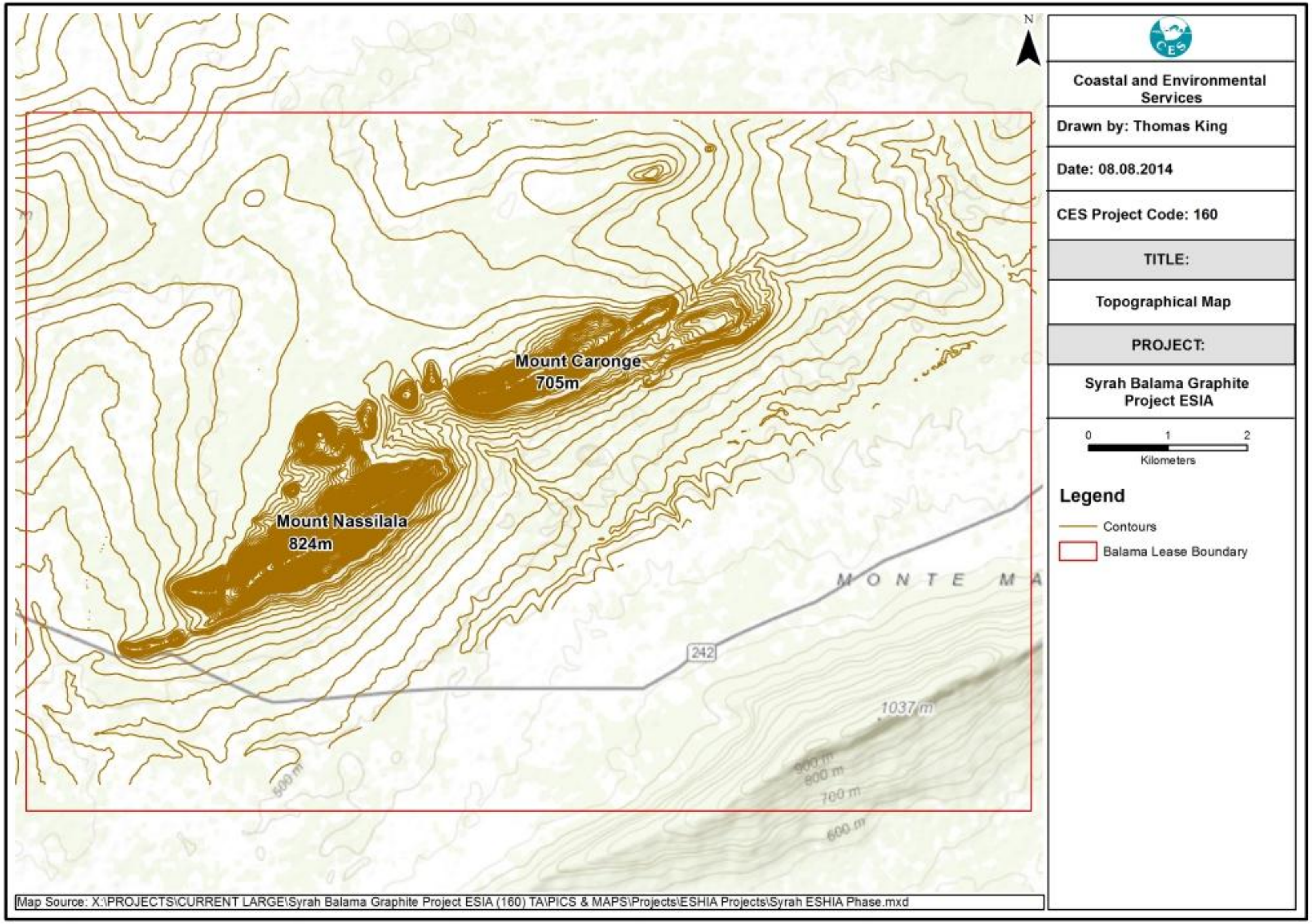

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Figure 4.5: Contour map for the proposed Syrah Balama Graphite Project (the project site is demarcated in red)

4.2.3 Geology and Soils

Regional Geology

Metamorphic rocks of the Neoproterozoic Lurio Group that is included within the Xixano Complex (735 Ma), dominates the project area. These rocks are characterized by ultra metamorphites of granulite to upper amphibolite facies (paragneisses) intruded by high grade orthogneisses while the Xixano Complex is characterized by Neoproterozoic lithologies formed between 820 and 740 Ma. In a western shear zone the Marrupa Complex and the Xixano Complex connect, where the Marrupa Complex overlies the Xixano Complex. In the east the Montepuez Complex is strongly folded, where the Xixano Complex and the Nairoto Complex is separated by a major shear zone. Predominant rock types within the Xixano Complex include calcic, mafic gabbro and diorite and low-K tonalite.

Local Geology

Graphitic, pelitic and psammite schists with a large granitic intrusion in the northeast occur in the proposed Balama site. Other minerals such as vanadium and pegmatites have been found by local artisanal miners. The graphite layer is comprised of a sequence of metamorphosed carbonaceous pelitic and psammitic sediments within the Proterozoic Mozambique Belt (Brice, 2012). The sediments have been metamorphosed to graphitic schists (pelites) and graphitic sandstones (psammites) (Figure 4.6).

Metamorphosed carbonaceous and, in parts, calcareous pelitic and psammitic sediments makes up the graphitic zone. Granite outcrops are evident in the north east of the western portion of the project area. Within these outcrops associated pegmatites occur which together with the granites appear to be intrusive into the schists. It is believed that the metasomatism between these rocks have resulted in the introduction of vanadium and chrome into the mineral assemblage. The foliation and bedding strike and dip appear to be one and the same (i.e. N 50° strike and dip 50° – 60°N).

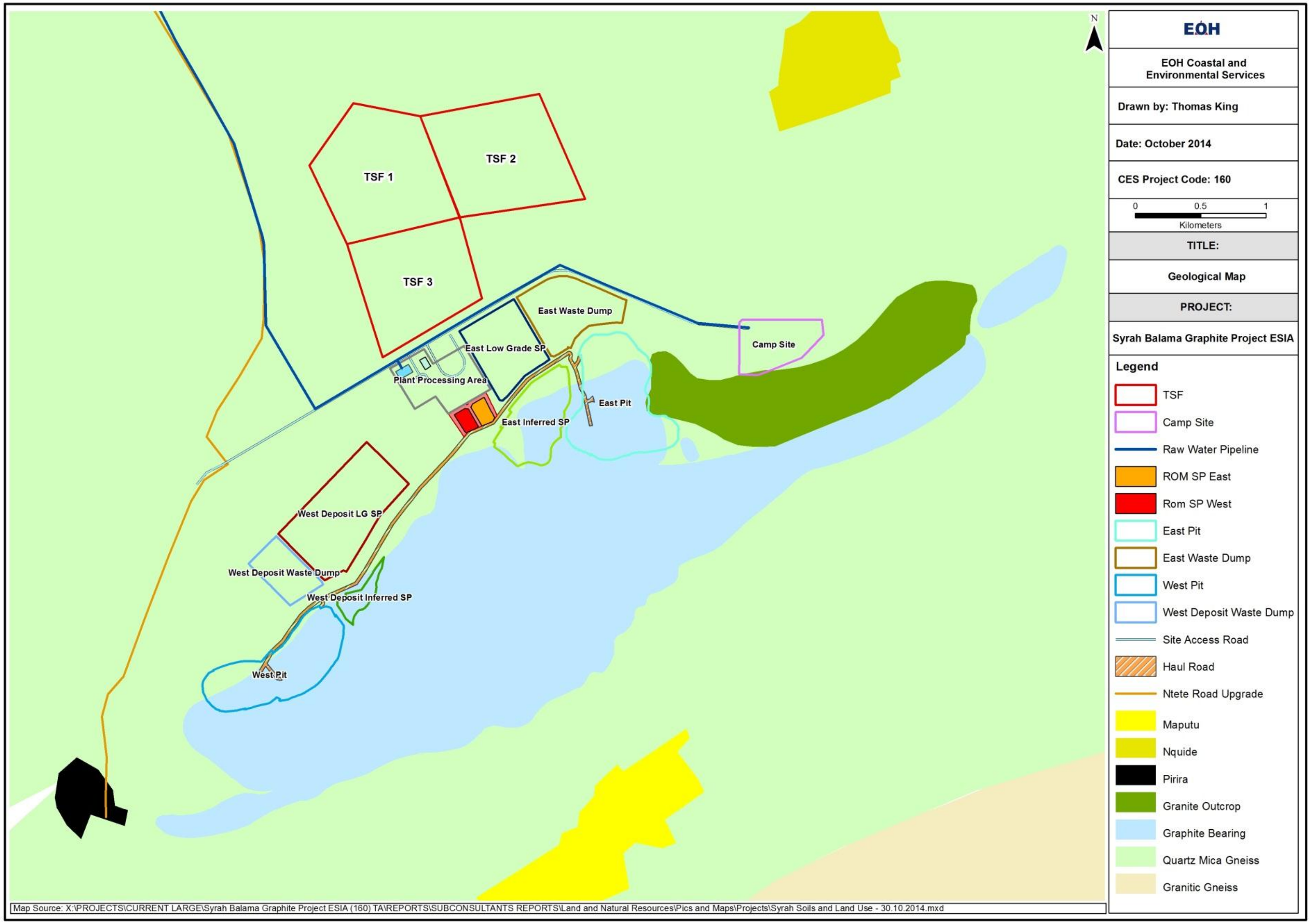

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Figure 4.6: Detailed geological map of the area

(Source: Land Natural Resources and Agricultural Assessment, 2013)

Local Soils

Loose graphitic brown soils (with no outcrop) cover flat areas, north and south of a range of hills, where the soil horizon can reach a maximum depth of 7 m. Most of the mining concession is underlain by red loam and sandy loam soils with high clay contents around the Mehucua River. The area where the mining activities will take place varies between medium textured soils in the west to sandy loam soils that are easily eroded located centrally and eastwards (Figure 4.7).

Three exposed soil profiles were assessed as part of the Land, Natural Resource and Agricultural Assessment (CES, 2013). This assessment identified two soil types at the proposed Balama graphite mine site. The first is Red Arenosols, found on the plains and occurring in approximately 80% of the mining concession area. This soil group has a thin brown ochric surface horizon over deep subsoil and consists of sandy soils developed after *in situ* weathering of old, quartz-rich soil material or rock. These soils are highly erodible with low water containing capacity.

The second soil type identified is Leptosols which occur on steep sloped inselbergs. These soil types accommodate very shallow soils over hard rocks. They are found in strongly eroded areas (like steep slopes). The A horizon is thin and has rich organic matter. For this reason, they have haplic characteristics. The pH is expected to be slightly acid.

Soils found on the flat plain areas had an average pH of 6.1 compared to soils on the sloped area which were more acidic, with a pH of 5.1. This is to be expected as the outcrop is of a granitic origin and is considered a more acidic parent rock for soils on these slopes.

Organic matter concentrations were found to differ when comparing soils on the sloped areas to soils on the plains. The low organic humus percentage found in the latter may be due to a high erosion potential combined with traditional agricultural methods (slash-and-burn clearing, incorrect cropping etc.) practiced on the plains.

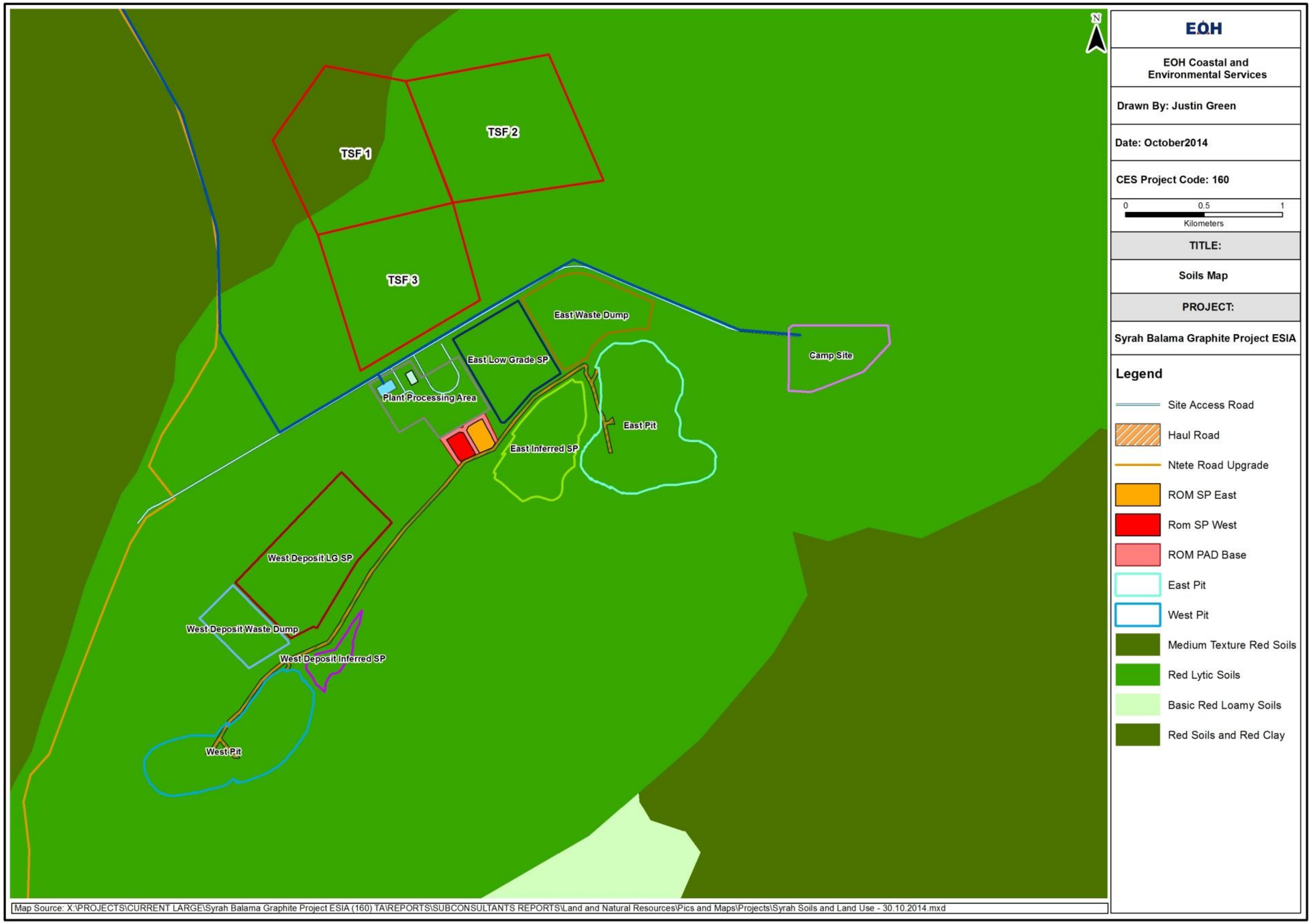


Figure 4.7: General soil types found within the mining concession area
(Source: Land Natural Resources and Agricultural assessment, 2013)

4.2.4 Air Quality

Adequate ambient air quality monitoring data is not available to evaluate the baseline air quality situation. However, dust fallout monitoring results from May 2013 were available for evaluation, and is shown in Table 4.3 below.

Based on the various activities in the study area, the main sources identified as possibly impacting on air quality in the region included, but are not limited to:

- Vehicle tailpipe (exhaust) emissions;
- Domestic fuel combustion;
- Biomass burning;
- Informal refuse burning;
- Charcoal production;
- Slash and burn practices for agriculture
- Fugitive dust emissions from vehicles on roads; and
- Wind erosion of open areas.

Table 4.3: Dust fallout results for the proposed Balama Project Site (2013)
(Source: Digby Wells Air Quality Assessment, 2013)

DUST LEVELS MEASURED IN MG/M^2/DAY				
Site ID	**April (31 days)**	**May/June (57 days)**	**July to August (62 days)**	**September (34 days)**
Camp	70	264	559	588
Phirira	96	31	349	850
Nquide	60	26	938	1061
Ntete	84	363	486	504
Maputo	65	156	765	685
Plant	50			

*Exposure period in bracket

4.2.5 Noise

Based on the daytime results measured at the rural receivers, the general existing ambient noise levels are mostly below the IFC's guideline rating limits (55 dBA) for the maximum allowable outdoor daytime limit for ambient noise in residential districts. Overall the ambient noise levels at the rural receivers are at the level of what is expected of rural villages according to IFC guidelines, the only exception being the Ntete Village during the morning and afternoon, due to the operation of a maize milling machine, near the measurement location at Ntete which caused the average to increase to 69 dBA. The average noise levels, not taking the maize milling machine into account, is 52 dBA. The baseline level at Ntete is set at the lower level of 52 dBA because of the fact that the maize milling machine is not always in operation and thus also falls within the IFC acceptable limits.

The night time noise levels indicate that the ambient night time levels are mostly below the IFC's residential guideline limit (45 dBA). The only exception was at Piriri, however this was due to a Cicada that set itself on top of the windscreen covered microphone and the noise it produced caused the baseline level to measure at 77 dBA, which distorts the more representative baseline level. The more representative level, excluding the Cicada's noise contribution, is 43 dBA which falls within the IFC acceptable limits.

The noise sources that were audible during the baseline measurements at the time of the noise survey and that were responsible for the day/night time levels are summarised in Table 4.4.

Table 4.4: General noise sources during baseline measurements
(Source: Digby Wells Noise Assessment, 2013)

Noise source description			
Day	**Duration**	**Night**	**Duration**
Maize milling machine at Ntete	Intermittent	*Gryllidae* (crickets)	Continuous
Socializing activities	Intermittent	*Cicadidae* Cicada	Continuous
Vehicular activities on gravel roads passing through the villages as well as main road passing through Maputo	Intermittent	Vehicular activities on main road passing through Maputo	Intermittent

4.2.6 Radiation

To manage naturally occurring radioactive material (NORM) it is recommended that Syrah adopt the NORM guidelines as published by the Government of Western Australia, Department of Mines and Petroleum. As stated in the guideline NORM 1 the purpose of this set of guidelines is to summarise the system of radiation protection as recommended by the International Commission on Radiological Protection (ICRP), International Atomic Energy Agency (IAEA) and the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). The guidelines illustrate how the system of radiation protection may be practically applied in the mining and mineral processing industry and in particular:

- implementing best practicable technology to reduce exposure and contamination levels. For example, ensuring suitable engineering controls are used to the extent feasible;
- classifying employees, work conditions and workplaces on the basis of measured or predicted radiation levels. For example the classification of designated employees, restricted areas, controlled areas and supervised areas; and
- the establishment of contamination levels that trigger radiation protection responses. For example, defining special exposures and setting investigation and reporting levels.

Measurements taken (sampling points shown in Figure 4.8 and Figure 4.9), indicated the levels of radioactivity naturally occurring in radioactive materials. The readings were in the order of 3 to 10 times the background level and generally across the field locations where measurements were taken. One test at location number 35 exhibited a value about 30 times background. Measurements on core samples at the core shed also followed the same trend although one specific piece of core from drill hole BMDD0123 at a depth of 18m exhibited a value about 30 times background.

Calculations based on the field measurements indicate the dosage level encountered by personnel working in these areas will be less than 5mSv per year. The NORM guidelines provide classifications of work conditions and at dosage levels less than 5mSv the work area would be classified as a supervised area. The ARPANSA definition of a supervised area is "an area in which working conditions are kept under review but in which special procedures to control exposure to radiation are not normally necessary". As the project progresses to production, ongoing monitoring will be conducted and any actions and mitigation measures required will be determined by the NORM guidelines.

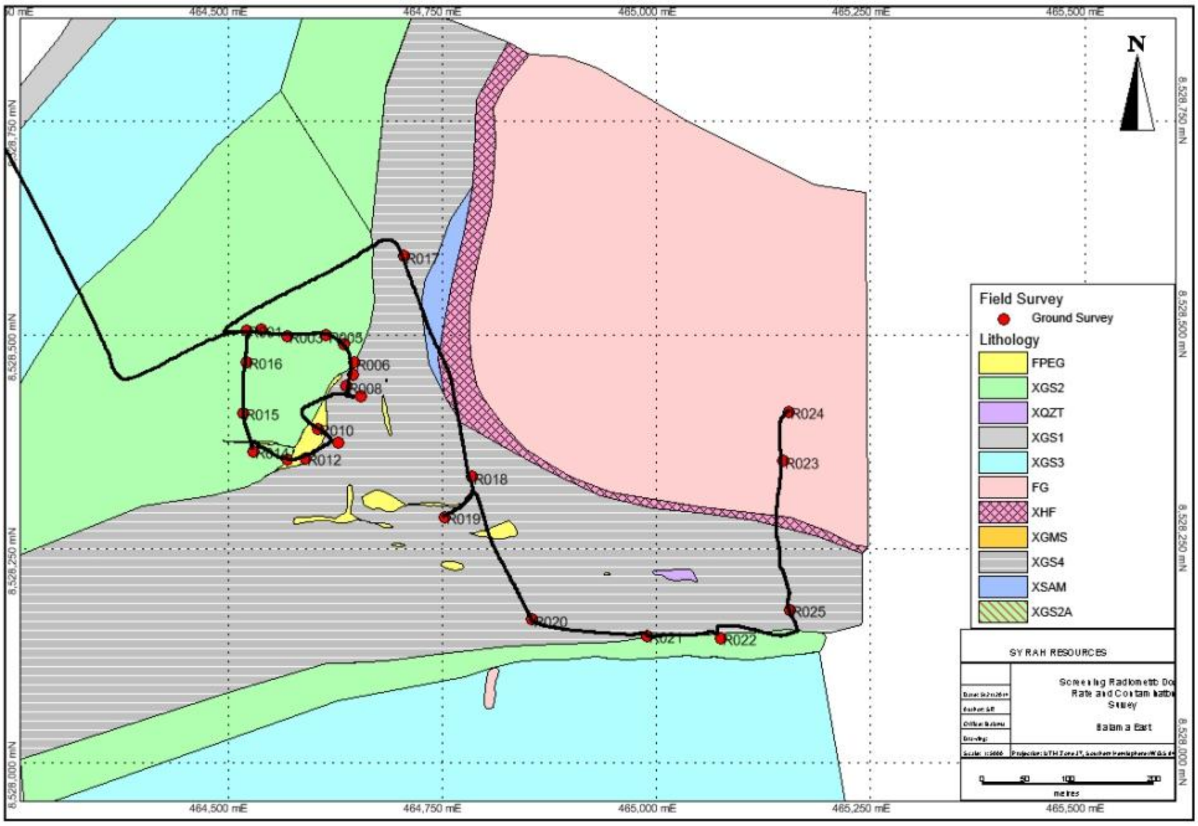


Figure 4.8: Radiation sampling points east pit

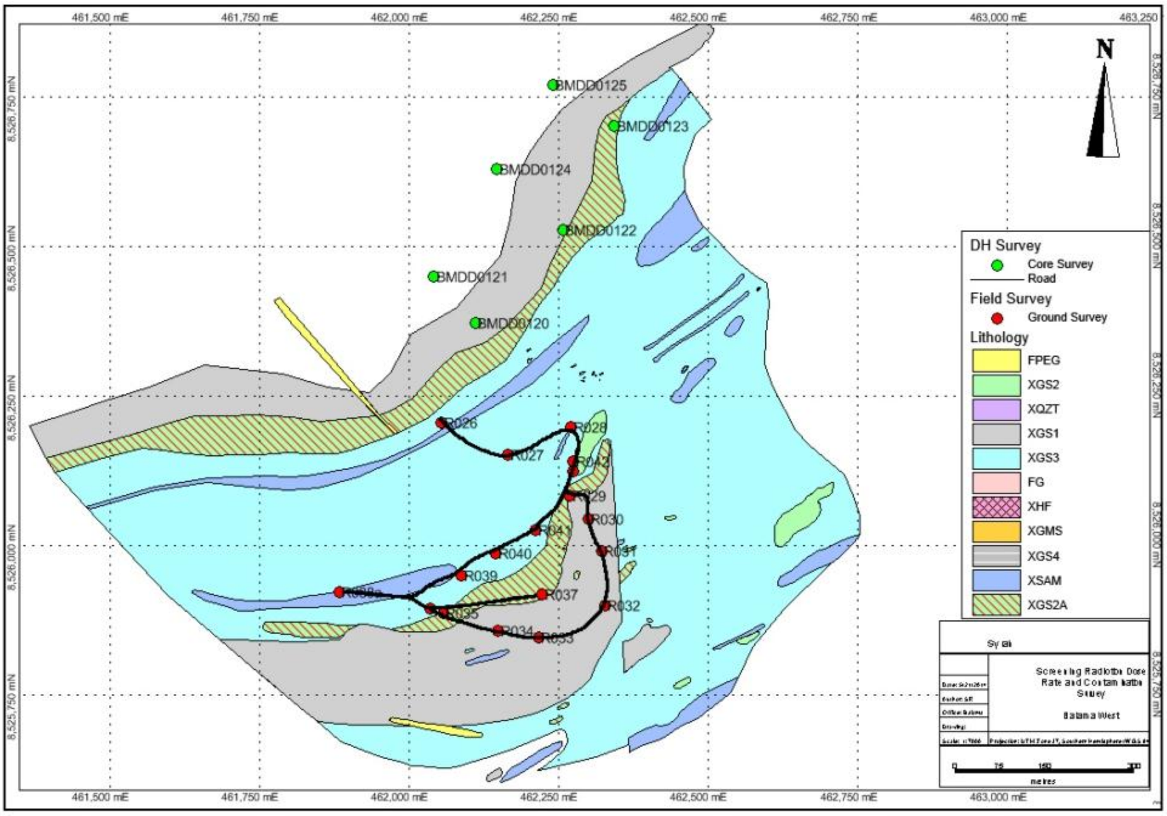


Figure 4.9: Radiation sampling points west pit

4.2.7 Surface water

The project area lies south of the Ruvuma River in the upper reaches of the Montepuez/Megaruma River catchment area. This area is dominated by seasonal rivers such as the Messalo, Montepuez, Megaruma, Lurio, Mocuburi and Monapo Rivers. Most of these rivers are lined with swamps, with the lower courses of several expanding into long narrow lakes, such as Lake Biribizi on the Montepuez River.

The Mehucua River flows through the southern section of the project site in a south-west to north-east direction. At this point it joins the Montepuez River 25 km downstream of the project site. The Mehucua River has three major tributaries; two of which - the Namiticu and the Naconha rivers - are upstream of the project area, both of which were sampled as part of the aquatic survey. The third tributary joins the Mehucua some distance downstream of the project area. The Namiticu and Naconha Rivers flow parallel to each other, and are both approximately 20 km long from their sources to their confluence, where they join to form the Mehucua River at a point on the southern boundary of the project site (Figure 4.10).

A few small wetlands occur in the project area, the most notable being swampland located approximately 2 km south west of the proposed site and a wetland located approximately 7 km east south-east. The largest water body in the area, but outside of the project area, is the Chipembe Dam which is located 13 km northwest of the site. Completed in 1985 the dam covers approximately 7.1 km^2 and has a capacity of close to 24 million m^3. The primary water use is intended to be irrigation, but the planned irrigation scheme has largely failed (FAO, 2005a). The Mozambique Water Authority is responsible for the management of Chipembe Dam and has confirmed that there is suitable available capacity and allocation for Syrah to obtain over 2 000 000m^3 annually for use in the processing of graphite (EBS, 2012).

In situ and ex situ water quality indicated that in general the water quality was good when compared to the various relevant water quality guidelines, specifically the MICOA standard for Category (a) human consumption (Ministerial Diploma of 18/2004).

Aquatic macroinvertebrates were collected using the standard South African Scoring System (SASS5) protocol. The number of aquatic macroinvertebrate taxa ranged from 16 at the Chipembe Dam site to 10 at the Mehucua River site.

The United States Environmental Protection Agency (USEPA) approach to the qualitative assessment of the biotic integrity of a stream was applied to the sample sites. The objective of the Ephemeroptera, Plecoptera and Trichoptera (EPT) Taxa Richness Metric is to provide a baseline for future rapid bioassessments. The percentage contribution of EPT taxa per site showed a range from 2 at the Namiticu River site and at Chipembe Dam, to 5 at the Namiticu River confluence site. and contributed a third of the overall invertebrate assemblage at the Namiticu River Confluence site. The high percentage contribution (> 30%) of EPT taxa to the overall invertebrate assemblage at the Namiticu River confluence site indicates that biotic integrity remains high at this site despite the impacts of riparian zone clearing and associated sedimentation of the river. Also, at the time of sampling, far more habitat structure was available for sampling, potentially accentuating the result unevenly.

Further evidence of the good quality of the catchment in general, was the presence of a number of taxa with lower tolerance to pollution.

In terms of the SASS methodology, three principal indices are calculated, namely the SASS Score, the Number of taxa, and the Average Score per Taxon (ASPT). By dividing the SASS Score by the Number of taxa identified, the ASPT index is calculated. This index provides a reliable measure of the health of a river. Table 4.5 shows the calculated ASPT for each of the sites sampled. The Mehucua River has the highest ASPT and SASS score, largely due to the category taxon (Oligoneuridae), while the Chipembe Dam site had a higher number of taxa and the lowest ASPT, as most taxa found at this site were in the lower, more pollution tolerant, ranges.

Table 4.5: Number of taxa, SASS and ASPT scores at the five sample sites

	Namiticu River	Naconha River	Namiticu River Confluence	Mehucua River	Chipembe Dam
SASS Score	70	63	89	75	76
No. of Taxa	13	11	15	10	16
ASPT	5.4	5.7	5.9	7.5	4.8

The following conclusions were reached based on the March 2013 survey of aquatic ecosystems:

- In situ water quality indicated that in general the water quality was good. The dissolved oxygen content was slightly lower than expected, but this is in all likelihood due to the turbidity of the water due to the sediment loads present from the recent seasonal rains. The high air temperatures would also reduce the DO concentration in the upper water column, where the in situ measurement probe would rest.

- The moderate/high percentage contribution (25 - 30%) of Ephemeroptera, Trichoptera and Plecoptera (EPT taxa) to the overall invertebrate assemblage in the general area indicates that biotic integrity remains high despite the impacts of riparian zone clearance and sediment load increases due to local farming practices;
- The relatively low levels of taxon richness measured at all sites can be attributed to the relatively poor habitat availability. This was due to various reasons related to seasonality, including high flow levels and flood damage to marginal vegetation. It is anticipated that the dry season taxon richness may be higher.

Although guidelines for freshwater quality from other jurisdictions may provide some criteria appropriate to Mozambican, it is recommended that Syrah initiate a long-term water quality monitoring programme. This will allow for the development of a site-specific baseline water quality database. This database can then be used to provide a target water quality guideline specific to the Syrah site. Water quality monitoring subsequent to the initiation of mining operations can then be compared to the guideline developed from the baseline monitoring programme. As it is probable that there will always be natural fluctuation in ambient water quality, it is important to establish a mechanism to identify when a parameter is abnormally high rather than slightly elevated. It is recommended that the median values and associated percentiles of exceedance (as recommended in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality – ANZEEC) be used.

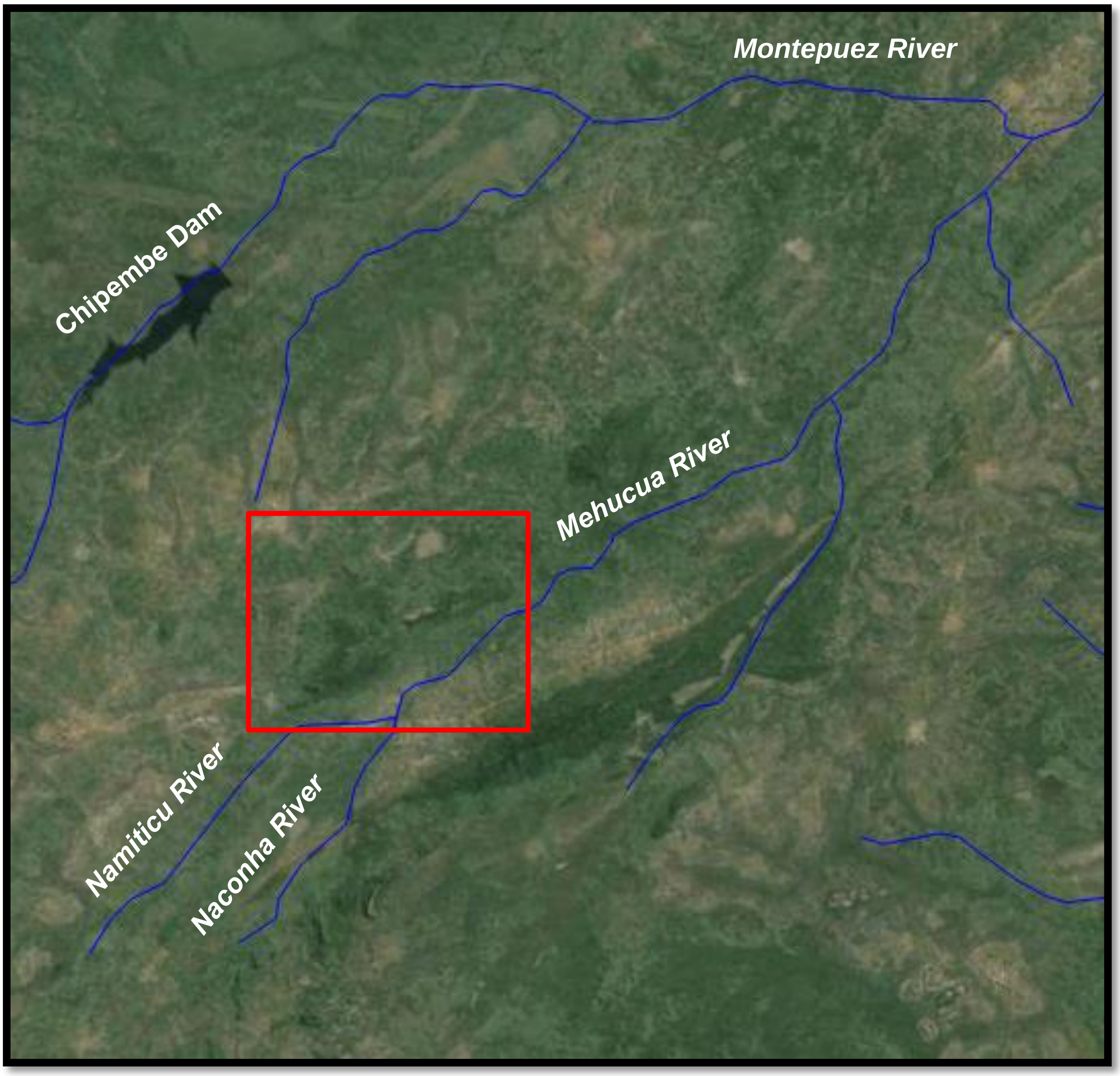


Figure 4.10: River systems in and around the project area (Source: Aquatic Impact Assessment, 2014)

4.2.8 Groundwater

The groundwater system of the Mt Nassilala range of hills plays a major role in the regional surface water system as groundwater discharging from the hillside supports perennial flows in streams originating from the mountains.

Groundwater levels in the project area range between 2 meters below ground level (mbgl) at Pirrira BH3 (Balama west) to 33 mbgl in BH8 (Balama east), (Sample sites are shown in Figure 4.11). A plot of all available groundwater level data against borehole surface elevation depicts that the inclusion of BBH2, BBH7 and BBH8 distorts a 99 % correlation to an 81 % correlation. This is indicative of two sets of aquifer systems in the project area: a weathered aquifer and a fractured aquifer system.

Thus groundwater occurrence in the project area is associated with weathered and fractured graphitic schist, granites and pegmatites. The aquifer associated with the weathered bedrock varies in thickness throughout the area, but it can extend to depths of about 40 mbgl. The weathered aquifer is fairly permeable as only minor seepages were recorded in the weathered material during drilling. The pockets of deeper weathering may allow seepage migrating to the fractured zone aquifer.

Graphitic schist, granites and pegmatites, when not weathered, are impermeable and have no storage capacity. The permeability and the storativity of these rocks are solely dependent on secondary structural features like fissures and fractures. In general fractures close when the lithostatic pressure increases with depth. However, important groundwater flow may occur in fractures accompanying fault zones.

Exploration geology data indicates that 51 per cent of the fractures in the study area occur in the upper 60 m of the geological succession. Up to 27 % of the fractures occur between 140 and 180 mbgl. However a majority of the deeper fractures are unweathered. The fractures in the upper 60 m are mostly moderate to highly weathered. Therefore fracturing is relatively common in the upper 20 m of the fractured aquifer and groundwater flow is well interconnected. At greater depth groundwater flows may be associated with individual disconnected water bearing fractures.

All major water strikes intercepted during drilling were between 40 and 60 mbgl. The major water strikes had yields between 0.78 and 9 L/s. Besides the fault gouge at Balama East, all major water strikes were associated with fractured intrusives at contact zones.

Eleven boreholes were sampled for baseline assessment and compared against the WHO drinking water guidelines. The results indicated the following:

- Groundwater from water supply boreholes Pirira BH2 and Pirira BH3 are not fresh due to elevated TDS values above 1000 mg/L;
- Acid mine drainage (AMD) processes have taken place due to oxidation of exposed pyrrhotite in the dug trenches. As such BMRC 005, BBH2, BBH3 and BBH7 have AMD signatures due to their proximity to the trenches:
- The only common heavy metals that have been significantly mobilised are iron, manganese, nickel and zinc;
- Although all major and minor ions in BBH1 are within guideline values, its alkalinity has been depleted. The pH of BBH1 will further decrease due to seepage of AMD water from the nearby trenches;
- BBH6, BBH8, Camp BH1, Pirira BH1 and Pirira BH3 are relatively unpolluted water with calcium-magnesium-bicarbonate signatures; and
- The chloride enrichment in Pirira BH2 is associated to seepage from the sewage disposal at Pirira village.

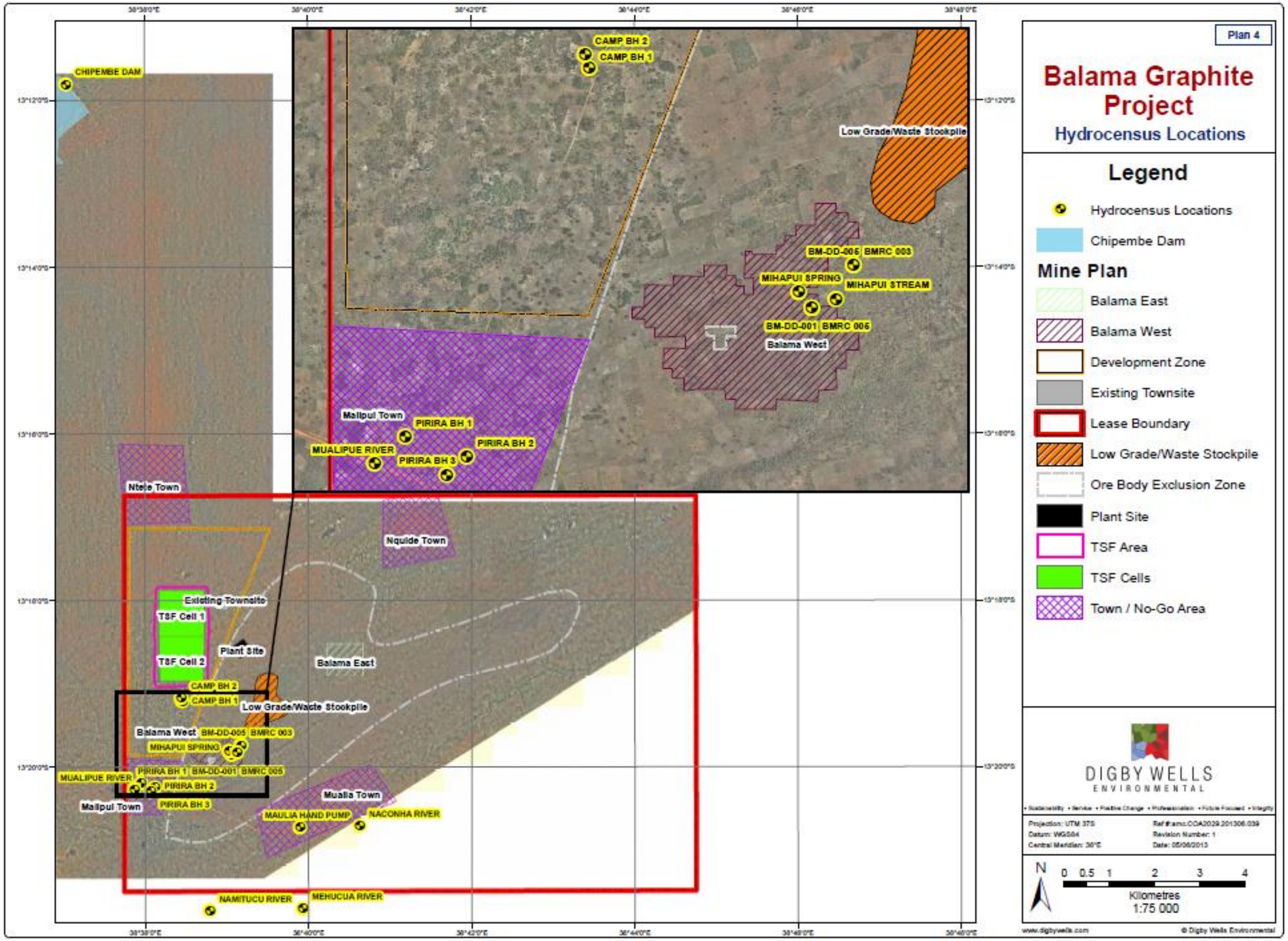


Figure 4.11: Groundwater sampling site

4.2.9 Geochemistry

A geochemical baseline study was undertaken to investigate the potential formation of acid rock drainage and metal leaching from different types of bedrock found in the mineralized areas of the Balama Graphite ore body. Nine (9) rock samples (selected and provided by the client) were submitted for geochemical evaluations to determine the acid mine drainage (AMD) potential and risk of contaminants leaching into solution from both the graphite and the waste rock. These 9 samples were taken from 3 boreholes (3 samples per borehole) representing the pit areas that will be mined based on the pit layouts and mining plan at the time of sampling. The overburden and underburden from each borehole was tested to represent the mineralogy and constituents of the waste rock material. The third sample in each borehole was taken from the graphite zone. Samples were tested using the XRD method (measurement of the crystal structures to determine the mineralogical composition), the XRF method (determination of the elemental composition of a material), the ABA method (measuring the acid- and alkaline producing potential of undisturbed soil and rock overburden) in order to determine if, after disturbance, the waste material will produce acid and subsequently leach metals. NAG tests, which evaluate the Net Acid Generation and neutralising potential of the material, and Synthetic Precipitation Leachate Procedure (SPLP) tests were also done to simulate the heavy metal and anion leachate potential of soils and waste material left in-situ under normal conditions with only rain water allowing leaching to occur.

The geology of the sampled material is extremely rich in metals and various other elements. The XRD and XRF tests revealed that the waste rock and graphite material are not homogenous in nature and that a combination of a wide range of oxides and metals form the rich mineralogy of the deposit. These tests identified the main oxides present as SiO_2, Al_2O_3 and Fe_2O_3 with smaller amounts of MgO, CaO, K_2O and MnO. Clay minerals, with high concentrations of K, Mg, Al, Fe and Mn, were found to dominate the waste rock mineralogy. Other major silicate minerals such as microcline and plagioclase were also present in the waste rock. The high pyrrhotite content in the waste rock can lead to oxidation reactions and the formation of AMD. The mineralogy of the Graphite ore body is dominated by a quartz based metamorphic sequence with traces of clay minerals. The high concentrations of Mn, Mg, Fe, SO_4, K, Zn, Al and Ca elements in the samples could potentially leach from the material.

The test analyses have revealed that almost all common metal concentrations found in the samples (Au, Ag, As, Ba, Fe, Cu, Cr, Zn, U, Co,Cs, Mo, Ni, V, W, Y and Pb) are above the global average crustal concentrations (Table 4.6). Even though these metals are much higher than normal most of them do not pose a significant health risk and are not mobile under normal aquatic and atmospheric conditions. The current pH of the groundwater system at Balama is close to neutral, with some boreholes close to pits and trenches having a more acidic pH due to oxidation processes. As pH affects the rate of metal dissolution and their mobility in groundwater it is important to note that once the graphite is mined and exposed to oxygen, AMD formation is a possibility because of the high Sulphur content observed in the ABA results. A drop in pH will result in the mobility of most metals which can lead to environmental risks. The main elements to highlight are Zn, Pb, Ni, U, As, Fe and Cu.

The ABA and NAG results revealed that the Sulphur (S) content for all the tested samples were above the margin concentration of 0.3% S with the exception of BMD009HW and BMD012HW being below 0.01%. This means that the tendency for acid generation in the samples that were above 0.3% is higher than in the other samples, if the Net Neutralising Potential (NNP) is below 0. All the samples are classed as rock type 1 (potentially acid forming) with the exception of boreholes BMD009HW and BMD012HW, which has a low Sulphur content and a high neutralising potential. The paste pH values of the waste rock material (overburden and underburden) are all above 8 with the exception of borehole BMD022HW, which has a slightly acidic paste pH of 5.3. The mineralised material were found to have a neutral paste pH, with only BMD009MZ showing an acidic formation.

The SPLP test results were classed against the South African drinking water standards to quantify the quality of any leachate produced from the test samples (waste rock and Ore material). The SPLP tests are a leachate procedure in which the contaminants that can potentially seep into the groundwater and surface water reserves from waste facilities and stockpiles can be determined. The bio-availability of the elements is thus evaluated.

The total elemental analysis indicated the total amount of metals present in the samples available for dissolution and seepage, the SPLP results will however show the amount that will leach from the solid state into fluids as water recharges through stockpiles and waste facilities. When the concentrated seepage does reach the receiving environment (groundwater or surface water) the concentrations will however be diluted to levels most probably below any levels potentially posing risks.

The quality of the leachate was classed against the SANS 241:2005 drinking water guidelines, as well as WHO drinking water guidelines to evaluate its suitability for human consumption and the potential for contamination; should leachate reach and mix with local water resources. WHO guideline values were only used where the SANS guideline do not give criteria for that specific parameter. SANS 241:2005 identifies 3 classes namely Class 1 (recommended operational limit), Class 2 (maximum allowable concentration for limited duration) and Class 3 (Not recommended for human consumption).

The metals found to be above the recommended drinking water guidelines, but within the maximum allowable limits were Ca, Co, Cr, Mn, Se and Zn. However Al, Cd, Fe, Cu, Ni, V and U were found to have concentrations well above the allowable drinking water limits and are cause for concern as these pose both a human health risk and environmental impact risk. All other metal concentrations that were identified were found to be within the limits and will thus have no environmental or health risk.

Based on the results of the Geochemistry assessment discussed above, it is evident that material representing the waste rock as well as the ore body has samples that could potentially generate acid drainage. The waster rock dumps and tailings storage facility has a moderate potential for AMD due to the high Sulphur content and acid generation potential in the samples that were tested. The high concentrations of U, Sr, Se and Rb in the graphite zone were also found to be potentially radioactive posing a health risk. Potential trace element contamination is also possible from the waste rock dump due to the high concentrations of Mn, Fe, Ni and U identified in the waste rock samples. The ore material has a high potential for AMD formation due to the high Sulphur concentrations and low paste pH levels, which could result in leachate water with a low pH and high metal content. Trace element contamination risk from stock piles and exposed ore zones with a high potential of metal contamination with concentrations of Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, V, Zn and U entering the receiving environment were identified and the high concentrations of U, Sr, Se and Rb in the graphite zone were also found to be potentially radioactive posing a health risk.

Table 4.6: Whole rock chemistry results summary (concentration in ppm)

(Source: Digby Wells Geochemistry Assessment)

Element	Upper Crustal Averages	Hanging wall			Footwall			Mineralised zone		
		BMD009HW	BMD012HW	BMD022HW	BMD009FW	BMD012FW	BMD022FW	BMD009MZ	BMD012MZ	BMD022MZ
Ag	**0.05**	0.03	0.08	0.12	0.12	0.08	0.05	0.04	0.04	0.08
Al	**80400**	31955.5	41428.9	52506.0	58586.9	44302.7	39746.0	25001.3	21428.9	31124.6
As	**1.5**	5.35	2.66	1.10	1.06	0.86	0.74	0.79	1.05	0.84
Au	**0.0018**	0.02	0.01	0.02	0.09	0.02	0.02	0.02	0.01	0.03
B	**15**	5.3	2.0	6.1	8.1	3.6	6.9	0.1	0.1	54.0
Ba	**550**	631.0	1980.0	1010.0	1648.0	2437.0	2021.0	1224.0	104.0	758.0
Be	**3**	1.7	1.5	1.8	2.1	1.6	1.7	1.0	0.6	2.8
Bi	**0.127**	0.2	0.1	0.3	0.4	0.3	0.2	0.3	0.1	0.5
Ca	**30000**	472.5	532.5	5411.0	5039.3	3783.4	8670.5	1732.0	39914.2	58098.6
Cd	**0.098**	0.4	0.7	5.4	4.7	3.0	2.5	16.8	15.2	12.9
Ce	**64**	30.9	35.6	1.6	7.8	2.3	15.7	3.6	50.3	59.9
Co	**17**	37.1	33.3	28.5	100.9	62.7	59.3	72.0	77.8	44.2
Cr	**85**	475.0	133.0	497.0	417.0	415.0	337.0	188.0	221.0	326.0
Cs	**4.8**	3.8	3.9	14.1	11.1	7.3	21.8	2.0	0.5	6.6
Cu	**25**	238.0	127.0	242.0	167.0	147.0	156.0	224.0	115.0	191.0
Fe	**35000**	95640.0	43670.0	42380.0	46100.0	23320.0	23430.0	21920.0	9749.0	27040.0
Ga	**17**	10.3	9.5	9.5	12.4	9.0	7.3	6.0	4.2	6.3
Ge	**1.6**	0.8	0.4	0.5	1.1	1.0	0.8	1.2	1.6	0.8
Hf	**5.8**	2.1	4.5	4.5	7.3	4.6	3.2	2.2	1.6	2.9
Hg	**0.09**	0.14	0.14	0.28	0.38	0.27	0.33	0.70	0.55	0.78
Ho	**0.8**	0.27	0.28	0.10	0.21	0.19	0.89	0.28	2.20	2.00
Ir	**0.00002**	0.09	0.09	0.07	0.08	0.08	0.06	0.07	0.07	0.04
K	**28000**	3426.9	8305.6	17367.1	18546.5	14510.0	18164.5	1711.8	58.1	8218.4
La	**30**	10.6	14.0	1.7	4.5	1.9	5.6	3.3	28.1	25.2
Li	**20**	8.0	9.9	32.1	31.9	21.0	33.5	10.0	2.2	15.4
Mg	**13300**	546.4	1131.3	7680.7	10915.7	4030.1	4241.6	755.4	279.5	7241.0
Mn	**600**	313.5	143.7	134.3	249.1	169.4	98.7	74.2	94.8	198.8
Mo	**1.5**	122.4	90.3	39.9	45.5	28.1	36.2	100.8	252.9	114.1
Na	**28900**	251.9	539.6	4124.1	5710.7	3221.7	2519.7	195.1	36.8	1535.0
Nb	**12.5**	2.9	2.3	1.1	33.5	4.9	2.9	4.6	3.3	5.7
Nd	**26**	22.5	27.3	4.3	9.7	4.9	14.4	6.9	52.0	50.6
Ni	**50**	170.0	105.0	469.0	456.0	266.0	397.0	916.0	558.0	746.0
Pb	**16**	23.1	8.9	9.3	19.1	8.0	10.2	16.9	19.1	23.7
Rb	**112**	48.6	56.0	120.8	139.5	62.5	87.3	9.8	6.5	92.3
Sb	**0.2**	0.6	0.4	2.3	0.2	0.1	0.5	0.2	0.1	0.6
Sc	**13**	23.2	14.2	10.4	14.2	10.3	11.6	13.0	9.9	5.7

Element	Upper Crustal Averages	Hanging wall			Footwall			Mineralised zone		
		BMD009HW	BMD012HW	BMD022HW	BMD009FW	BMD012FW	BMD022FW	BMD009MZ	BMD012MZ	BMD022MZ
Se	**50**	0.2	0.9	1.7	1.9	1.1	1.0	0.8	1.2	1.3
Si	**308000**	272931.3	288592.8	268864.0	251192.1	309864.4	312529.2	253015.4	234174.8	210144.9
Sn	**5.5**	3.0	2.1	3.6	2.2	4.1	2.2	2.7	1.6	15.7
Sr	**350**	51.3	89.0	82.6	140.0	109.6	139.4	61.1	61.5	299.5
Ta	**1.1**	0.4	0.4	0.2	6.6	0.8	0.5	0.5	0.4	1.2
Th	**10.7**	13.2	4.9	0.5	6.2	0.6	2.3	0.6	3.1	5.2
Ti	**3900**	1733.5	2911.4	3846.7	4917.4	2669.5	2574.9	1666.5	1162.9	1571.9
Tl	**0.75**	1.5	2.8	7.4	5.2	2.5	9.1	1.5	2.2	3.5
U	**2.8**	21.6	14.1	14.4	28.2	9.6	13.6	36.2	85.4	46.9
V	**110**	2094.0	1072.0	942.0	1001.0	459.0	667.0	3050.0	2982.0	2634.0
W	**2**	199.4	226.2	184.9	527.1	452.7	424.0	200.0	388.8	278.2
Y	**22**	5.9	7.4	2.0	5.4	4.8	14.0	8.5	93.9	74.7
Zn	**71**	380.0	332.0	1247.0	773.0	690.0	505.0	4917.0	546.0	2962.0
Zr	**190**	113.4	172.5	160.2	248.8	172.2	140.7	119.1	81.1	121.0

4.3 Biological Environment

4.3.1 Vegetation

Vegetation Types in Mozambique

The vegetation of Mozambique and the Cabo Delago Province specifically has very little detailed and published information available. Descriptions by Wild and Barbosa (1967) and a biogeographical survey by White (1983) are currently the most reliable sources of vegetation information. The above literature largely describes plant formations on a broad landscape level, but provides very little information on the communities found within the major vegetation types.

Eight broad vegetation types have been described and mapped for Mozambique (MICOA, 2009). Miombo Woodland is the most widespread, dominating in the north and centre of the country followed by Mopane Woodland which occurs in the southern and northern parts of the country. The third most widespread vegetation type is Undifferentiated Woodland which covers extensive parts of the south, central and northern portions of the country. The remaining vegetation types include Afromontane Elements, Coastal Mosaics, Halophytic Vegetation, Mangroves and Swamp Vegetation. According to the Broad Vegetation map of Mozambique (After White, 1983 in MICOA, 2009), the vegetation of the proposed project site is classified as Miombo Woodland.

Miombo Woodland covers almost three million square kilometres in southern, central and east Africa (Smith 2000). Despite this broad and extensive range, the World Wildlife Fund (WWF) has listed this vegetation type as Vulnerable. Miombo woodlands range from completely deciduous to almost evergreen vegetation but are mostly semi-deciduous in nature (White, 1983). Miombo tends to show resistance to fire, but cannot survive repeated fire events (White 1983). Natural stress and drought are important factors in the growth of Miombo (Chidumayo 1991) as well as its fruiting potential (Chidumayo, 1997). This vegetation type is characterized by nineteen (19) dominant species of *Brachystegia* and three (3) other species namely *Julberbernadia globiflora, Julbernadia paniculata* and *Isoberlinia angloensis* (White, 1983). The following species occur within this vegetation type and reach canopy height: *Afzelia quanzensis, Anisophyllea pomifera, Erythrophleum africanum, Faurea saligna, Marquesia macroura, Parinari curatellifolia, Pericopsis angolensis* and *Pterocarpus angolensis*. Included are a few species of *Uapaca* and *Monotes*, which tend to be about 10m tall (White, 1983).

Miombo Woodland can further be divided into two classes; namely Wet Miombo and Dry Miombo, generally separated by the 1100 mm mean rainfall isohyet (Chidumayo 1987). The vegetation assessment suggests that the project area occurs within the drier Miombo type which can be defined by the following characteristics:

- Rainfall is less than 1000mm.
- Canopy height usually less than 15m.
- Floristically poor.
- *Brachystegia floribunda* absent or very localized.
- *Brachystegia spiciformis, Brachystegia boehmii* and *Julbernardia globiflora* are often the only dominants present.
- Associates in rocky places include many species which otherwise occur in deciduous forest and thicket or other dry types.
- Associated vegetation includes dry deciduous forest and thicket, deciduous riparian forest, and dry dambos.

Site specific vegetation types

A fine scale assessment of the site identified two main vegetation types namely Miombo Woodland and Riparian Woodland (Figure 4.12). The Miombo Woodland is further split into three types based on their species composition - Miombo Wodland Graphite, Miombo Woodland Granite and Miombo Woodland Plains (disturbed / intact). For the purpose of the site specific vegetation assessment the definition of woodlands, as described by Palgrave et al. (2007), has been adopted: "*Woodlands are open stands of trees at least 5 m tall with crowns that cover at least 20% of the surface and are not interlocking. Grass cover is usually present*".

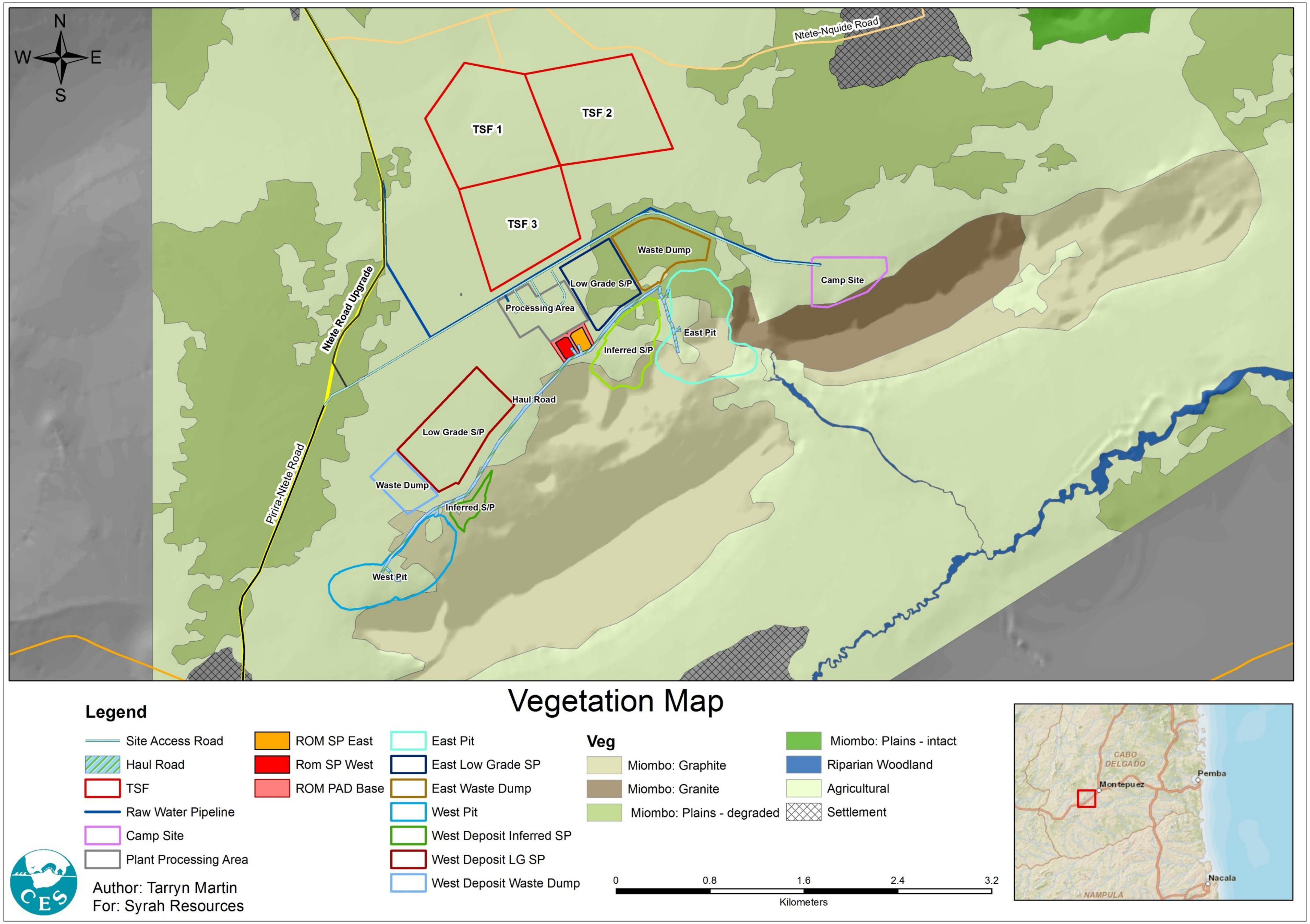


Figure 4.12: Vegetation map of the project site

Riparian Woodland

The Riparian Woodland is entirely restricted to a narrow band of a few metres, adjacent to the rivers and streams, throughout the Balama Graphite project area. In most cases, the riparian woodland is absent or highly degraded (Figure 4.12; Plate 4.1). The narrow strips of riparian trees were difficult to detect on the aerial imagery, limiting accurate mapping of this vegetation type. The dominant species in the intact areas are *Brachystegia boehmii, Albizia adianthifolia, Grewia forbsii, Combretum sp., Tabernaemontana elegans* and *Xylotheca kraussiana* (Plate 4.2) (see Vegetation Assessment for all species found in this habitat).

Plate 4.1: Riparian Woodland

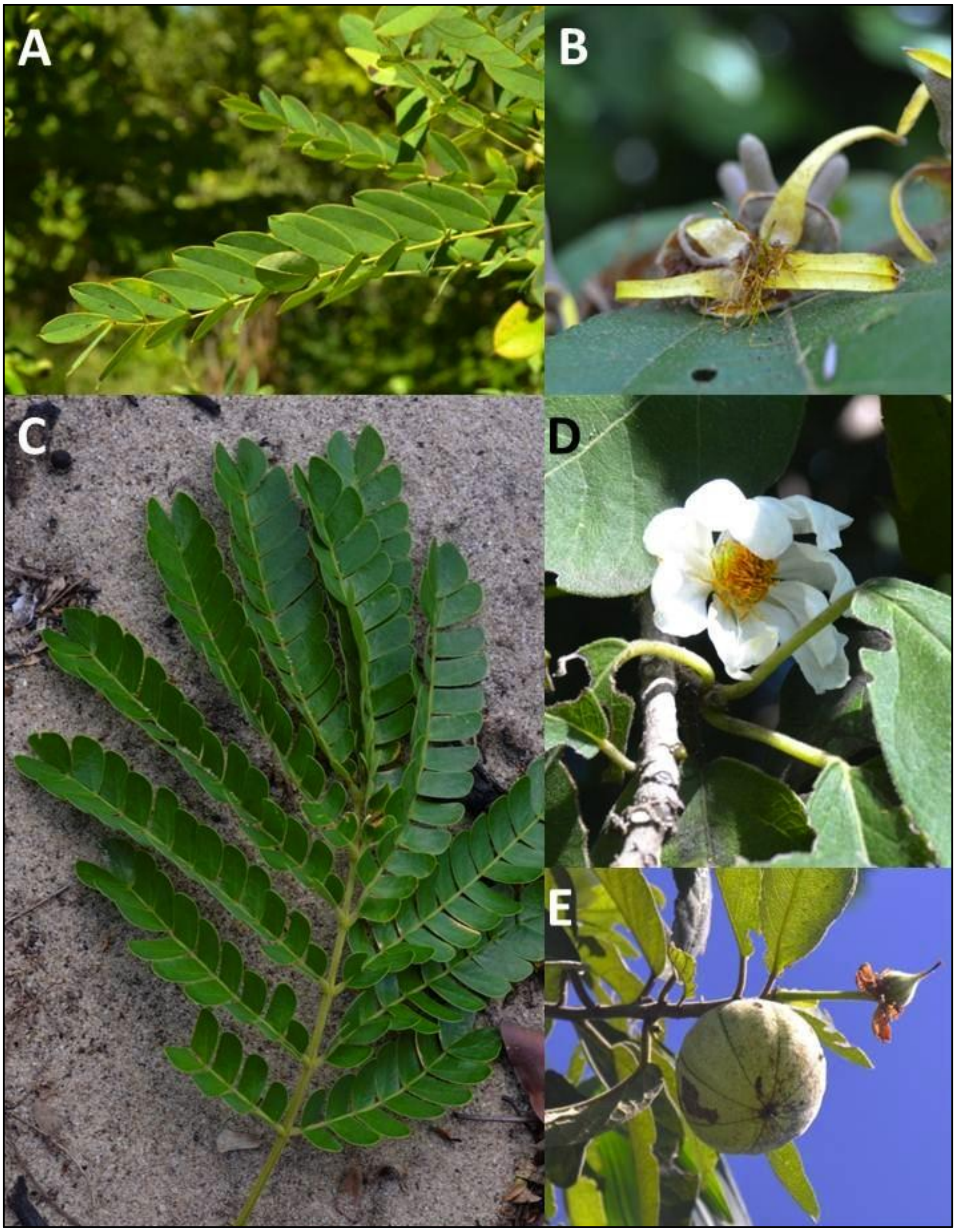


Plate 4.2: Dominant species found in the Riparian Woodland *A) Brachystegia boehmii. B) Grewia forbsii, C) Albizia adianthifolia D) Xylotheca kraussiana* flower and *D) Xylotheca kraussiana* fruit*.*

Miombo Woodland

Miombo Woodland is found throughout the project site in varying states of degradation and transformation. Further analysis of the survey data indicates that this vegetation type can be further divided into three distinct vegetation types based on their species composition. These are described in detail below and their distribution is illustrated in Figure 4.12.

Miombo Woodland: Graphite

This vegetation type is found on the slopes of the inselberg Mount Nassilala and is strongly associated with the underlying graphite. It is characterised by a closed canopy with a distinct grass layer beneath (Plate 4.3). It is interspersed with fairly large patches of bamboo (*Oxytenanthera abyssinica*) which appear to be invasive and may become a problem if left unchecked. Dominant species include *Securidaca longipedunculata, Bauhinia galpinii, Milletia stuhlmannii* and *Cussonia arborea,* with a notable absence of *Brachystegia* species. *Diplorhynchus condylocarpon* was dominant in areas that had been recently disturbed by harvesting. During the dry season it was noted that large trees were being harvested on Mount Nassilala for construction materials. The vegetation on this inselberg therefore provides an important ecosystem service to the surrounding villages.

Plate 4.3: Miombo Woodland (on the hill slopes) associated with the graphite deposit

Miombo Woodland: Granite

This vegetation type predominates on the granite intrusion Mount Coronge (Plate 4.4). The dominant species include *Cussonia cf arborea*, *Sterculia appendiculata* and *Milletia stuhlmannii.* Other species include *Combretum molle* and *Steganotaenia araliaceae.*

Plate 4.4: Miombo Woodland (on the hill slopes) associated with the granite intrusions

Miombo Woodland: Plains

This vegetation type predominates in the flat areas surrounding the inselbergs. It is largely secondary woodland, having been transformed by agricultural practices. Patches of degraded woodland occur along the road from Pirira village to Chipembe dam and within the project site.

However, a significant patch of intact woodland was found to occur east of Nquide village (Plate 4.5). It is unclear why this woodland has not been transformed and planted by the local community but it is highly probable that this is a sacred site.

Dominant species in the intact areas include *Gardenia resiniflua, Ficus sp. Antidesma vernosum, Brachystegia boehmii, Brachystegia bussei* and *Strychnos madagascariensis.*

Dominant species in the degraded areas include *Securidaca longipedunculata, Bauhinia galpinni, cf Dovyalis sp., Pseudolachnostylis maprouneifolia, MIlletia stuhlmannii* and *Antidesma vernosum*.

Plate 4.5: Intact woodland found in the flat plains near the Nquide village

Agricultural Land

Large sections of the plains have been cleared for the cultivation of crops such as maize, cassava, beans and cotton. Despite the majority of tree species being cleared it was noted that there were numerous Baobab trees (*Adansonia digitata*) and Tall Star Chestnut trees (*Sterculia appendiculata)* that had not been removed (Plate 4.6). These trees are either too large to remove or they serve a functional purpose such as a source of shade or in the case of the baobab trees, as a source of food. They could also have spiritual significance to the local communities.

Plate 4.6: Example of typical agricultural fields with a single Baobab tree

Vegetation Distribution

Twenty percent of the project site is comprised of degraded *Miombo Woodlands: Plains* (Table 6-1 and Figure 6-3). *Agricultural areas* and *Settlement*s make up a further 65.8% of the project area. The Miombo Woodlands associated with the granite intrusions and graphite deposits (i.e. the vegetation that occurs on Mount Coronge and Mount Nassilala) collectively make up 12.4 percent of the vegetation in the project area.

Figure 6-3 illustrates the distribution of each vegetation type throughout the project area. The *Miombo: Graphite* vegetation is found on Mount Nassilala and the eastern portion of Mount Coronge. The *Miombo: Granite* vegetation can be found on the western portion of Mount Coronge. The *degraded Miombo Woodlands: Plains* is found in patches throughout the flat, low-lying areas and is surrounded by agricultural land. There was only one small patch of *intact Miombo Woodlands: Plains*. This occurs to the east of Nquide village.

The vegetation type that will be most heavily impacted by the proposed mining infrastructure (excluding roads) is the *Miombo Woodland: Graphite.* 7.8% of the total area of this vegetation type will be lost during the mining process. The second most impacted vegetation type is the degraded *Miombo Woodlands: Plains* with a loss of 1.4% of this vegetation type. 1% of the *Miombo Woodlands: Granite* will be lost. The intact *Miombo Woodlands: Plains* will not be directly impacted by the mining operation. Although not included here, riparian vegetation will be impacted by infrastructure such as roads. Although not a "vegetation type" it is worth noting that 13.0% of agricultural land will be directly impacted.

Table 4.7: Total Area of Each vegetation type and the area that will be directly impacted

Vegetation Type	Total Area (Ha)	% of Project Area	% of veg type Impacted
Riparian Woodland	56	0.7	0
Miombo Woodland: Graphite	824	10.5	7.8
Miombo Woodland: Granite	149	1.9	1.0
Miombo Woodland: Plains – degraded	1561	19.9	1.4
Miombo Woodland: Plains - intact	91	1.2	0
Agriculture	4840	61.6	13.0
Settlements	332	4.2	0
TOTAL	**7 853 (Mapped Area)**	**100**	**9.1**

Floristic Diversity

Historically, vegetation surveys in Mozambique have been limited. However, there has been an increase in the last 20 years with specific areas of interest being targeted. These include protected areas (such as national parks and reserves), centres of endemism and suspected biological hotspots. From these surveys, it is estimated that over 5 500 plant species have been recorded in Mozambique although the actual number of species is likely to be much higher (MICOA, 1997 and 2009). Of these 5 500 species, 177 species are endemic and 300 occur on the Mozambique Red Data List (MICOA, 2002).

Based on habitat distribution it is possible that nine vulnerable species listed on the Mozambique Red Data List could occur in the project site. These are listed in Table 4.8 below.

Table 4.8: Vulnerable Plant Species that could occur in the project site

Species	Status	Endemism
Adenia mossambicensis	Vulnerable	Endemic
Cassipourea obovata	Vulnerable	Endemic
Combretum stocksii	Vulnerable	Endemic
Dichapetalum zambesianum	Vulnerable	Endemic
Grevea eggelingii	Vulnerable	Near-Endemic
Hexabolus mossambicensis	Vulnerable	Possible Endemic
Homalium mossambicensis	Vulnerable	Endemic
Maerua andradae	Vulnerable	Endemic
Viscum littoreum	Vulnerable	Endemic

Many of the identified endemic species and rare and threatened habitats are associated with isolated inselberg's such as the Chiperone and Namule hills, Mecula and Gorongosa Mountains and Chimanimani massive. While these areas are recognised as areas of floristic endemism, many more inselberg's are yet to be documented in the country (MICOA, 2007). Two inselbergs were identified on the project site, both being relatively intact compared to the surrounding vegetation. However neither of these can be described as critical habitats, as defined by the IFC Performance Standard 6, from a floral perspective since they do not contain critically endangered and/or endangered species, and neither of them are habitats of significant importance to endemic and/or restricted range species. Neither of these inselbergs can be classified as highly threatened or unique ecosystems and they are not associated with key evolutionary processes. While these habitats are not classified as critical habitats they have been classified as natural habitats using the IFC definition *"areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition."* (IFC, 2012).

Based on the species identified on site (Total number of 111 species identified) the following was concluded:

- No species of special concern appear on the IUCN (2012) list.
- One exotic species is listed as data deficient and 25 species are likely to be classified as Least Concern since no species within their family occur on the list. There is no information available for the remaining 46 species.
- According to the Mozambique Red Data List (2002), one species (*Sterculia appendiculata)* is considered "vulnerable" as a result of over exploitation for firewood, timber and local construction
- One CITES species, from the Orchidaceae family, appears in Appendix II. This species is not necessarily threatened, but is controlled in terms of international trade whereby CITES controls international trade of certain species i.e. all import, export and re-export of CITES species has to be authorised through a licensing system
- No species appear on the Tanzanian, Zimbabwean, Zambian or Malawian Red Data Lists
- No Alien species were identified on site. However, mango trees were prevalent in the flat plains near the villages, in amongst the cultivated lands. Bamboo (*Oxytenanthera abyssinica*) was also noted to occur in the woodlands, particularly the degraded woodlands at the foot and on the slopes of Mount Nassilala. Although this bamboo is indigenous to the region, it could become invasive, especially in disturbed areas where they regenerate and disperse rapidly from seeds and form impenetrable stands that prevent other species from establishing. It was noted that local communities avoided planting in areas previously covered by bamboo, possibly due to the extensive root system which is difficult to remove without machinery.

In terms of ecological sensitivity (Figure 4.13), a large portion of the project area had been cleared for agricultural crops such as cotton, maize and cassava, resulting in these areas having a low sensitivity as they have been transformed through anthropogenic activities and are highly degraded. Areas of natural vegetation, such as the degraded Miombo Woodland: Plains, were assigned a medium ecological sensitivity as they still have a relatively high species richness and form important ecological process areas for small mammals and birds in the area. These areas can withstand a limited loss of, or disturbance to, natural areas.

Areas of high sensitivity were assigned to the Miombo Woodland: Granite and Miombo Woodland: Graphite, the intact Miombo Woodland: Plains and the Riparian Woodland. These vegetation types were assigned a high sensitivity score as these areas are all relatively intact and have high species diversity. They also contain species of special concern such as *Sterculia appendiculata* (listed as Vulnerable on the Mozambique red Data Lists). A number of these species were noted to occur on the slopes of the Granite Inselberg (Mount Coronge). Although highly degraded in most parts, the Riparian zone was assigned a high sensitivity score as it is an important process area for ecosystem functioning. It also scored a high biodiversity value.

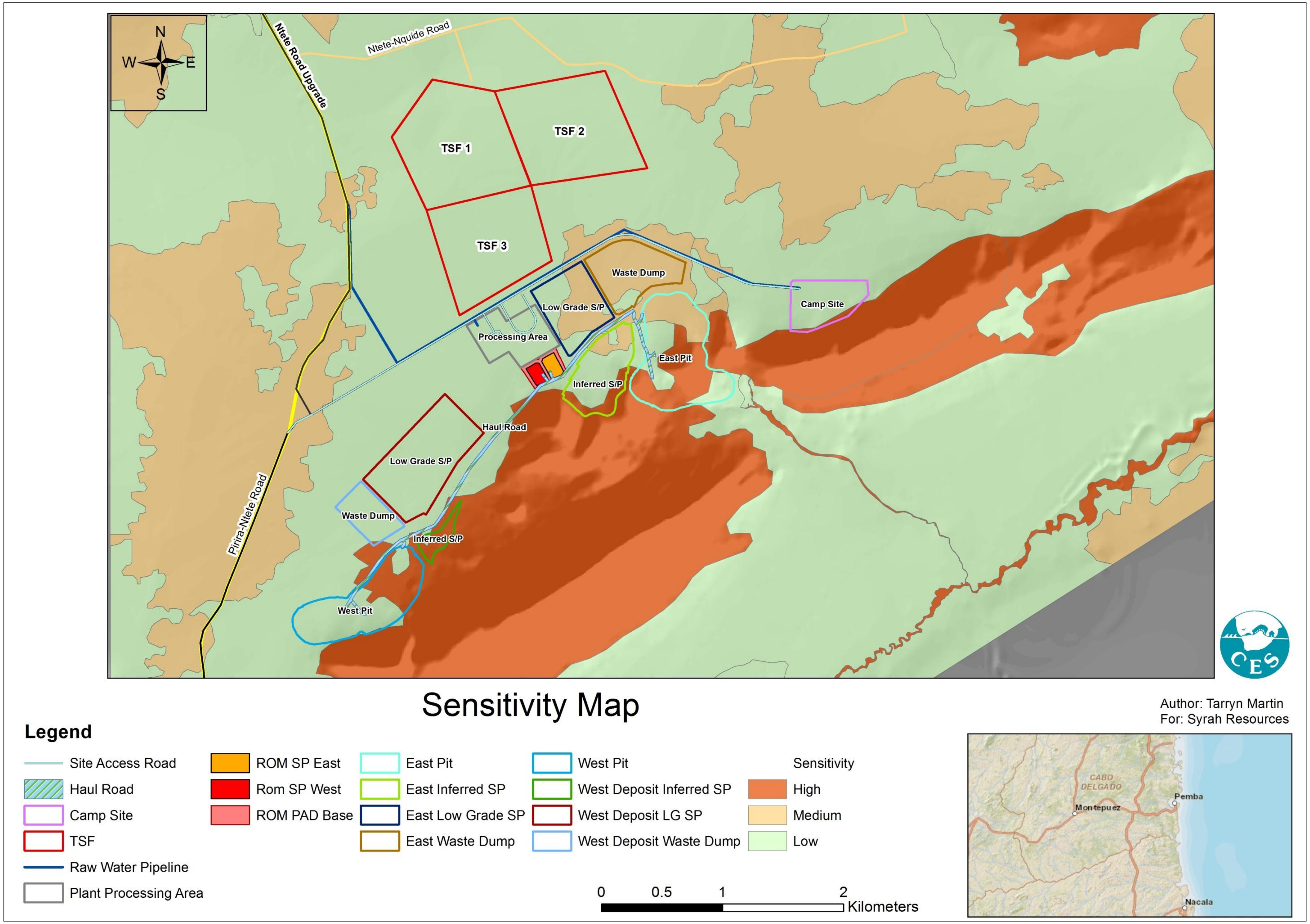


Figure 4.13: Ecological Sensitivity map of the Project area (Source: Vegetation assessment, 2013). Note: SP – Stock pile; LG – Low Grade.

4.3.2 Fauna

Amphibians

Although the faunal surveys did not occur at the beginning of the amphibian breeding season, many amphibians were still breeding and a good sample of the known and possible amphibians occurring the region was obtained. Only two problematic amphibians were obtained. One small reed frog was assigned to *Hypeolius acuticeps* of the *Hyperolius nasutus* complex (Channing *et al.* 2013), although this is based on geographical location and was not confirmed by vocalisation of genetic analysis. The other was a small puddle frog, provisionally assigned to the *Prhynobtrachus* cf. *perpalmatus* complex.

Most of the observed amphibian fauna are characteristic species of wetlands in the lowlands of northern Mozambique, from which 25 species are recorded and a further 13 species are possible. Two amphibians collected in the region, *Hyperolius acuticeps* (previously *H. nasutus*) and *Ameitia quecketti* (previously *A. angolensis*) remain of problematic status as both belong to groups that have recently undergone taxonomic revision (Channing et al. 2013 and Channing & Baptista 2013, respectively), and assignment of material from northern Mozambique is only provisional. No amphibians in the Balama region are endemic or of conservation concern. No amphibians are endemic to northern Mozambique.

There is no evidence of significant direct utilization of amphibians in the region, either for international trade or for food consumption. Amphibian threats are thus indirect, of which the most significant is habitat loss due to existing agricultural practises. This may be exacerbated by future industrial developments in the region, of which the proposed mine forms part. Increasing habitat fragmentation from land clearance or degradation resulting from agriculture or industry, can lead to secondary impacts, including road mortalities and exposure to predators as amphibians move to and from wetland breeding sites.

Plate 4.7: An array of amphibians which were recorded during the site visit (Top: *Arthroleptis stenodactylus*, *Chiromantis xerampelina*. Bottom: *Amietophrynus gutturalis*, *Amietophrynus maculatus*)

Reptiles

Of the potential 87 reptiles that may occur in the Balama region, only 20 were recorded during the survey. A further eight large or conspicuous species, namely Southern Rock Python *(Python natalensis*), Spotted bush snake (*Philothamnus semivariegatus*), Mozambique spitting cobra (*Naja mossambica*), black mamba (*Dendroaspis polylepis*), green mamba (*Dendroaspis angusticeps*), tree agama (*Acanthocercus branchi*), and Eastern hinged tortoise (*Kinixys zombensis*), were reported by mine personnel and local villagers to be present. Most reptiles documented on site were conspicuous diurnal lizards, with relatively few snakes observed or captured. Although snakes form the dominant component of reptile diversity in the region (48, 52%), they are mainly small, cryptic and nocturnal and therefore easily overlooked. Although only six snakes were collected during the survey, numerous additional snakes (15-20) are likely to be present in the various habitats on site. Two of the snakes collected (Puff adder and southern burrowing asp) are venomous and are commonly responsible for snake bites in East and Southern Africa.

One lizard of scientific interest was collected during the survey. A series of small, snake-eyed skinks (*Panaspis* cf *wahlbergii*) were collected beneath cashew trees near Nquide village. Molecular analysis of similar material collected near Lishinga indicates that a new species occurs in northern Mozambique. It is unlikely that this new species, which already appears to have a relatively wide distribution, will be of conservation concern although it may be endemic to Mozambique.

Five Mozambican reptiles are listed as threatened in the IUCN Red List (2012); all are sea turtles found at the coast. These will not be impacted in any way due to the development. No other formally recognized threatened (IUCN 2012) reptiles were recorded in the region. Only one Mozambique reptile (the Zambezi soft-shelled terrapin, *Cycloderma frenatum*) is listed in the `Near Threatened' category of the Red List (2012), but no suitable habitat for the species occurs in region, although it is common in Lake Niassa and the Rovuma River. A number of non-threatened species in the region (e.g. the Flap-necked Chameleon, *Chamaeleo dilepis*), monitor lizards (*Varanus niloticus* and *V. albigularis*), a girdled lizard (*Cordylus tropidosternum*), tortoises (*Kinixys spekii, K. zombensis* and *Stigomochelys pardalis*) and Nile crocodile (*Crocodylus niloticus*), are involved in international trade and are listed on CITES Appendix 2 that controls and documents their numbers in international commerce.

Endemicity in Mozambique reptiles is surprisingly low, with only approximately 14 taxa endemic to the country, most being associated with isolated populations on the various offshore islands of the Bazaruto Archipelago. Two new species have also recently been described from isolated montane habitats in northern Mozambique (Branch & Bayliss 2009, Branch & Tolley 2010), with additional new species being described (Branch *et al.* in press). Although these taxonomic novelties are associated with montane isolates, a new burrowing skink has also been discovered north of Pemba in the coastal region of northern Mozambique (Verburgt & Broadley in press). The unusual snake-eyed skink recorded during the faunal surveys indicates that additional new species may even occur in the Balama region.

As with amphibians, there is no evidence of significant direct utilization of reptiles in the region, either for international trade or for food consumption. However, all snakes are treated as dangerous and are usually killed when discovered by local inhabitants; this despite the majority of snakes in the region being non-venomous and thus harmless. Interviews with local inhabitants and mine personnel confirmed that snakebites in the region were rare, and usually non-fatal (albeit with pain and occasional morbidity). No tortoises were observed in the wild during the survey, although an adult leopard tortoise (*Stigmochelys pardalis*) was offered for sale by local villagers. It was refused, but was not released as it was retained by its captors for eating. Tortoises are known to be readily collected for food by local communities (Lindsey & Bento 2010), and their numbers may be very low or even locally extirpated due to local consumption.

The most significant threats to reptiles are indirect, and result mainly from habitat loss due to existing agricultural practises. Proposed industrial developments in the region will compound this threat, especially from the resulting habitat fragmentation that leads to elevated mortality from road traffic and exposure to predators as reptiles (particularly tortoises, snakes and monitors) move over the landscape.

Adult Nile crocodiles (*C. niloticus*) are the most important dangerous reptiles in the region. Crocodile encounters in the dam on the Chipembe River pose a serious threat, with three attacks (two fatal) reported in 2012 (pers. comm. Christian Nyaundi, Digby Wells).

There are numerous venomous snakes in the region, including black mamba (*Dendroaspis polylepis*), green mamba (*D. angusticeps*), several cobras (Mozambique spitting cobra, *Naja mossambica* and the forest cobra, *N. melanoleuca*), the Puff adder (*Bitis arietans*), the snouted night adder (*Causus rhombeatus*), the boomslang (*Dispholidus typus*), the twig snake (*Thelotornis mossambicanus*), and the southern burrowing asp (*Atractaspis bibroni*). All, except the latter and the snouted night adder have venoms capable of causing death and therefore represent important clinical concerns. Despite this, only a few (about 3 a year) snakebites were reported locally, with no recent fatalities (pers. comm. Christian Nyaundi, Digby Wells).

Plate 4.8: An array of reptiles recorded during the site visit (Top: *Trachylepis varia*, *Panaspis wahlbergii*. Bottom: *Trachylepis margaritifer, Hemidactylus platychephalus*)

<u>Birds</u>

Of the possible 300+ bird species which may occur in the study area, 133 were observed during the wet season survey. The number of birds recorded is to be expected for a short-term survey, especially as it is likely that many intra-African and Palaearctic migrant birds had already departed at the time of the field trip.

The majority of the recorded species were typical residents of Miombo woodland and secondary woodlands in agricultural landscapes, which are the dominant habitats on site. Typical species included: black-headed oriole, black-backed puffback, black-crowned tchagra, spotted flycatcher, neddicky, tawny-flanked prinia, flappet lark, and broad-tailed paradise-whydah. Other species well represented in secondary clearings and grassy areas near rivers, included: black-winged bishop, yellow bishop, white-winged widowbird and Red-collared widowbird.

A number of waterbirds, including white-faced whistling duck, pygmy goose, Hottentot teal, black crake, common moorhen, African jacana, grey, rufous-bellied and green-backed herons, white-breasted cormorant, pied and malachite kingfisher, etc., occurred in the open water and surrounding reedbeds of the Chipembe River and associated dam, and also along the small water impoundment on the Malipe Stream associated with the embankment on the road to Balama.

Typical bird species found within the Riparian corridors (including riparian forest) included: pied kingfisher, little bee-eater, Klaas's cuckoo, Senegal coucal, Meyer's parrot, African green-pigeon, tropical boubou, orange-breasted bush-shrike and the ubiquitous dark-capped bulbul.

The hydrophilic grasslands and reed beds associated with the streams and depressions were inhabited by hamerkop, rattling cisticola, African pied wagtail, golden weaver, village weaver, red-billed firefinch, blue waxbill, bronze mannikin as well as yellow-fronted canary.

Numerous guilds of birds, common in uninhabited regions, were absent or very rare in the study area. These included: bustards and cranes, plovers and lapwings, francolin and spur fowl, ibis, and thrushes. These are large to medium-sized birds that are often eaten by rural people, and their absence is best explained by a long history of subsistence hunting targeting larger birds for food. In addition, increased fire regimes in floodplain habitats occur during cane rat hunts or when grazing is prepared for cattle. These fires can also lead to local extinctions of bird roosting and breeding sites. Many secretive birds of dense wetland vegetation, e.g. crakes, rails and fluff tails, were probably present but overlooked.

Domesticated and introduced birds included: chickens (*Gallus gallus domesticus*), feral pigeon (*Columba livia*) and house sparrow (*Passer domesticus*), all of which occur in villages in the region.

No bird species which are considered threatened by the IUCN were recorded on site. However, several (11) CITES listed species were recorded, while a further 61 bird SSC may occur in very low numbers or as vagrants on site. The recorded SSC include mainly the Falconiformes species (e.g. eagles, buzzards, goshawks, sparrowhawks etc), and Strigiformes species (owls), of which 10 species were recorded in the area. Of the *Tauraco* (louries) species that also fall under CITES legislation, only the purple-crested turaco was observed on site.

Table 4.9 lists all possible and recorded bird SSC for the project area.

Table 4.9: All possible and recorded bird SSC for the project region

Species	Common Name	Category	CITES	Possible	Recorded
Balearica regulorum	Grey Crowned-crane	EN	II	1	
Necrosyrtes monachus	Hooded Vulture	EN	II	1	
Gyps africanus	White-backed Vulture	EN	II	1	
Bugeranus carunculatus	Wattled Crane	VU	II	1	
Torgos tracheliotos	Lappet-faced Vulture	VU	II	1	
Trigonoceps occipitalis	White-headed Vulture	VU	II	1	
Sagittarius serpentarius	Secretarybird	VU	II	1	
Bucorvus leadbeateri	Southern Ground-hornbill	VU		1	
Terathopius ecaudatus	Bateleur	NT	II	1	1
Circus macrourus	Pallid Harrier	NT	II	1	
Polemaetus bellicosus	Martial Eagle	NT	II	1	
Stephanoaetus coronatus	African Crowned Eagle	NT	II	1	
Falco vespertinus	Red-footed Falcon	NT	II	1	
Falco concolor	Sooty Falcon	NT	II	1	
Coracias garrulus	European Roller	NT		1	
Gallinago media	Great Snipe	NT		1	
Falco peregrinus	Peregrine Falcon	LC	I	1	
Tauraco porphyreolophus	Purple-crested Turaco	LC	II		1
Tyto alba	Barn Owl	LC	II	1	
Tyto capensis	African Grass-owl	LC	II	1	
Otus leucotis	White-faced Scops-owl	LC	II	1	
Bubo africanus	Spotted Eagle-owl	LC	II		1
Otus senegalensis	African Scops-owl	LC	II		1
Bubo lacteus	Giant Eagle-owl	LC	II	1	
Scotopelia peli	Pel's Fishing-owl	LC	II	1	
Strix woodfordii	African Wood-owl	LC	II	1	
Glaucidium perlatum	Pearl-spotted Owlet	LC	II	1	
Glaucidium capense	African Barred Owlet	LC	II	1	
Asio capensis	Marsh Owl	LC	II	1	
Eupodotis melanogaster	Black-bellied Bustard	LC	II	1	
Pandion haliaetus	Osprey	LC	II	1	
Aviceda cuculoides	African Cuckoo-hawk	LC	II	1	
Pernis apivorus	European Honey-buzzard	LC	II	1	
Macheiramphus alcinus	Bat Hawk	LC	II	1	
Buteo augur	Augur Buzzard	LC	II	1	
Elanus caeruleus	Black-shouldered Kite	LC	II		1
Buteo buteo	Common Buzzard	LC	II		
Haliaeetus vocifer	African Fish-eagle	LC	II		1

Species	Common Name	Category	CITES	Possible	Recorded
Milvus migrans	Black Kite	LC	II	1	
Milvus aegyptus	Yellow-billed Kite	LC	II	1	
Circaetus cinereus	Brown Snake-eagle	LC	II	1	
Circus aeruginosus	Western Marsh-harrier	LC	II	1	
Circaetus pectoralis	Black-chested Snake-eagle	LC	II	1	1
Circus ranivorus	African Marsh-harrier	LC	II	1	
Circaetus cinerascens	Banded Snake-eagle	LC	II		1
Polyboroides typus	African Harrier-hawk	LC	II	1	
Kaupifalco monogrammicus	Lizard Buzzard	LC	II		1
Melierax metabates	Dark Chanting-goshawk	LC	II		1
Melierax gabar	Gabar Goshawk	LC	II	1	
Accipiter tachiro	African Goshawk	LC	II	1	
Accipiter badius	Shikra	LC	II	1	
Accipiter minullus	Little Sparrowhawk	LC	II	1	
Accipiter ovampensis	Ovambo Sparrowhawk	LC	II	1	
Accipiter melanoleucus	Black Sparrowhawk	LC	II	1	
Aquila pomarina	Lesser Spotted Eagle	LC	II	1	
Aquila rapax	Tawny Eagle	LC	II	1	
Aquila wahlbergi	Wahlberg's Eagle	LC	II	1	
Aquila nipalensis	Steppe Eagle	LC	II	1	
Hieraaetus spilogaster	African Hawk-eagle	LC	II	1	
Hieraaetus pennatus	Booted Eagle	LC	II	1	
Hieraaetus ayresii	Ayres's Hawk-eagle	LC	II	1	
Lophaetus occipitalis	Long-crested Eagle	LC	II	1	
Falco naumanni	Lesser Kestrel	LC	II	1	
Falco rupicolus	Rock Kestrel	LC	II	1	
Falco dickinsoni	Dickinson's Kestrel	LC	II	1	
Falco amurensis	Amur Falcon	LC	II	1	
Falco subbuteo	Eurasian Hobby	LC	II	1	
Falco cuvierii	African Hobby	LC	II	1	
Falco biarmicus	Lanner Falcon	LC	II		1
Falco eleonorae	Eleonora's Falcon	LC	II	1	
Ciconia nigra	Black Stork	LC	II	1	
TOTALS				**61**	**11**

The woodlands in the project area are under anthropogenic pressures from population expansion, the long history of subsistence farming, and recent developments such as logging, charcoal production and coal mining operations in the region. The proposed mining operation will cause direct habitat loss at the footprints of the mining and infrastructure, but may also lead to secondary habitat degradation by facilitating access to wooded areas by loggers and charcoaling groups along new road networks.

Mammals

Due to the brief faunal survey no detailed investigation of the mammal fauna could be undertaken. Of the possible 145 mammal species which may occur in the study area (including 13 large mammals now locally extinct), only 14 were recorded during the wet season survey. A further 21 species were reported to still occur in the region, although some are now acknowledged to be very rare. The reported species derived from two interviews undertaken with local people at Nquide Village aimed to supplement field observations and to record dependence of the community on faunal resources. The interview group included the village headman and elders and local hunters. The group were shown pictures of mammals illustrated in Kingdon (1999) and further mammal images on a laptop. They were asked a series of general questions relating to mammals within the region and people's attitudes to them, i.e.:

- Was the illustrated species still known in the region, and how common was it?
- If considered very rare, when was it last seen?
- Was it historically present before the onset of the civil war?
- If present was it hunted or used for any other purpose?
- If hunted, how commonly was it caught?
- What hunting techniques were used?

The results of the interviews are summarised in Table 4.10. Hunting was still common and it was reported that all large villages had 1-2 specialist hunters. Young boys would also hunt opportunistically. Despite this effort, few medium-sized animals were collected (1 per week or month, depending on species). As insufficient animals were caught, all meat was sold or consumed locally, with no bushmeat traded in adjacent urban areas.

Scrub Hare (*Lepus saxatilis*) was said to be present, relatively common and snared or hunted with dogs to eat. Although Smithers & Tello (1976) do not show the species to occur in northern Mozambique, it is recorded in the region by Kingdon (2004). A number of medium-sized to large mammals recorded by Smithers & Tello (1976) were considered locally extinct by villagers, although were all known and some recorded seeing them still occasionally. They include: Greater Kudu (*Tragelaphus strepsiceros*), Impala (*Aepyceros melampus*), Reedbuck (*Redunca arundinum*), Waterbuck (*Kobus ellipsiprymnus*), Sable (*Hippotragus niger*), and Roan (*Hippotragus equinus*).

Table 4.10: Mammals present in the region and their use as a faunal resource

SPECIES	SCIENTIFIC NAME	COMMENTS
Rock Hyrax	*Procavia sp.*	Present but restricted to mountains. Hunted, but difficult to snare
Pangolin	*Smutsia temmincki*	Very rarely found. Always killed as they had high commercial value for local good luck charms and, especially for sale to Chinese businessmen.
Fruit Bats	*Eidolon*, etc.	Seasonal, but not common and not eaten
Scrub Hare	*Lepus saxatilis*	Present and hunted with dogs
Porcupine	*Hystrix africaeaustralis*	Present, relatively rare, and snared or dug out of burrows to eat
Cane Rat	*Thryonomys* sp.	Present in dambos and hunted with dogs in the dry season after fires
Vervet monkey	*Cercopithecus pygerythrus*	Mainly found along rivers. Not eaten, but may be problem in crops; hunted with dogs
Baboon	*Papio cynocephalus*	Mainly in hills. Not eaten, but a big problem in crop fields near hills; hunted with dogs, chased into trees and killed with bow and arrows (and probably guns).
Side-striped Jackal	*Canis adustus*	Still present, but restricted to less disturbed areas; no problem to livestock and not hunted
Slender Mongoose	*Herpestres sanguinea*	Common, seen almost daily
Spotted-neck Otter	*Lutra maculicollis*	Reported in Chipembe River, where it damages fish nets and steal fish from traps. Not hunted.
Honey Badger	*Mellivora capensis*	Very rare, not a problem (probably as few people collect honey in the region)
African Civet	*Civettictis civetta*	Present, not considered a problem
Genet	*Genetta sp.*	Present, not considered a problem
Spotted Hyena	*Hyaena hyaena*	Uncommon. Attacks livestock, but few recent records.
Lion	*Panthera leo*	No recent records.
Leopard	*Panthera pardus*	Still present in mountains, but not a problem with livestock
Hippopotamus	*Hippopotamus amphibious*	Recorded infrequently in Chipembe River
Elephant	*Loxodonta Africana*	Common before war, now rare. A small group comes to the dam on the Chipembe River each year. Three came to the village region 3 years ago and were chased off as they were damaging crops, and two were shot by agricultural services and all the villages remembered the feast.
Cape Buffalo	*Syncerus caffer*	Present before war, but no recent records
Bushbuck	*Tragelaphus scriptus*	Very rare now, but present in areas of thicker vegetation in riparian and hilly areas; hunted with dogs and snares
Suni & Common Duiker	*Neotragus moschatus* & *Sylvicapra grimmia*	Common in dambos; hunted with dogs and snares; one a month killed and sold in village (Sold at a cost of Me1800)
Bush Pig	*Potamochoerus larvatus*	Still present and hunted for food with dogs, snares and guns.

Domestic mammals observed on site included: cats (*Felis catus*), dogs (*Canis africanis*), zebu cattle (*Bos* sp.), pigs (*Sus scrofa*), and goats (*Capra aegagrus*).

A number of mammals not recorded during the survey are known by local people to still be present in the region. Hippo were reported to occur infrequently in the Chipembe River, and spotted hyaena were also reported to still occur in the region to the north of the study area. Yellow baboon, ground pangolin, civet, cane rats, porcupine, etc. (see Table 4.9) were also all reported to still occur in the region.

Of the large number (96) of small mammal species which could possibly occur in the study area, the majority are either rodents (Rodentia), bats (Chiroptera), or shrews (Eulipotyphla). These are all small mammals which can prove to be difficult to capture and identify: bat surveys require long-term trapping, using diverse arrays and in diverse habitats to achieve meaningful coverage of the species likely to be present. For bats these difficulties are increased by seasonal movements, usually associated with food availability.

The bat fauna of Mozambique has until recently been poorly documented. The most recent synopsis is 35 years old (Smithers & Tello 1976), in which only a single site (Ilha de Mozambique) had been surveyed north of the Zambezi River. Prior to 2000, a total of 56 bat species were known to occur in Mozambique, and 28 (50%) of these were known from two or fewer sites (Smithers &Tello, 1976), and at least three of these 56 species were based on misidentifications. To rectify this, Monadjem *et al*. (2010b) conducted a series of bat inventories across the country (2005 and 2009), including the first detailed surveys in northern Mozambique. They collected 50 species, including seven species new for the country, and increased the country total to 67 species. Subsequently, Taylor *et al*. (2012) described two new species, both endemic to Mozambique, bringing the country list (as of 2012) to 69 species. Monadjem *et al*. (2010b) modelled the distribution of bats across the country and recorded 38 bat species for northern Mozambique. Much of this diversity was restricted to montane isolates in the west, and the eastern coastal region of northern Mozambique had the lowest bat species diversity in the country. Two sites in the Balama region were surveyed and both had low diversity; i.e. Namapa and Balama Coutada where only four and two bat species were collected, respectively. However, *Taylor et al.* (2012) revised horseshoe bats of the *Rhinolophus hildebrandtii* complex, describing four new species of which two were endemic to Mozambique, including one species (*R. mossambicus*) from Namapa. The bat fauna for Mozambique thus includes 69 species, with 40 species recorded north of the Zambezi River.

Due to the cryptic nature and migratory movements, the conservation status of bats is generally poorly known. Of the 69 bats recorded from Mozambique (Monadjem *et al.* 2010b, Taylor et al. 2012), most were considered of Least Concern (54, 78.3%), six were Data Deficient (8.7%), six were Near Threatened (8.7%) and only three (4.3%) were considered Vulnerable (*Lissonycteris goliath* and *Myonycteris relicta*, Pteropodidae; *Cloeotis percivali*, Hipposideridae). None of these were recorded from the study site, and one of these (*Myonycteris relicta*) has only been recorded once for the country.

Many of the bat species which occur in the project area are wide-spread species of savannah and woodland. Many are associated with rivers and other water resources, and require either caves or buildings, or in some cases riparian forest, where they can roost during the day. While no large bat roosts in caves were observed or reported to occur in the study area, tall trees for fruit-eating bats do occur along the rivers systems in the region and can be expected to be used, at least seasonally.

Although many large grazing mammals once occurred in the region, most have been extirpated from accessible regions. The large carnivores associated with the megafauna, such as lion, leopard, cheetah, and wild dog, have either been hunted to local extinction (e.g.

lion, cheetah, and wild dog), or have simply moved away from the area due to disturbance or food shortages.

Eight mammal SSC were identified for the study area: three of these occurred in the area during historical times, but local people report no recent records and they are highly unlikely to still occur locally; two mammal SSC (African Elephant and Hippopotamus) were reported by locals to still occur in the area (see Table 4.11).

Table 4.11: Mammals SSC which are likely to occur or have occurred within the project area

Scientific Name	English Name	Red List status	Historical	Possible	Reported	Recorded
Lycaon pictus	African Wild Dog	EN	1			
Acinonyx jubatus	Cheetah	VU	1			
Panthera leo	African Lion	VU	1			
Loxodonta africana	African Elephant	VU			1	
Hippopotamus amphibius	Common Hippopotamus	VU			1	
Hipposideros vittatus	Striped Leaf-nosed bat	NT		1		
Eidolon helvum	Straw-coloured Fruit Bat	NT		1		
Panthera pardus	Leopard	NT		1		
Totals			**3**	**3**	**2**	

Major threats to mammal biodiversity in the region is subsistence hunting and habitat destruction, as well as the impacts of uncontrolled burning, slash and burn agriculture, livestock overgrazing and uncontrolled settlements. With regards to larger mammals, many of the threatened species in Mozambique are either hunted for subsistence, are susceptible to habitat loss, or are key factors in human/wildlife conflict. Subsistence use and habitat degradation are key factors affecting the population dynamics of Red-Data small mammals in the region.

4.3.3 Aquatic environment

All rivers in the Study Area are considered to be seasonal and only flow in the wet summer months, considered to be from November to March or April. During the dry winter months when flow ceases, the rivers within the Study Area mostly consist of disconnected, shallow pools, barely able to support fish life. In addition, there are a few deeper pools with permanent surface water that provide refuge during the dry season.

The co-ordinates and a brief description of these sampling sites are described Table 4.12.

Table 4.12: The 6 sites sampled for fish within the Study Area at the Syrah Balama Graphite mine (from north to south) during both the wet season (March) and/or dry season (August) 2013.

Site (River)	Co-ordinates		Description & Comments
	South	East	
Chipembe Dam (Montepuez R)	13^0 12' 8.3"	38^0 3 7' 19.6"	In shallow marginal areas of the dam near spill way and below the dam in flowing river. Sampled 6/03/13.
Mehucua River (u/s)	13^0 19' 5.8"	38^0 42' 34.2"	At track crossing river to the Chief Musa's homestead. Sampled 4/03/13 & 17/08/13.
Malipe River	13^0 20' 15.6"	38^0 37' 51.3"	First bridge after turnoff from camp on road to Balama Village. Sampled 5/03/13/ &19/08/13.
Namiticu River (confluence)	13^0 20' 40.3"	38^0 40' 36.8"	Below bridge over Namiticu R. at confluence with Naconha R. Sampled 4/03/13 & 17/08/13.
Namiticu River	13^0 24' 28.8"	38^0 35' 12.8"	Drift on first tributary from Balama Village. Sampled on 5/03/13 &19/08/13.
Naconha River	13^0 25' 59.1"	38^0 36' 41.2"	Bridge on second tributary after Balama Village. Sampled on 5/03/13 & 19/08/13.

Fish were captured using the following equipment:

- A 6m minnow seine (4 mm mesh).
- A series of gill nets of various mesh sizes (15m sections of 4, 8, and 10 cm mesh size).
- A fyke net (4 mm mesh, largest hoop of 60 cm).
- A 12 volt DC back-pack electro-fisher (Samus 725G), in combination with a variety of dip nets.
- Long line (15 hooks baited with fish).

The fishing gear used was determined by the aquatic habitats present at the various sites and the river flow conditions at the time of sampling.

A total of eleven fish species were observed and captured in the study area, with most of the species found at more than one site (Table 4.12**)**. Most species appear to be common throughout the study area and have widespread distributions throughout Southern Africa. However, one species (the Mozambique tilapia, *Oreochromis mossambicus*) is near threatened and two species, the sand catlet (*Zaireichtys cf. monotap*a) and the orange finned killifish (*Nothobanchius sp. "orange fins*") appear to be previously un-described scientifically.

Local villagers carry out fishing activities in these seasonal rivers mainly during the summer months (wet season and beginning of the dry season). Fish fences using wooden stakes and reeds are constructed across the river channel to trap fish upstream and to position funnel traps to capture fish migrating downstream when the water levels drop. Hook and line fishing for barbel and tilapia, is also undertaken, mainly by young boys. In the Chipembe dam fishes are captured all year round by means of gill nets set in open water and small reed funnel traps which are placed among vegetation in shallow water along the dam shoreline using dugout canoes. The majority of fishes captured (*Oreochromis mossambicus*, *Clarias sp*. and *Barbus sp*.) are less than 30 cm in length.

All the streams sampled are located in the upper catchment of the Montepuez River system which under natural, undisturbed conditions drain well-vegetated catchments. Under pristine conditions, there should be dense riparian woodland along the seasonal rivers with a naturally high plant biodiversity. In most river reaches in the study area the riparian zone is seriously degraded due to the clearing of the riparian vegetation to create lands for planting crops such as sugarcane and maize on deep, fertile soils near the rivers. Apart from animal manures from domestic stock and soap from washing activities at specific sites, no sources of pollution were apparent and the water quality appeared suitable for aquatic life.

The main existing negative impacts on the aquatic habitats in the study area are associated with clearing of riparian vegetation to cultivate crops and the construction of roads and river crossings. These activities have resulted in localized river bank instability, soil erosion and elevated sediment input, the filling in of deeper refuge pools and also higher than normal turbidity in the rivers after rainfall events. Based on the baseline assessment of the aquatic environment it was found that the aquatic habitat integrity in the study area has been moderately modified based on the loss and modification of natural habitat and biota. These river reaches will thus fall into a Habitat Integrity of Category C after Kleynhans (1996) and Kemper (1999).

In the upper tributaries of the Mehucua River, where human population densities are low, environmental impacts on aquatic habitat quality, diversity, size and variability are present at a relatively low number of sites and are also limited in severity. In terms of significance, the modifications to habitat integrity in these upper catchment streams are considered small to moderate and would fall into a Category B after Kleynhans (1996) and Kemper (1999). In this category the habitat integrity is described as largely natural with few modifications and a small change in natural habitat and biota may have taken place, but the ecosystem functions are essentially unchanged.

Table 4.12: An annotated list of fish species (listed alphabetically) collected during the fish surveys in the Study Area at the Syrah Balama Graphite Mine Study Area in March 2013, in the Wet Season (W) and in August 3013 in the Dry Season (D). NE = Not evaluated in IUCN Red List; DD = data deficient; LC – Least Concern, NT – Near Threatened, as classified in the IUCN Red Data List (IUCN 2010). Meh = Mehucua; Nac = Naconha; Mal = Malipe; Nam = Namiticu. (Source: Baseline fish and Aquatic habitat study, 2013)

Taxon (Genus, species	Common Name	Fish Sample sites												Comments: Conservation Status/food value
		Chip Dam		Meh R.		Nac R.		Mal R		Nam R (confl.)		Nam R (u/s)		
		W	D	W	D	W	D	W	D	W	D	W	D	
Barbus cf afrohamiltoni	Plump barb		ns	√		√		√	√	√				**LC.** Common in East Coast rivers from Zambezi to Phongolo. Attains 175 mm SL.
Barbus cf litamba	Tamba	√	ns				√					√		**LC**. Occurs in the Lake Malawi basin and northern Mozambique. Feeds on invertebrates and smaller fishes. Attains 440 mm in length.
Barbus paludinosus	Straightfin barb	√	ns	√		√		√	√			√	√	**LC**. Widespread in central and southern Africa. Attains 150 mm SL.
Barbus radiatus	Beira barb	√	ns	√		√		√		√		√		**LC**. Widespread in Central Africa and east coast rivers south to the Phongolo system. Attains 120 mm SL.
Barbus trimaculatus	Three-spot barb	√	ns			√		√				√		**LC.** Widespread in central and southern Africa. Attains 159 mm SL.
Barbus cf viviparus	Bowstrip barb	√	ns	√		√	√			√		√		LC. Widespread in east coastal rivers from Ramvuma to southern KwaZulu Natal. Attains 70 mm
Clarias gariepinus	Sharptooth catfish		ns					√	√	√	√		√	**LC**. Widely distributed throughout central and southern Africa
Nothobranchius cf macondorum	Annual killifish (Kapome)		ns			√		√	√	√	√	√	√	**NE.** A newly-described species. Distributed in SE Tanzania and NE Mozambique. There is currently no data on conservation status, but appears widespread
Nothobranchius sp 'orange fins'	Annual killifish		ns			√								**NE.** Probably a new species but have no data on distribution or conservation status
Oreochromis cf mossambicus	Mozambique tilapia	√	ns	√	√			√		√		√	√	**NT**. Widespread in east coasts rivers of southern Africa, from the Zambezi to Bushmans rivers. Attains 400 mm SL.
Zaireichthys cf monotopa	Sand catlet		ns	√		√			√					**NE.** A newly described species with no data on distribution or conservation status

4.3.4 Spatial Planning Tools

Spatial planning tools are used to determine ecologically sensitive and ecologically important areas and thereby guide decision makers. Tools such as determining Critical Biodiversity Areas and biodiversity mapping are now available in many countries. However, since very few of these tools currently exist for Mozambique, the following international planning tools were consulted:

WWF Eco regions

The World Wildlife Fund (WWF) has defined global eco regions based on geographically distinct assemblages of species, natural communities and environmental conditions. Information on each eco region and its conservation status are provided to assist with the continued conservation of these areas.

The project area falls into the Central and Eastern Miombo Woodlands Eco region as defined by WWF (Figure 4.14). This is a widespread eco region covering much of central and southern Africa. It is characterised by high species diversity and is dominated by a woody component whose dynamics can be attributed to three interacting disturbances: people, fire and wildlife. Anthropogenic activities such as clearing for agriculture, harvesting and burning have resulted in the modification or transformation of this ecosystem in many areas. Population growth therefore poses a threat to this Eco Region and it has consequently been listed as Vulnerable.

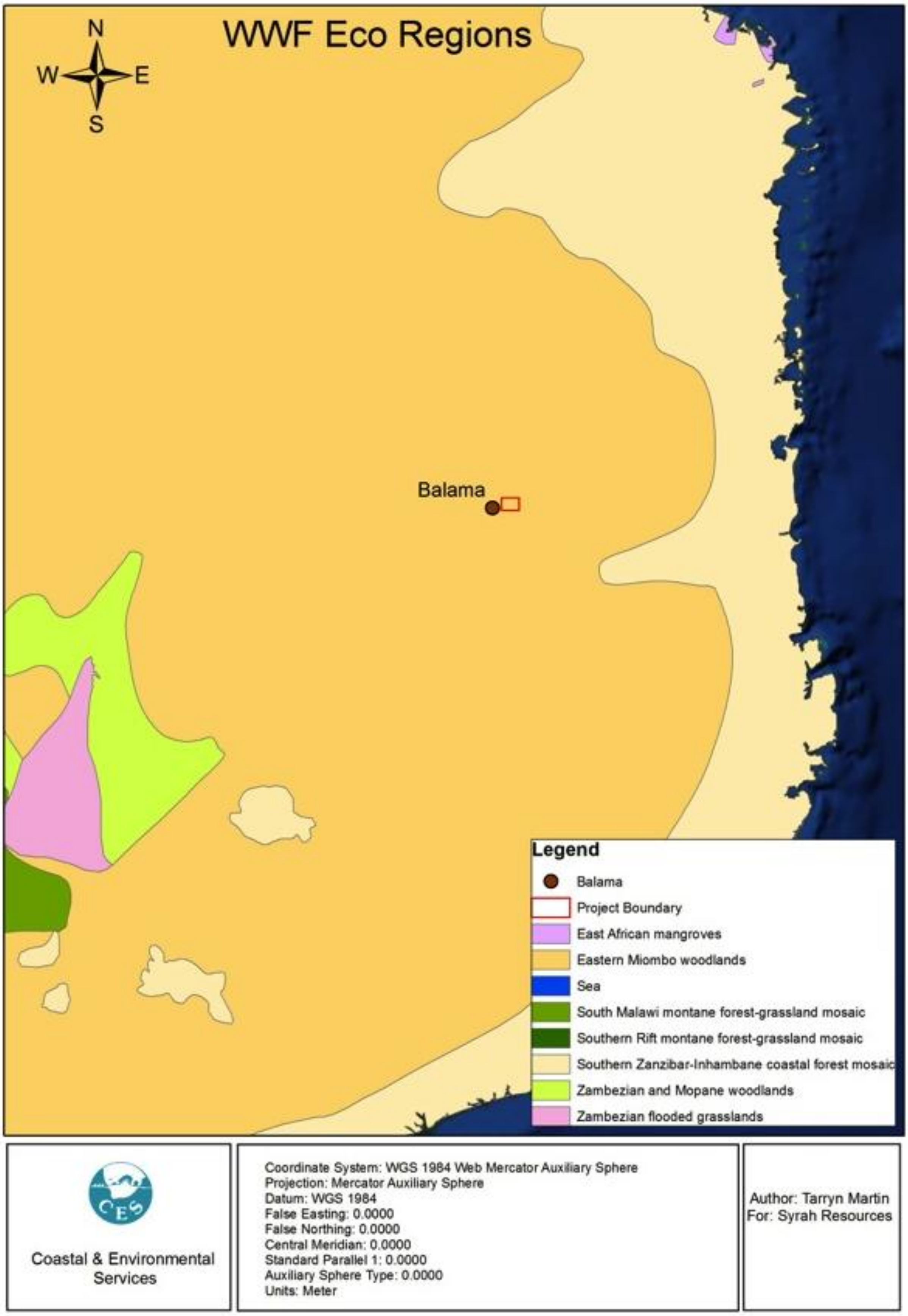


Figure 4.14: WWF Eco Regions surrounding the site
(Source: Vegetation Assessment, 2013)

Protected Areas

Current conservation legislation was drawn up by the colonial administration prior to 1977 and is in the process of being rewritten. The existing legislation makes provision for the creation of protected areas under six categories: National Park, Game Reserve, Partial Reserve, Faunal Reserve, Hunting and Photographic Safari Area and Forest Reserve. Management of protected areas petered out during the civil war. By 1992, all designated protected areas were unstaffed, without infrastructure and effectively unprotected.

However, rehabilitation of the protected areas is gradually being implemented. This is reflected in the statistic that between 1995 and 2008 protected area coverage increased from 11% to 16% with new conservation areas being created (MICOA, 2009).

Examination of these protected areas in relation to the project site revealed that no National Parks occur in close proximity to the project area (Figure 4.15). The closest protected area (Quirimbas), designated as a National Park, occurs 85 km north-east of the project site. The project site also occurs approximately 126 km north-west of a Hunting reserve, The Bloco C Luwiri, and between 92 km and 177 km from the three closest forest reserves, The Mecuburi Forest Reserve, The Mapalue Forest Reserve and the Ribaue Forest Reserve.

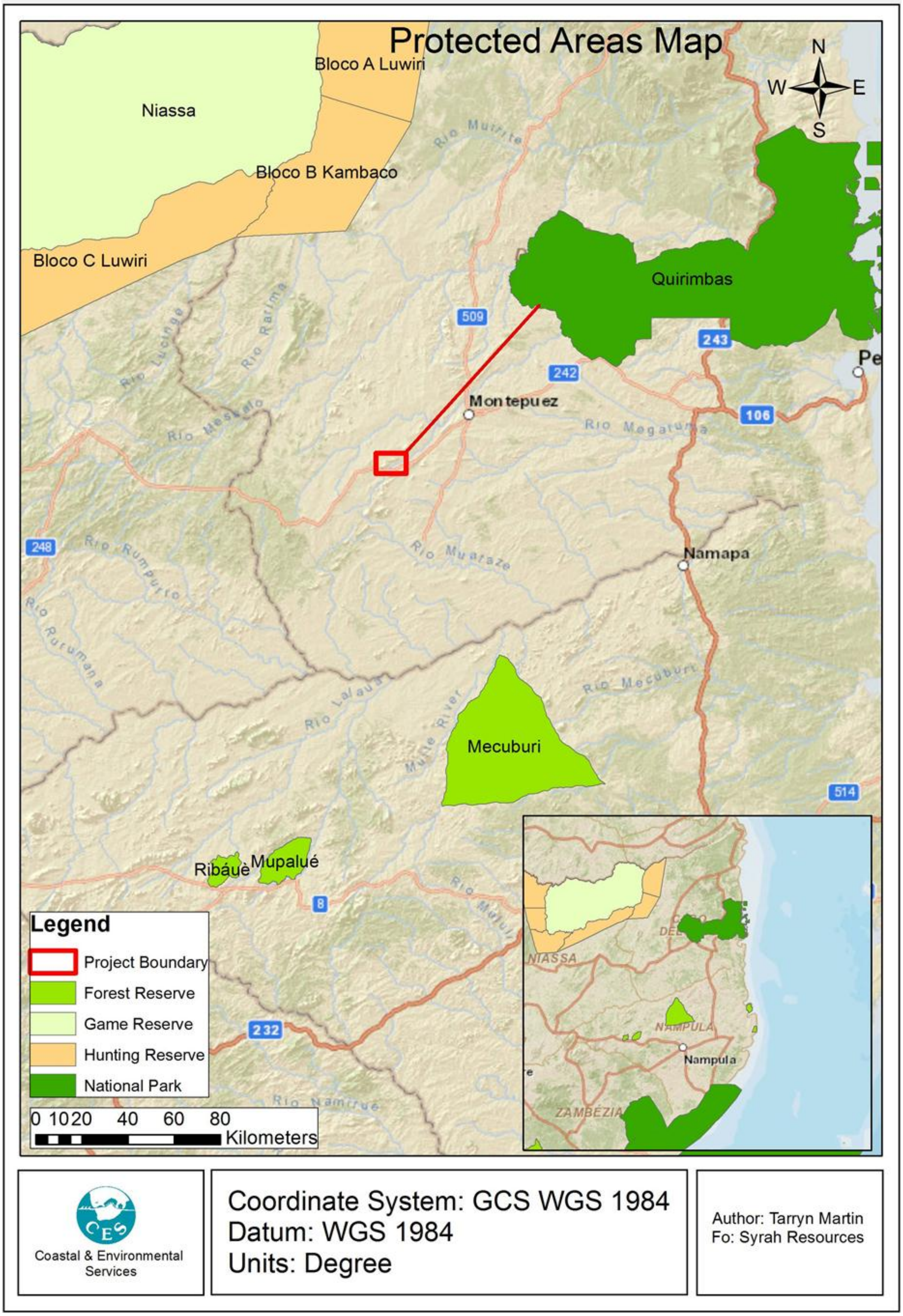


Figure 4.15: The protected areas surrounding the project site

(Source: Vegetation Assessment, 2013)

4.3.5 Land use

Mozambique has a relatively rich natural resource base including untransformed indigenous forests, savannah woodlands and coastal habitats. About 25% of the land has commercial forestry potential, 12.5% constitutes state-protected areas and a further 22% comprises potential wildlife habitat (GPZ, 2003).

Land use in the study area is primarily for subsistence agriculture (Plate 4.9). Crops such as maize, cotton and cassava are grown on the flat areas which are cleared using slash and burn techniques (Plate 4.10). Some small unit livestock is reared in the area, although these animals were only noted near the villages and are not abundant in the project site.

Almost all households are heavily reliant on the natural resources for their livelihoods. Natural resources are used for construction, medicinal consumption and to supplement their food. Charcoal production was also evident in the project site (Plate 4.11).

Plate 4.9: A) Ground nuts planted around a homestead; B) Maize intercropped with ground nuts; C) A maize food garden; D) Large machambas planted with maize in the background and to the right; and E) A small grain storage structure
(Source: Social Impact Assessment, 2013)

Plate 4.10: Recently burned field at the Project site
(Source: Vegetation Assessment, 2013)

Plate 4.11: Trees and shrubs are used for charcoal production in the study area

5. DESCRIPTION OF THE SOCIAL ENVIRONMENT

5.1 A Demographic overview of the Project-Affected Communities

The proposed project is encircled by four villages which are considered to be the direct Project-Affected Communities (PACs). These are Ntete, Nquide, Pirira and Mualia (formerly known as Maputo). The land and households of these communities seem to be privately controlled by individual families under the jurisdiction of the traditional Macua Tribe. Land is primarily held by the Government of Mozambique (GoM), which also legally recognises the role of customary tenure systems. In the rural areas, although land ultimately belongs to the state, the area is controlled by the chiefs and elders who regulate the land under the custodianship of the Macua Tribe. The tribe does not seem to have legal title to, or a certificate for, the land.

The villages are relatively large. The largest village is Ntete (with approximately 4 525 people), whilst the smallest one is Pirira (around 285 people). Considering the number of households, the village of Ntete has around 963 households, whereas few households have been recorded in Pirira (61). The average household size is approximately 4.4 members per household. The total population of all these villages combined is estimated at 11 048 people. The latest census of the Government of Mozambique (GoM, 2007) estimates the population of the Balama District at 124 100 people, which means that these four villages represent approximately 10% of the entire district’s population. Females out-number males slightly in most villages, with the exception of Nquide where women represent just less than 50% of the village’s gender make-up. Generally, with an average village male-to-female ratio of around 1:1, the data is similar to the male-to-female ratio for the district (*ibid.*).

Based upon data gathered by CES as part of a Socio-Economic Baseline Survey (SEBS) of these communities, undertaken in March 2013, the estimated population of each village, the number of households in each, as well as each village’s male-to-female ratio was determined (Table 5.1).

Table 5.1: Direct Project-Affected Community Demographics

Village	Estimated Population	Nr of Households	Male-to-Female Ratio
Ntete	4,525	963	1:1.73
Nquide	2,543	541	1:0.97
Pirira	285	61	1:1.01
Maputo (Mualia)	3,695	786	1:1.19
TOTAL	11,048	2351	1:1.0 (average)

The largest majority (56.5%) of the four villages’ members seem to be 18 years or younger. About 29.3% of the population are of school-going age (between seven and eighteen years old). As expected, very few members are above 90 years, while the largest number of people falling into the working-age bracket of 19 to 65 years (40.5%). This means that employment opportunities are needed to sustain a large working-age group, as well as a significant youth population. Table 5.2 below provides an age profile of the PAC members.

Table 5.2: Project-Affected Community Members' Age Profile

Age Categories	SEBS*		2007 Census	
	Nr	*%*	*Nr*	*%*
0-6	371	27.2	37278	30.0
7-18	400	29.3	30597	24.7
19-29	227	16.6	20439	16.5
30-65	326	23.9	32982	26.6
66-90	31	2.3	2739	2.2
91 +	10	0.7	65	0.1
TOTAL	1365	100.0	124100	100.0

** Data obtained by the SEBS conducted by CES in March 2013.*

5.2 Socio-Economic Living Conditions

5.2.1 Village Social Amenities

All villages have a primary school and a dedicated graveyard. The only clinic in the project area is located in Ntete Village. Football is a sport enjoyed by most, and all villages, with the exception of Pirira, have access to a football field. Most of the villages have churches and mosques. Table 5.3 below indicates the presence of basic social amenities in the PACs.

Table 5.3: Project-Affected Community Social Amenities and Basic Infrastructure

Village	Wells	School	Clinic	Graveyards	Football fields
Ntete	1	Yes	Yes	7	Yes
Nquide	1	Yes	No	4	Yes
Pirira	2	Yes	No	2	No
Maputo	4	Yes	No	9	Yes

5.2.2 Education

The schooling system in Mozambique consists of primary and secondary school. Primary schools cover grades one to seven, and enrolment commences at the age of seven. Children are enrolled in secondary school (grades 8-12) at around 12 or 13 years of age.

In terms of educational status, 55.5% of villagers over 18 years of age have no education. Approximately 3.3% completed primary school, whilst a near similar 3.6% completed some secondary school. Yet, around 36.0% of the households indicated that their children will be sent to Balama for secondary schooling. Apart from Balama, a secondary school is also located in Montepuez. Figure 5.1 below provides the PAC members' educations status.

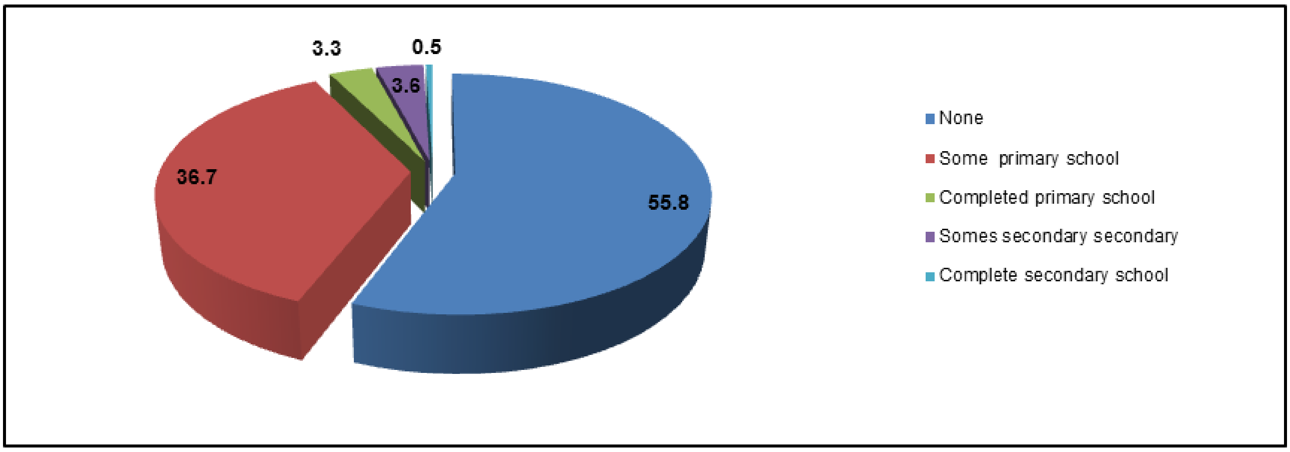


Figure 5.1: Project-Affected Community Members' Educational Status (% of those above 18 years of age)

5.2.3 Services

The GoM is in the process of installing 66kVA power lines in the area, although there is currently no grid provided electricity to any of the villages. The only form of electricity is from generators or solar panels, lanterns, wood or charcoal. Access to energy sources is indicated in Figure 5.2 below. The usage of wood as an energy source was listed by most households (57.7%). This means that wood and forested areas, provide an important ecosystem service to these rural villagers.

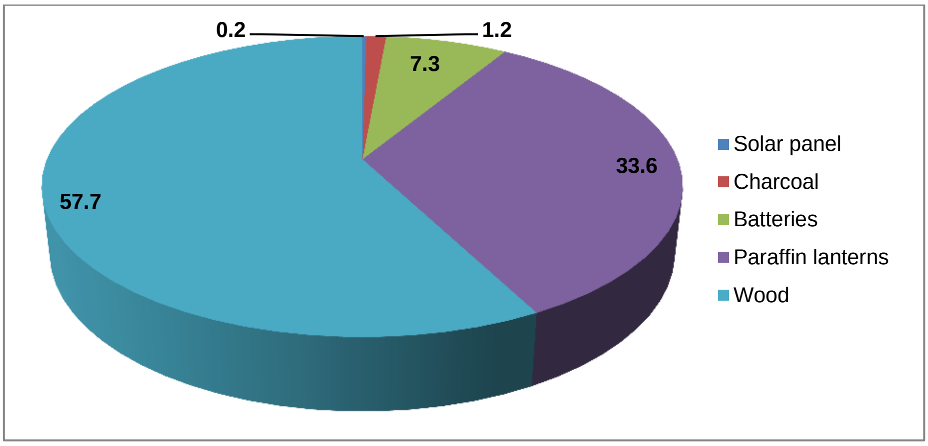


Figure 5.2: Project-Affected Community Access to Energy (%)

Wells with hand pumps have been constructed in all the villagers. In addition, all villages have several boreholes without hand pumps (Figure 5.3). All households make use of the wells with hand pumps, whilst tank water (7.0%), smaller river streams (3.9%) (used for bathing and washing of clothes) and the Chipembe Dam (0.3%) is used to a lesser extent. The Chipembe Dam is not used by the majority of the households as it is located relatively far from the villages (about 6 km from Ntete). Some households with agricultural land closer to the Chipembe Dam might use the water for their machambas and livestock.

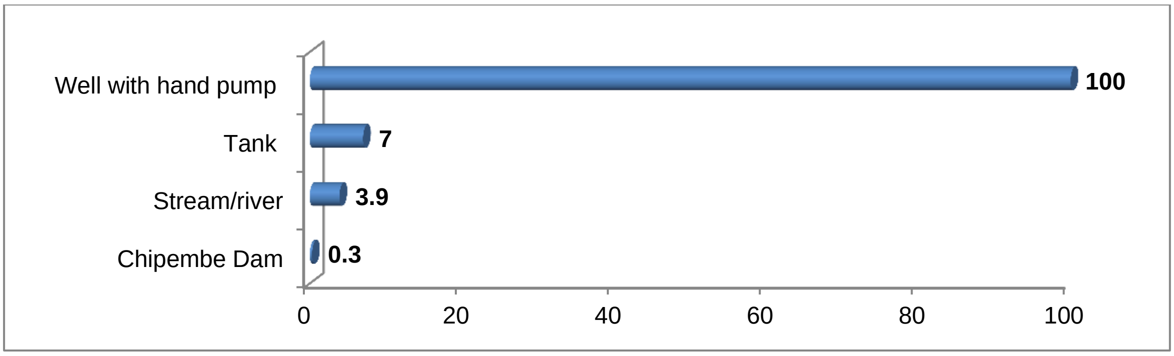


Figure 5.3: Project-Affected Community Access to Water (%)

5.3 Livelihood Strategies

5.3.1 Employment

Using the data from the SEBS, the unemployment rate of the PACs can be calculated. This rate is expressed as a percentage of those members who are unemployed within the labour force. The labour force constitutes village members in the working-age group (internationally accepted as between the ages of 18 and 65) who are capable of working. The labour force excludes home-keepers and disabled members, but includes self-employed members (such as on-farm workers not earning a salary). The unemployment rate of the PAP can be calculated at 21.7%. This figure is slightly lower than the unemployment rate of Mozambique, estimated to be around 27.0% (GoM, 2007). The reason for this rate is the fact that around 87.3% of the labour force is involved in subsistence farming or fishing, which constitutes informal employment.

Local agricultural production is the mainstay of the local economy, as it employees the bulk of the labour force. The data from the SEBS confirmed these district statistics, illustrating that a significant 306 of the 311 households interviewed (i.e. 98.4%) practice agriculture. As already mentioned, very few households have employed members (only 12 employed people have been counted). This number might be slightly more, as informal piece-jobs, such as drivers or some construction-related work, might be under-reported. Those who are employed are either absorbed in local construction work (such as road upgrading projects in the area), or render their services to government-related sectors, such as the educational or health sectors.

The largest sources of income are from self-employed, agricultural-related work. This includes crop sales, livestock sales and income derived from a households' productive trees. The remaining income sources are from charcoal trading (sold next to the roads or in Balama and Montepeuz), as well as formal employment, donations, and very few lease incomes (when farmland is leased to households). Most households, however, are involved in subsistence farming, foraging and hunting. These livelihood strategies sustain many rural households. Table 5.4 below indicates the employment sectors of the Balama District.

Table 5.4: Balama District Employment Sectors*

Sector	*n*	% (of total *n*)
Agriculture, forestry and fishing	50091	95.4
Trade, finance	1000	1.9
Other services	486	0.9
Manufacturing industry	382	0.7
Administrative services	264	0.5
Construction	167	0.3
Unknown	58	0.1
Extraction of mines	28	0.1
Transport and communication	23	0.0
Energy	7	0.0
TOTAL	**52506**	**100.0**

**Source: Census 2007 (GoM, 2007)*

5.3.2 Agriculture

Agriculture is an integral part of a villages' livelihoods, and forms the backbone of the area and country's economy. A significant number (98.4%) of the households in the area practice rain-fed, rotational crop (or 'slash-and-burn') agriculture for subsistence and commercial purposes. Of all the households studied, nearly all have agricultural fields (or locally called *machambas*), whilst most have smaller food gardens around their homesteads. Of those who have *machambas* and/or food gardens, the largest majority of them have between two and four *machambas*.

The following crops are planted either in *machambas* or smaller food gardens around homesteads:

- Cotton;
- Millet;
- Pumpkin;
- Cabbage;
- Peas;
- Cassava;
- Vegetables;
- Ground nuts;
- Tomatoes;
- Beans; and
- Maize.

It seems that November to April is the crop planting seasons, which coincides with the rainy months. For the most part, the majority of rural households in the area plant their maize and other crops in November and harvest it from April. The dry months are normally associated with harvesting and selling produce. No specific gender roles have been recorded, although a better understanding with regard to how gender mediates agricultural production in terms of roles and responsibility will be ascertained in the RAP.

Apart from agricultural produce, households are also reliant on productive trees, which many tend to grow in or around their homesteads. The largest categories of productive trees owned by households include banana (43.4%), pawpaw (32.5%), mango (22.8%) and orange trees (23.8%).

5.3.3 Animal Husbandry

Nearly two-thirds of households are engaged in livestock farming, and of these nearly all keep chickens and/or ducks. This is followed by a third of these households who own goats, followed by similar percentages for sheep and cattle. Some households also have doves, whilst one or two keep pigs and rabbits.

5.3.4 Natural Resource-Use

Most households are engaged in collecting firewood (97.1%), gathering grasses and reeds for house roofs (92.0%), collecting wild vegetables (74.3%) and using medicinal plants from the surrounding woodlands and forests (47.3%). Apart from this, nearly half of the households (47.3%) are engaged in making charcoal, which is normally sold at local shops or next to the roads. Slightly less than half of the households are engaged in hunting (44.4%), which is primarily a subsistence strategy. Animals hunted include antelopes, rabbits, bush goats and wild pigs, although some did mention larger species such as Hippopotamus (probably a rare and highly prized occurrence). In summary, such plant and animal resources provide a significant ecosystem service to these rural villagers, who are dependent on these resources.

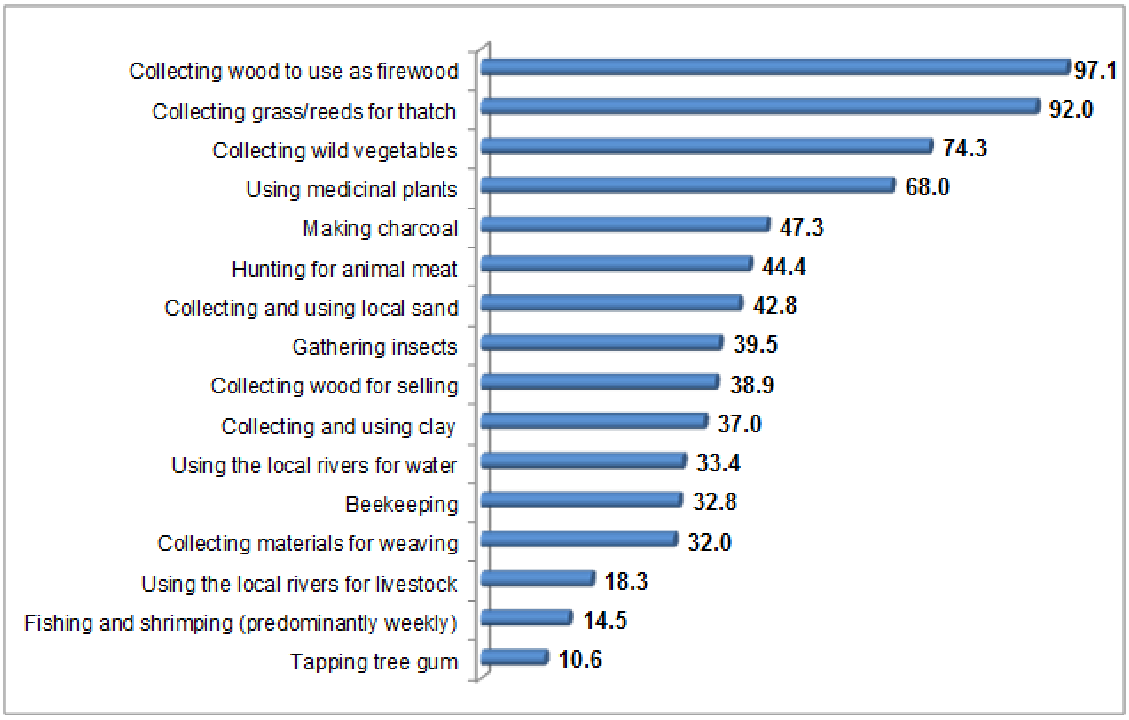


Figure 5.4: Project-Affected Community Household Natural Resource-Use (%)

5.4 Health

5.4.1 General Health Profile of the Country

The Mozambican health system is characterized by insufficient resources and by increased demand due to demographic increases, the epidemiological transition, emergence of major public health problems, such as HIV/AIDS and re-emergence of diseases that in the past were easily treated with few financial resources, for example: the resurgence of chloroquine-resistant malarial strain.

The health indicators for Mozambique describe a challenging situation and some health data for the country are lower than the average for other sub-Saharan African countries. Mozambique has a population of nearly 23 million and an annual population growth of about 2.8%. Life expectancy at birth is 48.2 years for men and 50.4 years for women in 2009 compared with the 52 and 54 respectively for the WHO African Region (WHO, 2011c). The national infant and under-five mortality rates are 96 and 142 per 1 000 live births respectively compared with regional figures of 80 and 127 in 2009, respectively (WHO, 2011c, UNICEF, 2009). Similarly, in Mozambique the density of (i) physicians and (ii) nurses and midwives per 1 000 population is 0.027 and 0.322 compared to regional figures of 0.217 and 1.172 respectively. In contrast, immunization coverage among 1-years-olds (e.g. measles 77%, DPT3 72%) in Mozambique is above the mean of the other sub-Saharan African countries (66% for both) (WHO, 2006c).

Mozambique has an epidemiological profile that is typical of developing countries, with significant levels of infant malnutrition and predominance of infectious diseases such as malaria, tuberculosis, HIV/AIDS, etc. This profile is worsened by natural disasters such as droughts and floods, making the population vulnerable to diseases of epidemiological nature, with emphasis on cholera, dysentery and other diarrhoeal diseases (Ferrinho and Omar, 2007).

The disability-adjusted life year (DALY) is a measure of overall disease burden. It is designed to quantify the impact of premature death and disability on a population by combining them into a single, comparable measure. The DALY is an important indicator and it is a health gap measure that extends the concept of potential years of life lost due to premature death to include equivalent years of ‘healthy’ life lost by virtue of being in states of poor health or disability. According to the last estimate of disease burden by the WHO in 2004 the total DALY in Mozambique in 2004 was almost 10 million (WHO, 2004a), as seen in Table 5.5 below

Communicable diseases remain the main health problem in Mozambique. 73% were attributable to communicable diseases with the remainder divided between non-communicable diseases and injuries. Overall HIV/AIDS accounted for the most DALYs with 22.4%, followed by perinatal conditions (e.g. prematurity and low birth weight; neonatal infections) (10.6%), malaria (9.4%), respiratory infections (8.0%) and diarrhoeal diseases (6.3%). A quarter of the DALYs of the non-communicable diseases are due to neuro-psychiatric conditions and mental illness. Road traffic injuries contribute substantially to total injuries (WHO, 2009a).

Table 5.5: Estimated DALYs ('000) by cause, 2004

Cause	**High income countries**		**Sub-Saharan Africa**		**Mozambique**	
Population (000)	*949 818*		*749 269*		*20 078*	
	(000)	***(%)***	***(000)***	***(%)***	***(000)***	***(%)***
TOTAL DALYs	**117 841**	**100.0**	**390 800**	**100.0**	**9 656**	**100.0**
I. Communicable diseases, maternal and peri-natal conditions and nutritional deficiencies	**6 579**	**5.6**	**276 438**	**70.7**	**7 052**	**73.0**
Infectious and parasitic diseases	2 513	2.1	165 196	42.3	4 588	47.5
Tuberculosis	*156*	*0.1*	*11 431*	*2.9*	*316*	*3.3*
STIs excluding HIV	*190*	*0.2*	*3 488*	*0.9*	*70*	*0.7*
HIV/AIDS	*609*	*0.5*	*47 296*	*12.1*	*2 167*	*22.4*
Diarrhoeal diseases	*343*	*0.3*	*33 235*	*8.5*	*606*	*6.3*
Childhood diseases	*51*	*0.0*	*13 523*	*3.5*	*115*	*2.0*
Meningitis	*97*	*0.1*	*5 448*	*1.4*	*84*	*0.9*
Hepatitis B (d)	*77*	*0.1*	*379*	*0.1*	*3*	*0.0*
Hepatitis C (d)	*151*	*0.1*	*158*	*0.0*	*1*	*0.0*
Malaria	*4*	*0.0*	*32 172*	*8.2*	*905*	*9.4*
Tropical diseases	*2*	*0.0*	*6 412*	*1.6*	*142*	*1.5*
Leprosy	*0*	*0.0*	*25*	*0.0*	*0*	*0.0*
Dengue	*0*	*0.0*	*9*	*0.0*	*1*	*0.0*
Japanese encephalitis	*3*	*0.0*	*0*	*0.0*	-	-
Trachoma	*0*	*0.0*	*719*	*0.2*	*1*	*0.0*
Intestinal nematode infections	*23*	*0.0*	*1 581*	*0.4*	*26*	*0.3*
Respiratory infections	1 263	1.1	44 514	11.4	769	8.0
Maternal conditions	577	0.5	15 365	3.9	320	3.3
Perinatal conditions	1 521	1.3	39 239	10.0	1 022	10.6
Nutritional deficiencies	704	0.6	12 125	3.1	354	3.7
II. Non-communicable conditions	**100 843**	**85.6**	**81 448**	**20.8**	**1 953**	**20.2**
Malignant neoplasms	17 618	15.0	6 179	1.6	142	1.5
Other neoplasms	358	0.3	339	0.1	7	0.1
Diabetes mellitus	3 496	3.0	2 165	0.6	47	0.5
Nutritional/endocrine disorders	1 815	1.5	3 134	0.8	72	0.7
Neuropsychiatric disorders	30 796	26.1	19 736	5.1	484	5.0
Sense organ disorders	8 916	7.6	9 475	2.4	262	2.7
Cardiovascular diseases	17 307	14.7	14 971	3.8	341	3.5
Respiratory diseases	7 138	6.1	7 308	1.9	180	1.9
Digestive diseases	4 605	3.9	5 751	1.5	120	1.2
Diseases of the genitourinary system	1 198	1.0	2 272	0.6	49	0.5
Skin diseases	212	0.2	939	0.2	23	0.2
Musculoskeletal diseases	5 129	4.4	2 483	0.6	65	0.7
Congenital abnormalities	1 473	1.2	6 049	1.5	142	1.5
Oral diseases	784	0.7	649	0.2	17	0.2
III. Injuries	**10 420**	**8.8**	**32 913**	**8.4**	**650**	**6.8**
Unintentional injuries	6 926	5.9	21 647	5.5	480	5.0
Intentional injuries	3 494	3.0	11 265	2.9	170	1.8

Major cause of death in children under-5 years in Mozambique is malaria, accounting for 23% of all deaths in this age group (Figure 5.5). This is followed by pneumonia (16%) and diarrhoeal diseases (11%).

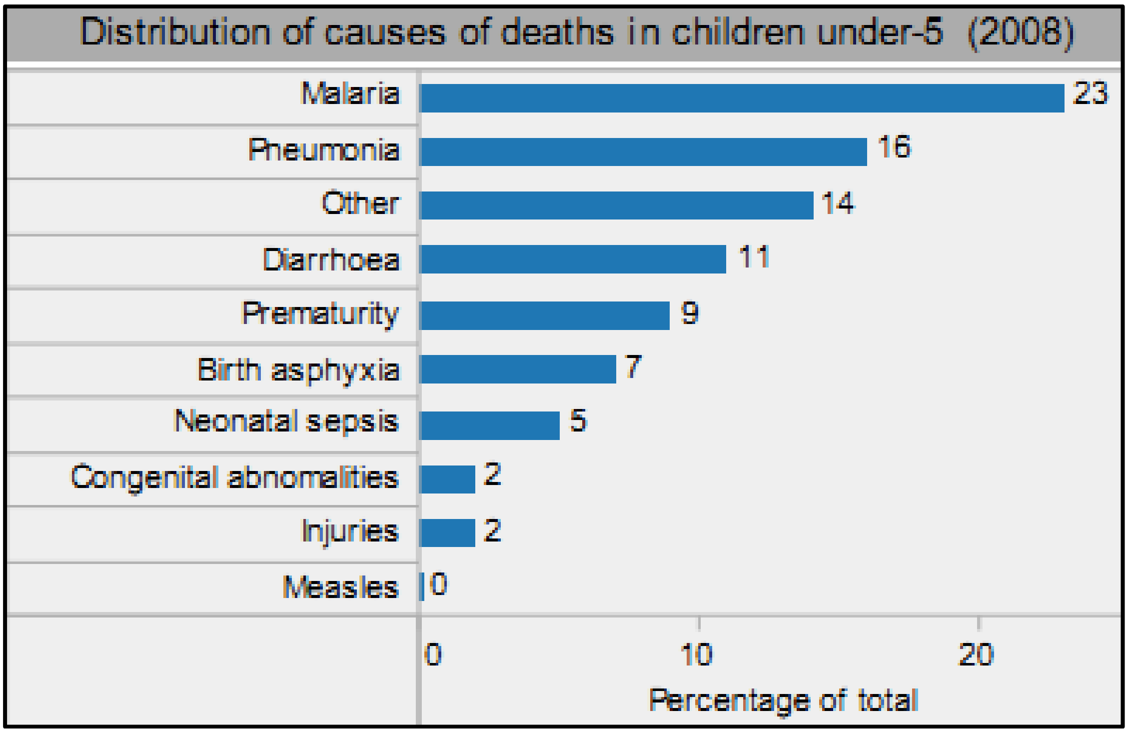


Figure 5.5: Ten major causes of death in children under 5 years, 2008

The mortality indicators for 2002 for the whole population of Mozambique are described in Table 5.6 (WHO, 2006b). Communicable diseases account for two thirds of deaths, whereas HIV/AIDS is by far the major cause of death, responsible for almost a third of all deaths in Mozambique (28%).

Table 5.6: Estimated total death ('000) by cause Mozambique

Cause of death	Total deaths ('000)	Percentage
HIV/AIDS	108	28
Malaria	34	9
Diarrhoeal diseases	30	8
Lower respiratory infections	28	7
Perinatal conditions	20	5
Measles	13	3
Tuberculosis	11	3
Cerebrovascular disease	8	2
Ischaemic heart disease	7	2
Protein-energy malnutrition	3	1

5.4.2 General Health Profile of Project Region

About 1.65 million people live in Cabo Delgado Province, which faces a more challenging health situation than other provinces in Mozambique. Balama District is a district of Cabo Delgado Province, and covers 5629km^2 with about 126 000 inhabitants. Health indicators in the province are usually below the national average and morbidity and mortality are higher. The under 5 year age group mortality rate in 2003 was 241 in 1 000 children, compared to the national average of 178 (World Bank, 2003b). Infant mortality was 178 in 1 000 children compare to the national average of 124.

Malnutrition rates were higher in this region than elsewhere, highlighting a precarious food security situation. The province had a chronic malnutrition rate of 56% in children under 5 years compared to 41% in the national average. However, acute malnutrition is within the national average of around 4%. HIV/AIDS prevalence is lower (7.5%) than country average (13.6%).

The main diseases of importance in Balama district are malaria, diarrhoea, HIV/AIDS and Sexually Transmitted Infections (STIs) that together account for almost all cases of diseases reported in the district. Social action in the district has been coordinated by Non-Governmental Organizations (NGOs) and the civil society, promoting the creation of equal opportunities and rights between men and women in all aspects of social and economic life, as well as integration in the labour market, income generation processes and school life.

Balama District has one level I health centre, and five level II & III health centres, with a total of 46 beds and 28 health professionals. The growth of the school and health system since 2000, and improving the care provided by personnel, have allowed an increase in people's access to National Education and Health services, which however still remain insufficient. There is one health facility for every 22 thousand people, one bed per 2900 inhabitants and one health professional for every 4800 residents in the district.

6. ASSESSMENT OF BIOPHYSICAL IMPACTS

6.1 Planning and Design Phase Impacts

Activities associated with the design and pre construction phase pertain mostly to exploration. As the project has a mining concession, impacts associated with exploration and the mitigation of these impacts were included in the Exploration EMP compiled to obtain this concession and will therefore not be repeated in this section. Other activities associated with the design and pre construction phase will not have impacts on the biophysical environment as this phase consists of planning and design of the proposed development, and is done at a desktop level. In some cases site visits need to take place but the impact of these visits is negligible, if any, e.g. photographs, borehole pump testing, botanical and other field surveys, etc.

6.2 Impacts resulting from the existing land use / no-go options

6.2.1 Impacts on topography and geology

Existing impacts on the topography of the area consist of relatively minor excavations for agricultural purposes and secondary and tertiary roads. These are considered to be negligible. No existing impacts on geology have been identified.

6.2.2 Impacts on soils and agriculture

Existing impacts on soils include erosion due to poor land use practices and reduced soil fertility due to infrequent crop rotation (insufficient rest periods and lack of mulching and/or fertilizer applications). However areas of erosion are limited. No impacts on agriculture have been identified. Impacts on the soil resources from agriculture are likely to be medium term across the study area. The environmental significance of this unmitigated impact is MODERATE NEGATIVE.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

6.2.3 Impacts on surface and groundwater resources

All the streams sampled are located in the upper catchment of the Montepuez River system which under natural, undisturbed conditions drain well-vegetated catchments. Under pristine conditions, there should be dense riparian woodland along the seasonal rivers with a naturally high plant biodiversity. In most river reaches in the study area the riparian zone is seriously degraded due to the clearing of the riparian vegetation to create lands for planting crops such as sugarcane and maize on deep, fertile soils near the rivers. Apart from animal manures from domestic stock and soap from washing activities at specific sites, no sources of pollution were apparent and the water quality appeared suitable for aquatic life.

6.2.4 Impacts on the aquatic environment

Cause and Comment:

In reference to the fish biota, the main existing negative impacts on the aquatic habitats in the Study Area are associated with existing clearing of riparian vegetation to cultivate crops and the construction of roads and river crossings. These activities have resulted in localized river bank instability, soil erosion and elevated sediment input, the filling in of deeper refuge pools and also higher than normal turbidity in the rivers after rainfall events.

Field observations indicated that the aquatic habitat integrity in the mine project area has been moderately modified. Here a loss and modification of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged. These river reaches, which would fall into a Habitat Integrity of Category C after Kleynhans (1996) and Kemper (1999), are representative of most of the mine project area.

Significance Statement

The loss of the riparian vegetation and increased sedimentation is definitely occurring and is having a moderate, long term, negative impact on the aquatic environment. The environmental significance of this unmitigated impact is MODERATE NEGATIVE.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

6.2.5 Impacts on flora

To contextualise the potential impacts of the mining activities and associated infrastructure proposed by the developer, the existing impacts (or *status quo*), associated with current ecological conditions, need to be described in terms of vegetation patterns, structure and composition. This baseline or *status quo* should be used as the comparison against which project impacts are assessed. The main issues identified with the existing impacts are discussed below:

Issue 1: Loss of Vegetation communities

Natural plant communities are dynamic ecosystems that provide habitats that support all forms of life. Different types of plant communities (and habitats) exist in the project area, and these occur within and around the project area. The villages in the area are reliant on natural resources found within the different plant communities and actively clear tracts of land for agricultural purposes. The current vegetation conditions in the low lying regions of the project area can be described as mostly transformed by anthropogenic activities and are of low to moderate ecological sensitivity. The current impacts on each plant community are assessed below.

Impact 1.1: Loss of Riparian Woodland

Cause and comment:

This vegetation type occurs along the banks of the rivers and tributaries that occur in the project area. Direct impacts on this vegetation type include clearing of river banks by local inhabitants to plant sugar cane and harvesting of plant materials for construction purposes.

Significance Statement:

The loss of the Riparian Woodland is definitely occurring and is having a severe, permanent, negative impact on the plant communities, the riparian system, and the rivers. The environmental significance of this unmitigated impact is HIGH NEGATIVE.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Severe	Definite	**HIGH**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

Impact 1.2: Loss of Miombo Woodland: Graphite

Cause and comment:

This vegetation type occurs on Mount Nassilala and Mount Coronge. This vegetation type is relatively intact despite existing evidence of harvesting plant materials for construction purposes.

Significance Statement:

The loss of the *Miombo Woodland: Graphite* is definitely occurring and is having a moderate, medium term impact. The environmental significance of this impact in the absence of mitigation is MODERATE NEGATIVE.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

Impact 1.3: Loss of Miombo Woodland: Granite

Cause and comment:

This vegetation type occurs on Mount Coronge. This vegetation type has been cleared for agriculture on the lower slopes and there is evidence of large trees being harvested at higher altitudes. The areas that remain intact provide important refugia for indigenous and threatened plant species, which is under threat from the current clearing activities.

Significance Statement:

The loss of the *Miombo Woodland: Granite* is definitely occurring and is having a severe, long term impact. The environmental significance of this impact in the absence of any mitigation is HIGH NEGATIVE.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Study Area	Severe	Definite	**HIGH**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

Impact 1.4: Loss of Intact Miombo Woodlands: Plains

Cause and comment:

This vegetation type occurs to the east of Nquide village and has been assigned a high sensitivity. Despite its proximity to Nquide village, this area has been left intact.

Significance Statement:

The loss of the *Intact Miombo Woodland: Plains* is unlikely to occur based on the current absence of exploitation. The severity of the impact is therefore rated as slight. The duration of the impact is predicted to be short term as the Miombo Woodland may be exploited at any time in the future. The environmental significance of this unmitigated impact is LOW NEGATIVE.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short Term	Study Area	Slight	Unlikely	**LOW**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

Impact 1.5: Loss of Degraded Miombo Woodlands: Plains

Cause and comment:

This vegetation type occurs in the flat, low lying areas through much of the project site and is heavily harvested by villagers for construction timber, firewood and charcoal production. Consequently it has a low species diversity index.

Significance Statement:

The loss of the *Degraded Miombo Woodland: Plains* is definite and has resulted in a severe, Long Term impact. The environmental significance of this impact if left unmitigated is HIGH NEGATIVE.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Study Area	Severe	Definite	**HIGH**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

Issue 2: Loss of Biodiversity

The Balama Graphite Mine concession area consists of a number of habitats which include inselbergs, the riparian zone, agricultural areas and surrounding natural vegetation, which has been described above.

Unique habitats on the site have been shown to contain a high biodiversity, especially the inselbergs that support the granite and graphite Miombo woodlands. The current land use is resulting in the destruction of these habitats, particularly in the low lying areas, reducing the areas potential to support biodiversity.

Impact 2.1: Loss of Biodiversity (general)

Cause and comment:

The clearing of land for agriculture and harvesting of plant materials for construction and charcoaling is resulting in the loss of biodiversity in the area.

Significance Statement:

The loss of biodiversity is definitely occurring and is having a moderate, long term impact. The environmental significance of this unmitigated impact is MODERATE NEGATIVE.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

Issue 3: Loss of Species of Special Concern

Three species of special concern (*Habenaria sp., Sterculia appediculata* and *Afzelia quanzensis)* were identified at the Balama Graphite Project site and are being impacted on by the current activities.

Impact 3.1: Loss of Species of Special Concern

Cause and comment:

Current land use activities, such as clearing, harvesting and charcoaling are resulting or have already resulted in the loss of species of special concern, as well as other species that are important to ecosystem functioning.

Significance Statement:

The loss of species of special concern is definitely occurring and is rated as a moderate, impact occurring over a medium term. The environmental significance of this unmitigated impact is MODERATE NEGATIVE.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

Issue 4: Disruption of Ecosystem Function and Process

The habitats that exist in the project area, together with those of the surrounding area that are linked, form part of a functional ecosystem where biological and biophysical processes such as nutrient cycling, soil formation, reproduction, competition, predation, succession, evolution and migration take place. Destruction or modification of habitats causes disruption of ecosystem function, and threatens the interplay of processes that ensure environmental health and the survival of individual species. This issue deals with a collection of complex ecological impacts that are almost impossible to predict with certainty, but which are nonetheless important.

Impact 4.1: Fragmentation of vegetation and edge effects

Cause and comment:

Fragmentation is one of the most important impacts on vegetation communities, especially when this creates breaks in previously continuous vegetation, causing a reduction in the gene pool and a decrease in species richness and diversity. In the context of the study area, this impact occurs when large areas are cleared for agriculture or burned to create green grass for grazing, or to establish crops. Fragmentation of vegetation communities may result in the fracturing of functional ecosystems, which could disrupt ecosystem functions such as nutrient cycling, soil formation, reproduction, competition, predation, succession, evolution and migration.

Significance Statement:

The fragmentation of vegetation is definitely occurring and is having a severe, permanent impact on ecosystem functions and processes. The environmental significance of this impact if left unmitigated is HIGH NEGATIVE.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Severe	Definite	**HIGH**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

6.2.6 Impacts on fauna

Issue 1: Loss of faunal biodiversity

Historically, the Miombo woodlands of Mozambique supported a large diversity of animals as noted by early travellers (Smithers & Tello, 1976). A long list of small (e.g. bushbuck, duiker) and large ungulates (e.g. zebra, kudu, sable) as well as mega-herbivores (such as elephant, black rhinoceros and hippopotamus) and predators (e.g. lion, hyena) were found in the region. However, the density of animals, as well as the extent of seasonal fluctuations in their populations, prior to human settlement, particularly prior to the protracted civil war, is unknown. The disruption to rural life and agriculture during the civil war, as well as the wide-spread availability and uncontrolled use of firearms, put tremendous extra pressure on the surviving large mammal fauna.

Present land use is primarily focused on agriculture, with livestock grazing incidental and restricted to fallow and recently cleared land. Cultivation is also practiced along the major river courses, which have richer, better watered soils. Pastoralism is considered a major threat to the biodiversity of the region.

Impact 1.1: Land use impacts on fauna

Cause and comment:

While many of the larger mammals were extirpated in historical times, small herbivores such as Bushbuck (*Tragelaphus scriptus*), Suni (*Neotragus moschatus*) and Common Duiker (*Sylvicapra grimmia*), Bush Pig (*Potamochoerus larvatus*), Scrub Hare (*Lepus saxatilis*), Porcupine (*Hystrix africaeaustralis*) and Cane Rat (*Thryonomys* sp.) are all reported to be hunted, either by specialist hunters with snares or weapons, or opportunistically by young men and dog packs. The bushmeat forms a small, but significant addition to the diet of rural communities.

Another faunal impact comes from problem animal control, either from predation on livestock and chickens, and also on crops (e.g. Vervet monkey, *Cercopithecus pygerythrus*, and Baboon (*Papio cynocephalus*). Although side-striped jackal (*Canis adustus*) and leopard (*Panthera pardus*) are present, they occur in low numbers and are reported not to be serious predators on livestock. Spotted hyena (*Crocuta crocuta*) are uncommon, but are the major cause of predation. The use of poisoned carcasses by farmers to kill "problem" animals was considered rare, but this may occur when deemed necessary. Some large birds-of-prey, like the martial eagle (*Polemaetus bellicosus*), and Bateleur (*Terathopius ecaudatus*) were perceived to prey on domestic livestock and poultry, and therefore may be deliberately targeted. Due to the long history of subsistence hunting and habitat burning certain guilds of birds were also absent or very rare in the project area, including game birds (francolin, spurfowl, etc.), storks, plovers and ibis, etc. Despite the loss of these large, conspicuous mammals and birds, the smaller minority such as reptiles, amphibians and small mammals are still represented in the region.

Significance Statement:

Existing land use impacts on fauna in the project area has resulted in a moderate negative impact in the medium to long-term in the Study Area. The environmental significance of this impact is MODERATE.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium Term	Regional	Moderate	Definite	**MODERATE**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

Impact 1.2: Habitat loss, fragmentation and degradation

Cause and comment:

The study area is located within a mosaic of cleared, degraded and fragmented Miombo woodland. Fauna diversity remains high, however, except for large mammals and birds. The presence of species of concern is limited to those with nutritional, commercial and medicinal value to local communities. Unsustainable use of these resources has led to these species occurring on the IUCN Red List of threatened species.

Removal of natural vegetation for cultivation destroys the natural habitat of many animals. Where vegetation has been removed for cultivation, old fields take several years for the vegetation and thus faunal habitats to be restored. They may fail to revert to natural vegetation for several decades, long past the life spans of most faunal groups.

Significance Statement

Habitat loss through existing land use impacts in the project area has resulted in a severe negative impact in the long-term in the Study Area. The environmental significance of this impact is HIGH.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Regional	Severe	Definite	**HIGH**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

In conclusion, it is evident that the natural vegetation of the study area has been degraded as a result of current land use, resulting in reduced biodiversity and low faunal populations. Mining related impacts need to be viewed in this context.

6.3 Mining related impacts resulting from the construction phase

6.3.1 Impacts on topography and geology

Cause and Comment

The construction of the mining camp, pipeline, and other associated infrastructure will require bulk earthworks, levelling areas and excavations in order to lay adequate foundations. Furthermore, minor excavations will be required for the construction of the haul road and establishment of borrow pits.

Significance statement

Only minor topographical manipulation will be required during the construction phase of the development, and only within selected areas. In addition, large parts of the area are relatively flat, and therefore impacts associated with changes to the topography of the area are considered to be of a low negative significance. There are no mitigation measures for this impact.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long-term	Localised	May Occur	Slight	**LOW -**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

6.3.2 Impacts on soils and agriculture

Issue 1: Impacts on soils

Impact 1.1: Removal of topsoil and soil erosion

Cause and Comment:

The construction of the haul road, ancillary roads and other associated infrastructure requires bulk earth works and moving quantities of soil in order to build the roads and other infrastructure, such as the landfill site. A cut-to-fill method is mostly employed where some areas are excavated and others filled-up in order to achieve final levels. The excavation of areas require the removal of vegetation and the stripping of topsoil layers and, in many cases, also the sub-topsoil layers. The removal of topsoil and bulk earthworks can lead to soil erosion.

Mitigation Measures:

- All topsoil to be stockpiled and replaced as a final graded layer over the subsoil contouring;
- Contoured new haul road to assist in dispersing water run-off instead of concentrating it and increasing the risk of erosion;
- Rehabilitation of disturbed areas to be undertaken progressively during the construction phase.
- Divert water flow around cleared areas to minimise the amount of runoff crossing over exposed areas by using berms, with temporary or permanent drainage ditches.
- Design access roads to be no wider than necessary to accommodate the immediate anticipated use.
- Minimise the alteration to topography.
- Minimise the area of impervious surfaces.
- Grade impervious surfaces to drain into vegetated areas.
- Ensure fine materials being transported are covered with tarps or equivalent material.
- Construct sediment control dams and silt fences;

Significance Statement:

Without mitigation, the soil structure of the area will be damaged and possibly compromised over the short term. The severity of the impact will be severe, while the risk of such impact is probable.

Since the proponent is committed to implementing the mitigation measures listed above, the effects will be short term, local in scale and have a moderate impact. These impacts will only take place during the construction phase.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short Term	Study Area	Severe	Probable	**MODERATE**
With Mitigation	Short Term	Localised	Moderate	May Occur	**LOW**

Impact 1.2: Soil contamination

Cause and Comment

Leakages and spillages from storage areas and construction vehicles could have a negative effect on the pH and salinity of the soil.

Mitigation measures:

- Design and implement a Hydrocarbon Operating Procedure. Copies of this document to be made available at designated facilities where hydrocarbons are used or stored. The purpose of this procedure is to provide for the proper storage and handling of hydrocarbons, including waste hydrocarbons, on site and hence prevent any form of contamination;
- Soil contaminated with hydrocarbon will immediately be removed and disposed of at a soil bioremediation facility to be established on site;
- All staff will be trained on the correct management of bunded facilities, including the discharge of collected liquids;
- Spill kits will be readily available at strategic points throughout the site and staff to be trained on the correct use of these kits;
- Prevent spillage and seepage of contaminants at all times through the implementation of good housekeeping and management procedures.
- Define a monitoring program in the EMP.
- Implement remedial measures in the case of accidents.
- Storage facilities will be adequately bunded and inspected on a regular basis
- Workshops and fuelling areas to have drainage to a sump with a hydrocarbon separator;

Significance Statement:

The impact of contamination from storage infrastructure is considered short term and at a localised scale. The issue is considered moderate to severe and of MODERATE significance. It is probable that the impact will occur. Since the proponent is committed to implementing the mitigation measures listed above, the impact will be of LOW significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short Term	Study Area	Probable	Moderate to Severe	**MODERATE**
With Mitigation	Short Term	Localised	May Occur	Slight	**LOW**

Issue 2: Impacts on Agriculture

Impact 2.1: Disturbance to the existing soil profile will result in a decrease in agricultural capability

Agricultural capability describes the potential for agriculture in a specific area as well as limitations or special management practices needed to improve soil, such as topography, stoniness, soil moisture deficiency, low fertility, etc. Good agricultural lands have ideal climate and soil to allow a farmer to grow the widest range of crops, while non-arable lands (including woodlands and bush) have low potential for soil bound agriculture.

Because urbanisation (including industries like mining) change the agricultural landscape, the agricultural capability of that area is therefore also changed.

Levelling of the site and excavations for the construction and subsequent mining as well as associated mining infrastructure will disturb the existing soil profile. If topsoil becomes buried, or the subsoil and rock, that is less suitable for root growth, remains at the surface, the agricultural capability of the soil that will become available for agriculture after decommissioning of the mining activities will be reduced.

Mitigation Measures:

- Strip and stockpile top soil to be retained for re-spreading over disturbed surfaces during rehabilitation. The Environmental Control Officer (ECO) to determine topsoil depth prior to stripping.
- ECO to monitor all excavations to ensure excavations are backfilled with subsoil first and then spread with topsoil.
- ECO to monitor depth and cover of topsoil spreading during rehabilitation.

Significance Statement:

Without proper soil management the possibility of a decrease in agricultural capability is high and the resultant impact may be HIGH negative during the construction phase. Since the proponent is committed to implementing the mitigation measures listed above the impact will be MODERATE negative.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Probable	Moderate to Severe	**HIGH**
With Mitigation	Long Term	Localised	May Occur	Slight	**MODERATE**

Impact 2.2: Loss of agricultural land due to establishment of mining infrastructure

Cause and Comment:

Current agriculture within the concession area is based on subsistence level, hand-cultivated units (called a *mashamba*) averaging 1.2 hectares in size. One farmer may hold multiple *mashambas*, containing multiple crops consisting of traditional varieties that are rain-fed, with very low intensity fertiliser and pesticide control used and little or no mechanisation resulting in low productivity.

The occupation of the land by mining infrastructure will exclude agricultural use of that land for the duration of the project, starting in the construction phase.

Land use is largely limited by available water and current agricultural methods, requiring larger than normal parcels of land to obtain sufficient yields. Thus, under the current agricultural practice land is in short supply and the loss of parcels of agricultural land will have very little impact on the total agricultural potential of the region.

Mitigation Measures:

- Utilise the IFC PS 5 to develop a RAP to include a detailed agricultural valuation of all the affected farmlands and owners' possessions to outline appropriate compensation strategies and entitlement matrixes; and
- Develop livelihood restoration strategies aimed at assisting households with re-establishing and improving their livelihoods. As the villagers are primarily involved in subsistence agriculture, it makes sense to provide agricultural support and/or training as a livelihood restoration strategy. Options include supporting the cotton and maize production capacity of the area by investing in market access, seed provision and agricultural training programmes. A key focus of such programmes needs to be the empowerment of vulnerable children and youth, as well as women (especially female-headed households).

Significance Statement:

Without mitigation, the impact will be VERY HIGH during the construction phase and will be permanent in nature and very severe. After mitigation the impact will be MODERATE due to the reduction in the temporal scale and the severity.

This impact takes place during construction, it is a permanent impact. It should be noted that the proponent is committed to implementing the mitigation measures listed and the mitigation measures must be in place prior to the commencement of construction .

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Definite	Very Severe	**VERY HIGH**
With Mitigation	Long Term	Localised	Definite	Moderate	**MODERATE**

Impact 2.3: Loss of subsistence crops due to establishment of mining infrastructure

Cause and Comment:

The occupation of the land by mining infrastructure will result in the loss of various subsistence and cash crops currently grown on the land. This includes maize, beans, cassava, cotton and ground beans.

Mitigation Measures:

The same mitigation measures as presented above (for impact 2.2) apply to this impact.

Significance Statement:

Without mitigation the impact will be considered to be VERY HIGH as the loss of a single season of crops will severely compromise the local communities food security, however with the implementation of the strategies developed as part of the RAP, the impact is considered to be LOW.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Definite	Very Severe	**VERY HIGH**
With Mitigation	Short Term	Localised	Definite	Moderate	**LOW**

6.3.3 Impacts on surface and groundwater resources

Issue 1: Water Quality

Impact 1.1: Sedimentation and elevated turbidity in rivers

Cause and Comment:

The negative impacts of sedimentation and elevated turbidity in rivers can be very significant and even lethal for aquatic biota, including fish. During the construction phase vegetation cover may be destroyed. Without measures to limit erosion and off-site transport of sediment during clearing for construction of infrastructure, and together with run-off from roads and construction of river crossings for vehicles, these actions may increase soil erosion and hence sediment-laden run-off into adjacent rivers. Mitigation measures are designed to prevent sediment-laden run-off from all cleared areas from entering drainage lines and adjacent rivers

Mitigation Measures:

- Locate the TSF and any out of pit dumps such as topsoil waste rock dump (WRD) in suitable areas away from drainage lines or rivers and develop practices in terms of design and operation to prevent sediment run-off, inclusive of cut-off drains.
- Detain mine-water and surface run-off from the mining areas in sedimentation ponds before the clear surface water (if uncontaminated) is allowed to flow into the adjacent drainage lines or streams.
- Store contaminated water from the process plant in the tailings storage facility (TSF) and the supernatant or decant water from the TSF fed back to the process water

reticulation.
- Stipulate details of mitigation measures for full containment and treatment (if feasible) of contaminated waters in the EMP document.
- Minimise the spatial extent of the area cleared of vegetation and re-vegetate as soon as is practically possible.
- Wherever practically possible, maintain a well vegetated buffer at least 30 m wide adjacent to construction sites and all drainage lines and other wetland areas to trap sediment.
- Wherever practically possible, carry out most of the vegetation clearance during the dry season.
- Wherever practically possible, use Turf or Grass pavers that are "honeycomb" style pavers which allow grass to growi in the holes. They allow for the establishment of permeable pavements and parking areas. Use mitre drains to spread flows in roadside drains onto adjacent slopes.
- Protect footpaths and tracks on steep slopes from runoff related erosion (e.g. use of low berms at short intervals).
- Use multiple rather than a single point of discharge downstream of a dewatered area.

Significance Statement:

During the construction phase of the project, a medium to long term severe impact is definitely anticipated without mitigation. With these mitigation measures in place this impact can probably be reduced to MODERATE significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Severe	Definite	**HIGH**
With Mitigation	Medium Term	Study Area	Moderate	Probable	**MODERATE**

Impact 1.2: Contamination from non-ore pollutants

Cause and Comment:

Hazardous materials and chemical pollutants (e.g. hydrocarbons, flotation reagents, uncured cement, paints, cleaning fluids, etc.) associated with construction, as well as washing detergents and soap, poorly-treated domestic effluents, and construction workers using rivers and riparian zones for ablutions, could pollute both groundwater and surface water. These pollutants could be harmful to aquatic biota and impact on drinking water quality for communities and domestic stock downstream.

Mitigation Measures:

- Strict management of hazardous chemicals.
- Prevent spills of hydrocarbon from machinery and vehicles.
- Treat domestic effluent from the mine camps in an on-site waste water treatment works
- Final effluent to be of high quality and used for irrigation or mining purposes.
- Contain and treat contaminated water from mine and associated infrastructure.
- Strict control of workers movements and behavior.
- Store chemicals of all types on impermeable surfaces in secure and bunded designated storage areas.

- Spills to be cleaned up immediately in accordance with an established protocol.
- Cement to be stored on impermeable storage areas protected from the rain and mixed only in designated areas. Cement residue to be cleaned up immediately.
- Prohibit defecation or any other ablutions other than in formal facilities.
- Develop and implement a stormwater management system for all areas from which sediment may be washed off into watercourses.
- Store fuel, oils and grease on impermeable surfaces with containment bunds and with drainage via Hydrocarbon separators;
- Hydrocarbon separators are to collect hydrocarbon residues and transfer them to a waste oil tank where they will be transported off site for recycling
- Piped and treat waste water and sewage in a properly designed, and maintained waste water treatment works. Regularly monitor the quality of effluent to ensure that it complies with Mozambique effluent standards. Where field toilets are necessary the number used will be sufficient for the number of people using them, and they will be regularly emptied and the contents disposed of at the waste water treatment works.
- Implement an ARD operating procedure.

Successful mitigation is readily feasible via a strictly implemented environmental management plan (EMP).

Significance Statement:

The construction phase may cause a medium term risk of pollution from chemicals and other hazardous materials, resulting in severe impacts of HIGH significance in the study area without mitigation. Since the proponent is committed to implementing the mitigation measures listed above the impact can be reduced to LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Severe	Probable	**MODERATE**
With Mitigation	Medium Term	Study Area	Moderate	May Occur	**LOW**

6.3.4 Impacts on the aquatic environment

Issue 1: Habitat Modification

Impact 1.1: Aquatic habitat modification

Cause and Comment:

During the construction phase aquatic habitats both within and adjacent to the project area might be modified. Degradation of upstream aquatic habitats will also impact on downstream reaches. The anticipated influx of work-seekers and the subsequent increase of the local population adjacent to the mine during construction will inevitably result in an increased degradation of the catchment, including clearing of vegetation, particularly in riparian areas, for farming activities and the construction of local dwellings. This secondary impact, together with the construction of new roads and upgrading of existing tracks near watercourses, may further degrade riparian zones leading to increased soil erosion and river bank instability resulting in elevated turbidity and sediment input degrading in-stream habitats. The opportunity for mitigating these impacts and protecting the riparian corridor and river channel will be greater within the designated project area, but attempts to mitigate the secondary impacts should also be made.

Mitigation Measures:

- Road and causeway construction will be guided by an EMP and specifications to ensure designs incorporate bank stabilization structures. These will be included on a construction environmental management plan (CEMP).
- Riparian buffer zones (no-development areas) of 30 to 50m on both banks to be demarcated on all watercourses within the project area where possible (and adjacent areas if feasible).

Significance Statement:

Without mitigation this highly significant, permanent potential impact on riparian and in-stream habitats will definitely occur both within and immediately adjacent to the project area. It should be noted that the proponent is committed to implementing the mitigation measures listed above and that the impact will be reduced to MODERATE significance

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Severe	Definite	**HIGH**
With Mitigation	Permanent	Study Area	Moderate	Probable	**MODERATE**

Impact 1.2: Loss of species of special concern

Cause and Comment:

The two fish species of special concern (the red-finned killifish and sand catlet) that may be new to science are adapted to shallow-water habitats and thus are vulnerable to impacts associated with this mining project, such as elevated sediment input and changes in flow dynamics. The other species of interest, the Red Data (Near Threatened) Mozambique tilapia, is known to be widespread in Mozambique, and there is a large “protected” population present in the Chipembe Dam, and which does not appear to be under any immediate threat.

Mitigation Measures:

A range of mitigation measures to reduce the negative impacts on aquatic habitats and fish biota in the study area are described in the aquatic assessment and in the sections above. However, effective mitigation is difficult, and in spite of these efforts, both these species may be at risk of being eradicated within the study area due to direct and indirect (secondary) impacts associated with the proposed mining venture, the latter been environmental degradation outside the mine project area. It is for this reason that the risk of this impact is rated as “may occur”.

Significance Statement:

The significance on a regional or national level of losing these two “new” fish species of special concern is difficult to assess, as their distribution in adjacent rivers is currently unknown. If widespread in this region of northern Mozambique, the loss of these two species may not be highly significant. However, as this information is not presently available, a precautionary approach was taken in this assessment.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Study Area	Severe	Probable	**HIGH**
With Mitigation	Long Term	Study Area	Moderate	May Occur	**MODERATE**

Issue 2: Aquatic Habitat Fragmentation

Impact 2.1: In-stream structures blocking migrations (bridges, causeways)

Cause and Comment:

The construction of any poorly designed in-stream structures associated with the project, could block natural fish migrations. Although the haul road does not traverse a steam, ancillary roads, especially during construction, are likely to impact on drainage areas.

Mitigation Measures:

- Ensure the provision of suitably designed bridges across rivers in the study area that allow free movement of fish and other aquatic biota.
- Incorporate suitably designed fishways on any in-stream dams or weirs, as required.

Significance Statement:

Any instream barriers to fish migration in these seasonal rivers would have devastating impacts on fish populations, as there would be no recruitment of migratory species into upstream reaches after the dry season. This could result in:

- Reduce breeding success of several fish species that undertake upstream spawning migrations.
- The natural longitudinal movements of fish for feeding, larval development or over-wintering could be blocked, increasing mortalities.
- The isolation of upstream fish populations could result in negative genetic impacts and reduced survival fitness, while the prevention of recolonisation after high mortalities could threaten long-term viability of fish populations upstream of the barrier.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Study Area/ Regional	Severe	Probable	**HIGH**
With Mitigation	Long Term	Study Area/ Regional	Low	May Occur	**LOW**

Issue 3: Fisheries Resource

Impact 3.1: Over-utilization of fish resources

Cause and Comment:

The increase in local population due to the mining project and easy access to the rivers could result in overfishing and depleting of local fish populations. The few refuge pools retaining surface water in the dry season will most likely be very heavily fished.

Mitigation Measures:

- This impact will be very difficult to counter by law-enforcement as this is not a declared fisheries area and currently environmental law-enforcement in this locality is virtually non-existent.
- A series of practical, common sense rules and restrictions to regulate fishing activities could be developed in consultation with the local Chief, village elders and local fishermen. If these rules are in place before the population increases, it will go a long way to help manage the fisheries resources in a sustainable way.
- The fisheries potential of Chipembe Dam should be investigated and possibly enhanced and developed. This could create work opportunities and catches from Chipembe Dam could provide a more sustainable all-year round source of fish for the local villages.

Significance Statement:

The fisheries resource in the seasonal rivers in the Study Area is fairly small and provides a seasonal protein source for a relatively small percentage of the local population.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Study Area/ Regional	Severe	Probable	**MODERATE**
With Mitigation	Long Term	Study Area/ Regional	Low	May Occur	**LOW**

6.3.5 Impacts on flora

Issue 1: Loss of Vegetation communities

Natural plant communities are dynamic ecosystems that provide habitats that support all forms of life. Different types of communities (and habitats) exist in the project area, and these occur within and around the project area. The Balama Graphite mine and associated project infrastructure will result in the clearance of approximately 150 ha of natural vegetation, resulting in the loss of plant communities. The impact of the loss of portions of the different habitats will differ, and these will need to be considered separately.

Impact 1.1: Loss of Riparian Woodland

Cause and Comment:

This vegetation type occurs along the banks of the river's and tributaries that occur in the project area.There are no planned project works that will directly impact on this vegetation type. Although degraded due to anthropogenic activities it is still considered to be an important ecological process area and activities in this area should be kept to a minimum.

Mitigation Measures:

The following mitigation actions are suggested:
- Detailed inventory in these areas to facilitate restoration;
- Restoration of this vegetation type after mining;
- Reducing the number of crossings through careful planning and design;
- Using bridge designs that afford the lowest impact on this vegetation;

- Locating project infrastructure away from sensitive areas where feasible;
- Locating bridges and river crossings at existing crossings and in areas that are already impacted;
- Designing and implementing a Rehabilitation Management Plan.

Significance Statement:

The loss of the Riparian Woodland during the construction phase will probably occur and will have a moderate, permanent impact. The environmental significance of this unmitigated impact would be MODERATE negative. With mitigation measures this will remain a MODERATE negative impact.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Moderate	Probable	**MODERATE**
With Mitigation	Permanent	Localised	Slight	Probable	**LOW-**

Impact 1.2: Loss of Miombo Woodland (Graphite)

Cause and Comment:

This vegetation type occurs on Mount Nassilala and will be most heavily and directly impacted by mining activities on the west and the east sections of the inselberg. Direct impacts are likely to be clearing of vegetation for the east and west pit as well as the plant site. Although there are large stands of bamboo, this vegetation type is fairly intact with a species composition unique to this inselberg. However, no locally endemic species were found to occur on the slopes of Mount Nassilala that did not occur elsewhere on the site. During the dry season it was noted that large trees were being harvested on this inselberg for construction purposes. This inselberg therefore provides an important ecosystem service to the surrounding communities.

Mitigation Measures:

- Detailed inventory in these areas to facilitate restoration;
- Areas impacted by construction activities and that are no longer required during the operation phase to be restored to their natural state;
- Restore impacted areas during the decommissioning phase;
- Creating no-go areas and ecological corridors on Mount Nassilala to preserve this area and facilitate the inselberg’s continued function as a stepping stone and refugia for biodiversity (plants and animals);
- Demarcate and implement a 50 m buffer around this area;
- Avoid locating unnecessary infrastructure such as the TSF and mine plant within this 50 m buffer.
- Design and implement a Rehabilitation and Offset Strategy Management Plan.

Significance Statement:

A total of 834 ha is found on site, making up 10.5% of the project area. The loss of 7.8% of the *Miombo Woodland: Graphite* (64.3 ha) on site due to clearence during the construction phase will have a severe, permanent impact. The environmental significance of this unmitigated impact would be HIGH negative. With mitigation measures this will be reduced to a MODERATE negative impact.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Severe	Definite	**HIGH**
With Mitigation	Permanent	Study Area	Moderatley Severe	Definite	**MODERATE**

Impact 1.3: Loss of Miombo Woodland: Granite

Cause and Comment:

This vegetation type occurs on Mount Coronge and may be directly impacted by mining activities on the western tail of the inselberg where the east pit is situated. Direct impacts are likely to be clearing of vegetation when the pit is mined. This vegetation type has been cleared for agriculture on the lower slopes and there is evidence of harvesting large trees higher up. Despite this, the areas that remain intact have a species composition that appears to be unique to this area. No locally endemic species were found to occur on the slopes of this area. There are a number of large *Sterculia appendiculata* that occur on the slopes of Mount Coronge.

Mitigation Measures:

- Restore this vegetation type to its natural state after mining;
- Areas impacted by construction activities and that are no longer required during the operation phase to be restored to their natural state;
- Avoid locating infrastructure in areas with large numbers of *Sterculia appendiculata;*
- Where feasible, design the mining pits to reduce the amount of vegetation that needs to be cleared;
- Create qualified-go areas and ecological corridors on Mount Coronge to preserve the areas that will not be mined. This will allow this inselberg to continue functioning as a stepping stone and refugia for biodiversity (plants and animals) and will continue to provide important ecosystem services to the local communities;
- Demarcate and implement a 50 m buffer around this area;
- Move infrastructure such as the new mine camp, outside of this 50 m buffer;
- ECO to ensure that no structures within the mine camp area fall within the 50m buffer area; and
- Design and implement a Rehabilitation Management Plan.

Significance Statement:

Based on the current layout, no infrastructure or project activities will impact this vegetation type. The loss of the *Miombo Woodland: Granite* is therefore unlikely to occur and the severity of the impact is therefore rated as a moderate, short term impact. The environmental significance of this unmitigated impact would be MODERATE negative as only 1.5 ha will be cleared out of 149 ha. With mitigation measures this will be reduced to a LOW negative. If the layout is to change then this impact will need to be reassessed.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short Term	Study Area	Moderate	Unlikely	**MODERATE**
With Mitigation	Short Term	Localised	Moderate	Unlikely	**LOW**

Impact 1.4: Loss of Intact Miombo Woodlands: Plains

Cause and Comment:

This vegetation type occurs to the east of Nquide village and has been assigned a high sensitivity. Although not directly impacted by project infrastructure, the displacement of agricultural fields and access to natural resources by the mine may lead to the clearing of this area as it is within easy walking distance of the village. In-migration from outside areas may place additional pressure on this area.

Mitigation Measures:

- Employ members of the local community instead of outsiders. This will reduce the level of in-migration from outside areas thereby reducing the pressure on the natural resources found in this vegetation type.
- Implement more efficient and intensive agricultural practices that reduces the amount of land cleared for agriculture. Possible irrigation systems using water from Chipembe Dam may be a viable solution.
- Introduce cash crops that are more economically viable than the cotton industry and produce greater yields per hectare. This will reduce the amount of clearing of natural vegetation.

Significance Statement:

The loss of intact *Miombo Woodland: Plains* during the construction phase is probable if there is an influx of outsiders seeking work at the mine and will have a severe, permanent impact. The environmental significance of this unmitigated impact would be MODERATE negative. With mitigation measures this will be reduced to a LOW negative impact.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Severe	Probable	**MODERATE**
With Mitigation	Long-Term	Localised	Slight	Unlikely	**LOW**

Impact 1.5: Loss of Degraded Miombo Woodlands: Plains

Cause and Comment:

This vegetation type occurs in the flat, low lying areas through much of the project site. This vegetation type is heavily harvested by villagers for construction timber, firewood and charcoal production. Consequently it has a low species diversity index. Despite this it is still considered an important ecological process area providing refuge to local wildlife such as birds, reptiles and amphibians.

Mitigation Measures:

- Where feasible, reduce the footprint of the infrastructure to the minimal required area;
- Impacted areas during the construction phase to be rehabilitated if not required during operation;
- It is possible that individuals who have had their agricultural land displaced by the mine will make up for this by clearing additional land within this vegetation type. Further clearing will result in induced secondary impacts which may be prevented through the introduction of more efficient agricultural practices as well as introducing cash crops that are more economically viable.

Significance Statement:

The loss of degraded *Miombo Woodland: Plains* during the construction phase will definitely occur and will have a moderate, permanent impact. The environmental significance of this unmitigated impact would be MODERATE negative. With mitigation measures this will remain a MODERATE negative impact.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	Long Term	Study Area	Moderate	Definite	**MODERATE**

Issue 2: Loss of Biodiversity

The Balama Graphite Mine concession area consists of a number of habitats which include inselbergs, the riparian zone, agricultural areas and surrounding natural vegetation. These habitats comprise of the following vegetation types: *Riparian woodland* in the Riparian zone; *Miombo Woodland: Granite* and *Miombo Woodland: Graphite* that occurs on the inselbergs and degraded and *Intact Miombo Woodland: Plains* that occurs in the flat low lying areas interspersed between agricultural land.

Unique habitats on the site have been shown to contain a high biodiversity, for example, the inselbergs that support the granite and graphite Miombo woodlands have a high biodiversity. The mine will result in the partial clearance of these habitats, particularly the Miombo Woodlands associated with the graphite deposits, reducing the areas potential to support biodiversity through habitat destruction and reduction.

Impact 2.1: Loss of Biodiversity (general)

Cause and Comment:

Mining activities and the associated infrastructure will result in the removal of large areas of vegetation, resulting in the loss of biodiversity.

Mitigation Measures:

- Set aside key representative portions of each vegetation type, as conservation areas within the mining area. The ecological corridors are presented to mitigate site specific impacts. However, in the event that additional resources are found to occur within these corridors, then alternative mechanism for protecting the habitats will be required. This may include, for example, establishing a biodiversity offset to protect

similar habitats, contributing towards the management of existing protected areas or other mechanisms that achieve the end goal of protecting ecological processes and sensitive vegetation types of importance.
- Prevent mining employees from harvesting plants for personal use, firewood or charcoal within the mining area;
- Maintain ecological corridors within the mining area; and
- Design and implement a Rehabilitation Management Plan.

Significance Statement:

The mining activities will definitely result in the loss of biodiversity and this will have a severe permanent impact. The environmental significance of this unmitigated impact would be HIGH NEGATIVE. Mitigation measures will reduce this to a MODERATE NEGATIVE impact.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Severe	Definite	**HIGH**
With Mitigation	Long Term	Study Area	Moderate	Definite	**MODERATE**

Issue 3: Loss of Species of Special Concern

Three species of special concern (*Habenaria sp., Sterculia appendiculata* and *Afzelia quanzensis)* were identified at the Balama Graphite Project site and will be impacted on by the proposed mine. It is likely that additional species will be identified during the construction and operational phase of the project.

The impacts at a larger spatial scale will only be important in the case of species that have a globally restricted range, or are otherwise in need of protection. In these cases the mining process may significantly reduce the *area of occupancy* of the species. A reduction of the area of occupancy in turn may threaten the chances of survival for these plant species of concern. However, the significance of an impact differs depending on our knowledge of the distribution of these plant species.

Impact 3.1: Loss of Species of Special Concern

Cause and Comment:

Mining activities and the associated infrastructure will result in the loss of species of special concern, as well as other species that are important to ecosystem functioning.

Mitigation Measures:

- Set aside key representative portions of each vegetation type as conservation areas within the mining area;
- Maintain an ecological corridor within the mining area;
- Avoid locating infrastructure such as the mine camp and TSF in areas with high numbers of species of special concern such as on the southern slopes of Mount Coronge where a number of *Sterculia appendiculata* trees were noted. Note that the revised layout plan has considered ecological sensitivity and have resulted in shifting some of the infrastructure including the camp site; and
- Collect seeds from established trees and where feasible relocate samplings of species of special concern.

Significance Statement:

The mining activities will probably result in the loss of Species of Special Concern and will have a moderate impact in the long term. The environmental significance of this unmitigated impact would be MODERATE negative. While mitigation measures could reduce the spatial and temporal scale of the impact, they are unlikely to be very effective and the impact will still remain MODERATE negative.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Study Area	Moderate	Probable	**MODERATE**
With Mitigation	Medium Term	Localised	Moderate	Probable	**MODERATE**

Issue 4: Disruption of Ecosystem Function and Process

Impact 4.1: Fragmentation of vegetation and edge effects

Cause and Comment:

Fragmentation is one of the most important impacts on vegetation, especially when this creates breaks in previously continuous vegetation, causing a reduction in the gene pool and a decrease in species richness and diversity. This impact occurs when large areas are cleared for agriculture or burned to create green grass for grazing, or to establish crops. Fragmentation results in the isolation of functional ecosystems, and results in reduced biodiversity and reduced movement due to the absence of ecological corridors. Although the project area already has large areas cleared for agriculture, mining processes and associated infrastructure such as roads and pipelines will severely increase fragmentation within the project area, and possibly remove an important “stepping stone” through the clearing of vegetation on Mount Nassilala.

Mitigation Measures:

- Set aside an ecological corridor within the project area that encompasses all of the vegetation types defined in this report;
- Use existing access roads where feasible;
- Align roads and pipelines within a single corridor and keep this as narrow as feasible; and
- Avoid locating linear infrastructure (such as roads and pipelines) through areas of high and moderate sensitivity.

Significance Statement:

The mining activities will definitely result in habitat fragmentation and will have a moderate, permanent impact. The environmental significance of this unmitigated impact would be HIGH negative. With mitigation, this will be reduced to a MODERATE negative impact.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Severe	Definite	**HIGH**
With Mitigation	Long Term	Study Area	Moderate	Probable	**MODERATE**

Impact 4.2: Disruption of ecological systems and functions

Cause and Comment:

Dust will be generated as a result of construction activities and, in particular, where there is exposed ground. Specific activities that may contribute to release of fugitive dust include offloading and stockpiling of building materials such as sand, excavation, demolition of existing structures, storage of excavated materials and movement of heavy vehicles, but especially the clearing of vegetation in areas for site preparation. The generation of dust may be higher during windy, dry periods. Dust may result in the smothering of vegetation located adjacent to these areas reducing light penetration and, subsequently stunting or inhibiting development and growth.

Mitigation Measures:

- Employ dust suppression measures such as wetting of the project area during dry, windy periods;
- Avoid clearing unnecessarily large areas;
- Limit the height of stockpiles;
- Enforce speed limits for vehicles associated with the construction activities.

Significance Statement:

The impact to terrestrial systems associated with any dust produced during construction will probably be a short term, moderate impact. The overall significance would be MODERATE negative. This can be reduced to LOW negative with the implementation of mitigation measures.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	Short Term	Localised	Low	Probable	**LOW**

6.3.6 Impacts on fauna

Various activities are associated with the construction phase of the mining project. This section presents the issues that may impact terrestrial faunal systems arising from the construction of the mine, including its associated infrastructure such as accommodation (which is minimal during normal operations), the haul road and the associated infrastructure.

Issue 1: Loss of Biodiversity

All faunal groups will suffer a general loss of biodiversity due to varied impacts, such as increased mortality from vehicle movements, loss and fragmentation of suitable habitat due to the footprint of project structures, and various forms of pollution associated with traffic and development. This will be greatest for small, slow-moving species, e.g. amphibians, tortoises and snakes; and terrestrial species will suffer higher mortalities than arboreal or burrowing species. Volant species (birds and bats) will suffer less mortality, except where important breeding or roosting sites are lost. For all groups there will be increased mortality. The main impacts affecting biodiversity include:

- Long-term displacement of faunal groups leading to loss of diversity due to a loss of essential habitat, especially woodland habitat.
- Definite and permanent loss of daily movement corridors for fauna dependent on closed-canopy vegetation or specialised (restricted) habitat along the drainage lines and rivers.
- Indirect, long-term impacts associated with increased anthropogenic encroachment and the non-sustainable use of natural resources (e.g., uncontrolled logging, charcoal extraction, and hunting).

Impact 1.1: Loss of Amphibian Diversity

Cause and Comment:

Amphibians are a specious group of terrestrial vertebrates in the concession area. Due to habitat loss and mortalities directly associated with specific project actions, a loss of amphibian diversity will probably occur. Amphibian mortalities will occur during all phases (construction and operational) but will be most significant in association with habitat loss, particularly of wetlands.

Applying a precautionary approach, a total of 39 amphibians may be expected to occur in the region of the study site.

The most sensitive habitats for amphibians are the riparian zone and associated wetlands, either on site or downstream from mining activities.

Mitigation Measures:

- Avoid clearing or damaging wetlands, and limit river and stream crossings as far as possible. Associated infrastructure, particularly transport linkages, should avoid these areas, including a buffer distance of 30 m.
- Wetlands will be protected and/or rehabilitated if damaged.
- Maintenance of water quality and flow dynamics.

Significance Statement:

Impacts associated with construction of the proposed mine development in the project area will probably result in a moderate negative impact in the medium-term in the Study Area on amphibian diversity. The environmental significance of this impact is MODERATE, and LOW after mitigation.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Moderate	Probable	**MODERATE**
With Mitigation	Medium Term	Study Area	Slight	Probable	**LOW**

Impact 1.2: Loss of Reptile Diversity

Cause and Comment:

The Study Area probably contains a greater diversity of reptiles than discovered during the survey. Reptile populations, particularly snakes, are difficult to study. Increased human numbers associated with the development of the project will lead to increased mortality of snakes directly from road mortalities and human attitudes, as well as the loss of other reptiles from habitat loss and fragmentation. Applying a precautionary approach, a total of 40+ reptiles may be expected to occur in the region of the study site.

The most sensitive habitats for reptiles are the rocky outcrops and wetlands, either on site or downstream from mining activities.

Mitigation Measures:

- Protect abiotic habitats, such as rock outcrops, which shelter many reptile species.
- Prohibit exploitation of sensitive reptiles, e.g. chameleons.
- Educate mine staff about the necessity of protecting snakes.

Significance Statement:

Impacts associated with construction of the proposed mine development in the project area will probably result in a moderate negative impact in the medium-term in the Study Area on reptile diversity. The environmental significance of this impact is MODERATE, and LOW after mitigation.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Moderate	Probable	**MODERATE**
With Mitigation	Medium Term	Study Area	Slight	Probable	**LOW**

Impact 1.3: Loss of Bird Diversity

Cause and Comment:

Birds are by far the most speciose vertebrate component in the region. Birds play important and diverse roles in ecosystem functioning (e.g. seed dispersal and trophic transfer) and maintenance of bird diversity is important to maintain viable habitats. Although a few birds are commensal, and can rapidly and successfully adapt to disturbed environments, the majority of birds are sensitive to disturbance and either migrate away from, or suffer greater mortality within, degraded habitats. However, because of their high mobility, birds are capable of rapidly re-colonising rehabilitated habitats, provided suitable microhabitats are available. Applying a precautionary approach, a total of nearly 300 birds may be expected to occur in the general region of the study site.

The most sensitive habitats for birds are mature miombo woodland, the riparian zone and associated wetlands.

Mitigation Measures:

- Maintain habitat connectivity, particularly to protected areas, via habitat corridors.
- Undertake habitat clearance during winter when birds are not breeding.

Significance Statement:

Impacts associated with construction of the proposed mine development in the project area will probably result in a moderate negative impact in the medium-term in the Study Area on bird diversity. The environmental significance of this impact is MODERATE, and LOW after mitigation.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium Term	Study Area	Moderate	Probable	**MODERATE**
With Mitigation	Medium Term	Study Area	Slight	Probable	**LOW**

Impact 1.4: Loss of Mammal Diversity

Cause and Comment:

The long history of human settlement, associated with subsistence and later commercial farming, has greatly reduced the presence of large mammals in the region. The maintenance of the small mammal diversity depends on the maintenance of habitat corridors and diversity.

Despite the largely undisturbed nature of the habitat, the study area appears to have very limited mammalian activity due to a series of existing impacts. These include vegetation clearing and logging, subsistence hunting, the effect of feral dogs and the effects of livestock agriculture. These impacts on mammals could be intensified by activities associated with the mine, particularly accidental road kills and increased hunting associated with increased human numbers in the region. Applying a precautionary approach, a total of 50+ mammals may occur in the region of the study site, although a significant proportion of these will be small mammals, particularly bats, whose use of the area may be seasonal. The most sensitive habitats for mammals are mature Miombo woodland and rocky ridges.

Mitigation Measures:

- Maintain habitat connectivity, particularly to intact habitats, via habitat corridors.
- Protect abiotic habitats, such as rock outcrops, which shelter many small mammals, particularly bat roosts.

Significance Statement:

Impacts associated with construction of the proposed mine development in the project area will probably result in a moderate negative impact in the medium-term in the Study Area on mammal diversity. The environmental significance of this impact is MODERATE.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium Term	Study Area	Severe	Probable	**MODERATE**
With Mitigation	Medium Term	Study Area	Moderate	Probable	**MODERATE**

Impact 1.5: Loss of Species of Conservation Concern

Cause and Comment:

No amphibian SSC occur in the region, although eight reptiles are listed on CITES appendices. Many large birds (particularly owls and raptors) and large mammal species are either of conservation concern, or are listed on international trade controls (CITES). Although no reptile species in the region are listed on the IUCN Red List, a number are listed on CITES. Trade in the African rock python (*Python natalensis*), two species of monitor lizard (*Varanus niloticus* and *V. albigularis*), two tortoises (*Stigmochelys pardalis* and *Kinixys zombensis*), and a chameleon (*Chamaeleo dilepis*) are regulated, all being listed on CITES App 2. One lizard (*Afroblepharus* cf. *wahlbergi*) is of problematic taxonomic status.

Among birds within the study area, three are endangered, five vulnerable and nine near-threatened species. Based on its geographical position, the study area is expected to provide habitat for bird species that are prominent in Miombo woodlands, although there are no regional endemic species for this habitat in the region. Specifically, the riparian woodland, rock outcrops and intact Miombo woodland were identified as important bird habitats, as these facilitate bird dispersal and provide specialised habitat for habitat-restricted species. Parker (2005a) noted an increased utilization of birds for food and for the cage-bird trade that can be expected to increase with increasing access to Asian markets.

There are no IUCN Red Listed mammal SSC in the area that will be impacted by direct project activities.

Mitigation Measures:

- Maintain habitat connectivity, particularly to intact habitats, via habitat corridors.
- Protect abiotic habitats, such as rock outcrops, which shelter many small faunal species, including reptiles and bats.
- Design project structures and transport linkages will avoid where possible sensitive habitat corridors, e.g. drainage lines and wetlands.
- Where possible limit road traffic after dark, as much of the surviving fauna is nocturnal, e.g. bats, most snakes, small rodents, amphibians, etc.
- Vehicle speeds will be limited, and should not exceed 50km/h on the mine site.
- Drivers will be educated regarding their role in impacting on animals and the need to minimize collisions with animals at all times.

Significance Statement:

Impacts associated with construction of the proposed mine development in the project area will probably result in a moderate negative impact in the medium-term in the Study Area on Species of Special Concern. The environmental significance of this impact is MODERATE, and LOW after mitigation.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Moderate	Probable	**MODERATE**
With Mitigation	Medium Term	Study Area	Slight	Probable	**LOW**

Impact 1.6: Faunal impact of habitat fragmentation and loss

Cause and Comment:

Various components of the development will cause biodiversity loss directly or indirectly through fragmentation of viable habitats for the various faunal groups. This is usually a loss of vegetation (plant communities) that supply food or shelter, but may include abiotic features such as the loss of temporary wetlands, caves or rock outcrops.

Impacts to sensitive habitats are highly probable and will be local and negative in nature, and occur over the long-term. The significance of these impacts may vary from low to high depending upon the local importance of the habitat and the particular fauna that it harbours.

The proposed transport linkages and associated infrastructure will all cause additional habitat loss and fragmentation, over and above the mining area. The greatest impact on habitat loss and fragmentation will be associated with the waste and tailings areas, as well as the mine site, dwellings and the haul road. The negative impact of habitat loss associated with the development of the mine cannot be fully mitigated. But the following mitigation measures can assist in reducing the severity of the impact.

Mitigation Measures:

- All specific project actions associated with construction, access roads, borrow pits and cut-and-fill construction will avoid sensitive habitats as far as is practicable.
- Natural drainage will be maintained and the silt loads into rivers, streams and wetlands must stay within normal limits.
- Maintain habitat connectivity, particularly to intact habitats, via habitat corridors.
- Protect abiotic habitats, such as rock outcrops, which shelter many small faunal species, including reptiles and bats.
- Where possible, design project structures and transport linkages to avoid sensitive habitat corridors, e.g. drainage lines and wetlands.

Significance Statement:

Impacts associated with construction of the proposed mine development in the project area will probably result in a moderate negative impact on the fauna in the medium term in the Study Area due to habitat loss and fragmentation. The environmental significance of this impact is MODERATE, and LOW after mitigation.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Moderate	Probable	**MODERATE**
With Mitigation	Medium Term	Study Area	Slight	May Occur	**LOW**

Issue 2: Additional Construction Impacts on Fauna

A variety of impacts are likely to result from the construction of the various components of the mine, both during the construction and operational phases.

However, a significant and widespread impact results from increased transport in the region. Roads are known to alter physical characteristics of the environment and through these impacts roads affect ecosystems, biological communities and species in numerous and different ways.

Impact 2.1: Ecological impacts from dust

Cause and Comment:

Increased dust levels are common during construction especially from veld clearance and increased vehicular traffic. Short-term increased dust levels will accompany all land preparation associated with construction of mine infrastructure.

Mitigation Measures:

- The unpaved haul road is to be watered down during high wind and dry weather conditions.
- Road speeds in sensitive regions e.g. near wetlands, across drainage lines, and during extreme dry climatic conditions, to be limited to curtail dust production.
- Vehicle speed should not exceed 50km/h.
- Where feasible, any construction material is to be transported by covered trucks or containers to avoid contamination to the surrounding area.

Significance Statement:

The impact of increased dust associated with the construction of the proposed mine development in the project area will definitely result in a moderate negative impact in the medium-term in the Study Area on the fauna. The environmental significance of this impact is MODERATE, and LOW after mitigation.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	Short Term	Study Area	Slight	May Occur	**LOW**

Impact 2.2: Disruption to fauna from increased noise levels

Cause and Comment:

Mining construction and associated vehicle traffic will create noise pollution that can depress local populations of sensitive faunal groups. Animals differ in the degree to which they tolerate such disturbance, and can be expected to have potentially negative and positive impacts on various faunal groups. Large breeding birds do not usually tolerate continuous disturbance. Increased noise and motor vibrations in wetlands may also impact amphibian breeding choruses, but these impacts will be localised and many amphibian species are surprisingly tolerant of vehicle noise. Noise pollution will occur during all phases (construction, operational, and de-commissioning/closure). Little mitigation is possible.

Mitigation Measures:

- Mitigation of this impact is difficult, but noise reduction measures should be implemented in all sensitive areas (e.g. adjacent to wetlands) at sensitive times (e.g. at night).
- Construction activities after dark will only be considered in special highly managed circumstances.

Significance Statement:

Impacts associated with increased noise levels during the construction of the proposed mine development in the project area will definitely result in a moderate negative impact in the medium-term in the Study Area on the fauna. The environmental significance of this impact is MODERATE.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	Short Term	Study Area	Slight	May Occur	**LOW**

Impact 2.3: Chemical Pollution

Cause and Comment:

Many faunal groups are sensitive to pollutants. Lead concentrations are higher in small terrestrial mammals collected alongside roads than in bats caught in the same areas. Frog diversity in ponds affected by pollution from road run-off is depressed, and the accumulation of herbicides and their residues in adjacent wetlands can lead to developmental abnormalities in tadpoles and metamorphosing froglets as well as masculinization of female frogs. Pollution may result from periodic accidents, or from a slow, on-going contamination. Operation of the mine particularly in relation to the use of inflammable liquids such as diesel will probably result in periodic accidents. Heavy vehicle traffic is also associated with increased local pollution resulting from exhaust fumes, oil spillage and accumulation of rubber compounds from tyre wear. These pollutants can cause localised impacts. Sensitive wetlands or patches of threatened vegetation may need protection from road surface water run-off containing such pollutants and the application of herbicides to control plant growth alongside roads and around buildings will be monitored.

Mitigation Measures:

- Storage facilities for chemicals, particularly diesel, will not be situated in low lying areas subject to flooding.
- Design chemical storage facilities so that in the event of spillage their contents are contained within the bunds for decontamination.
- The use of insecticides and herbicides will be closely monitored with dosages and applications detailed in the EMP.

Significance Statement:

Unmitigated chemical pollution resulting from impacts associated with construction of the proposed mine development in the project area will probably result in a moderate negative impact in the medium-term in the Study Area on the fauna. The environmental significance of this impact is MODERATE, and LOW after mitigation.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short Term	Study Area	Moderate	Probable	**MODERATE**
With Mitigation	Short Term	Study Area	Slight	May Occur	**LOW**

6.4 Mining related impacts resulting from the operational phase

6.4.1 Impacts on topography and geology

Cause and Comment:

Mining activities will result in the excavation of mine pits, a tailings storage facility and out of pit stockpiles all of which will change the natural surface topography and geology.

Mitigation Measures:

- The height of out of pit stockpiles and WRD will be kept low and where possible designed to blend with the natural topography;
- Out of pit stockpiles will be removed or re-profiled to more natural forms as part of the mine rehabilitation;

Significance Statement:

The impact on topography and geology is considered permanent at a scale affecting the mine area. The issue is definitely considered to be of MODERATE significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Localised	Moderate	Definite	**MODERATE**
With Mitigation	Permanent	Localised	Slight	Definite	**LOW**

6.4.2 Impacts on soils and agriculture

Issue 1: Impacts on soils

Impact 1.1: Soil contamination

Cause and Comment

Leakages and spillages from storage and infrastructure facilities could have a negative effect on soil.

Mitigation measures:

Mitigation measures are the same as that listed for the construction phase, thus refer to Section 6.3.2, Issue 1, Impact 1.2.

Significance Statement:

The impact of contamination from storage and infrastructure is considered long term at a regional scale. The issue is considered moderate to severe and of HIGH significance. It is probable that the impact will occur. Since the proponent is committed to implementing the the mitigation measures listed above the impact will be of LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Regional	Probable	Moderate to Severe	**HIGH**
With Mitigation	Short Term	Localised	May Occur	Slight	**LOW**

Issue 2: Impacts on agriculture

Issue 1: Groundwater contamination through tailings leachate

The remaining mined rock which has been ground to a slurry to allow removal of the graphite is tailings which are transferred and kept in a tailings storage facility (TSF). Water is decanted from the TSF and recycled while the dewatered solids remain. The tailings can contain sulphur which can convert to sulphuric acid if the tailings are exposed to oxygen. Acidity can be consumed by carbonates also contained in the ore but if not consumed could promote the leaching of metals in the ore that can migrate and contaminate the environment if not properly contained. Normal management of tailings would maintain high pH if necessary by the addition of lime during processing to avoid formation of acid. The impact is further mitigated by constructing the TSF with a clay liner, which will effectively prevent the penetration of any potentially contaminated leachate into the environment via the ground water.

Impact 1.1: Possible contamination of groundwater through leaching of toxic materials from tailings storage facility
Cause and Comment:

Potential environmental impacts may include groundwater and surface water contamination due to the leaching of metals. However, based on the groundwater modeling, plume migration from the fractured aquifer beneath the TSF will be negligible to nil as the TSF will be clay lined, and no water supply borehole is predicted to be impacted due to seepage of AMD water from the TSF.

Mitigation Measures:

- Mining must target low sulphur oxidised ore of which there are large quantities with low sulphur levels.
- The levels of sulphur and carbonates in the ore are to be tested and investigation made to determine the potential for acid formation. If there is potential for acid formation lime must be added to the ore being processed to consume any acid formed;
- The tailings storage facility will be designed and operated to contain tailings to prevent infiltration of leachate with the potential to cause AMD into groundwater.
- Geotechnical studies will be undertaken to determine the need for appropriate liner and sub-drainage systems to collect or recycle water.
- Install leak detection equipment with an appropriate Leak Response Plan.
- Monitor surface and groundwater on a continuous basis throughout all phases of the project to ensure early detection.
- Install groundwater monitoring points around the TSF.

Significance Statement:

A moderate potential exists for AMD formation from the TSF due to the high sulphur content and acid generation potential. As a result of AMD, the potential exist for low pH water, bearing high concentrations of Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, V, Zn and U to seep into the aquifers beneath these facilities during the operational phase, if the TSF and waste rock dumps are not lined. These ccontaminants will seep downward to the weathered aquifer beneath these facilities and are predicted to migrate further vertically to the underlying fractured aquifer, from where the plume will be directed towards the pits. However, as the TSF will be clay lined. This would result in an impact of HIGH significance. However, as the TSF will be clay lined plume migration from the fractured aquifer beneath the TSF is likely to be negligible to nil and the impact will be LOW negative.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Regional	Probable	Severe	**HIGH**
With Mitigation	Short Term	Localised	Unlikely	Moderate	**LOW**

6.4.3 Impacts on surface water resources

Issue 1: Water Quality

Impact 1.1: Sedimentation and elevated turbidity in rivers

Cause and Comment:

The negative impacts of sedimentation and elevated turbidity in rivers can be very significant and even lethal for aquatic biota, including fish. Earthmoving activities associated with mining operations may be undertaken without taking effective anti-erosion measures. After heavy rains sediment-laden run-off from mining sites, waste rock dumps (WRDs), as well as spills from the tailings storage facility (TSF), erosion of containment walls, etc., may result in sediment-laden water entering adjacent drainage lines leading to nearby rivers.

Mitigation Measures:

Mitigation measures are the same as what is listed for the construction phase, thus refer to Section 6.3.3, Issue 1, Impact 1.1.

Significance Statement:

During the operational phase of the project, a permanent impact of HIGH significance is definitely anticipated without mitigation. With mitigation this impact can probably be reduced to MODERATE significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Regional	Very Severe	Definite	**HIGH**
With Mitigation	Permanent	Regional	Moderate	Probable	**MODERATE**

Impact 1.2: Contamination from non-ore pollutants

Cause and Comment:

Hazardous materials and chemical pollutants (e.g. hydrocarbons, flotation reagents, uncured cement, paints, cleaning fluids, etc.) associated with mining activities, as well as washing detergents and soap, poorly-treated domestic effluents, and mine workers using rivers and riparian zones for ablutions, could pollute both groundwater and surface water. These pollutants could be harmful to aquatic biota and impact on drinking water quality for communities and domestic stock downstream.

Mitigation Measures:

Mitigation measures are the same as what is listed for the construction phase, thus refer to Section 6.3.3.

Significance Statement:

The mining operations may cause a medium term risk of pollution from chemicals and other hazardous materials, resulting in severe impacts of high significance in the study area without mitigation. It should be noted that the proponent is committed to implementing the mitigation measures listed above and the impact can be reduced to LOW.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Regional	Very Severe	Probable	**MODERATE**
With Mitigation	Permanent	Regional	Moderate	May Occur	**LOW**

Impact 1.3: Contamination from Ore and waste rock dumps

Cause and Comment:

The ore is generally depleted of sulphur above the limit of oxidation. However deeper underground the ore deposit contains sulphur and in the presence of oxygen and water this can be converted to acidic sulphide minerals. The mining of ore will target oxidised ore for processing which has low sulphur. Areas of ore bearing sulphide minerals within the pit will be exposed to rainfall and could generate acid. Waste rock dumps (WRDs) may generate acid mine drainage (AMD). Neutralisation of any acid will occur through reactions with carbonates contained in the ore thus countering the potentially acid forming materials (PAF). The amounts of sulphur and neutralising minerals will be tested to determine potential for excess acid. A limestone quarry in the vicinity of the mine may be a source for further neutralisation if required.

Contamination by metals present in the ore body is a possibility if AMD is not mitigated. Correct exploitation of these “natural” neutralising pathways should significantly minimize the potential for AMD generation and downstream contamination of water bodies. AMD could contaminate adjacent rivers as well as groundwater and impact negatively on aquatic biota as well as constitute a health hazard to communities downstream from the mine site.

Mitigation Measures:

- Mining of low sulphur ore preferentially;

- Testing and determination of the potential for acid formation.
- Design waste rock dumps and stockpiles to include encapsulation of PAF materials and control of runoff so that it does not discharge;
- Utilise limestone to neutralise the acid forming potential from sulphide minerals in mine waste.
- Retain and pump contaminated water from the mining operations and WRD sites to the TSF.
- Treat and neutralize low pH water .
- Conduct regular chemical analyses of effluent from the mine, including for metal concentrations.
- Implement practices, as set out in EMP, to prevent pollution from the TSFs and WRDs to ensure full containment and treatment of contaminated run-off, as well as anti-pollution management practices during mining operations, as well as during decommissioning/closure –.

Significance Statement:

The operational phase may cause a risk of pollution from AMD, resulting in severe impacts of MODERATE significance in the study area without mitigation. With mitigations in place this impact should be reduced to LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Regional	Severe	May Occur	**MODERATE**
With Mitigation	Permanent	Regional	Moderate	Unlikely	**LOW**

Issue 2: Hydrology

Impact 2.1: Alteration of river flow dynamics

Cause and Comment:

During operational phase earthworks associated with mining could alter the natural topography. This could destroy drainage lines or alter natural flow patterns within the project area and thus drainage to adjacent streams. Mine dewatering was modelled in the geohydrology study for two scenarios. An L-shaped zone of influence in the weathered aquifer was predicted to extend 3 km to the north. To the west, the zone of influence extends 1 km from the pit boundary towards Mualipue Town. The western zone of influence is not predicted to traverse the Mualipue River; however, the water levels in boreholes in the vicinity are predicted to be drawn-down by between 12 and 8 m during the operational phase. The zone of influence will likely extend 1.5 km south of the pit boundary and boreholes in Mualia Town are predicted to be impacted by the dewatering process. However, the results of the model indicate that all river systems fall outside the zone influenced by drawdown, and hence will not be directly impacted by any lowering of the water table Indirect effects due to topographical changes could affect the Mualipue River on the eastern boundary of the project area which drains into the Mehucua River, as well as the Mehucua River itself which is located downslope of the mining area to the south-east.

Mitigation Measures:

Little can be done to mitigate this impact apart from attempting to ensure that surface run-off within the project areas is kept as natural as possible and natural drainage lines remain functional. However, the impact is considered low and no mitigation, other than for stormwater management already mentioned earlier is required. In the long term rehabilitation at mine closure will mitigate this impact.

Significance Statement:

This long-term impact of moderate significance will probably only be apparent during the construction and operation phases, and the situation could revert close to the pre-mining condition after mine closure, with appropriate mitigation and rehabilitation measures. The groundwater contribution to base-flow in these seasonal rivers may be low, but could be important in maintaining permanent surface water in isolated refuge pools during the dry season, such as at the junction of the Namiticu and Naconha rivers.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Slight	Possible	**LOW**
With Mitigation	Permanent	Study Area	Slight	May Occur	**LOW**

6.4.4 Impacts on groundwater resources

Issue 1: Mine dewatering

Cause and Comment:

Excavation of the Balama pits will change the topography, creating a cone of depression with a hydraulic gradient toward the pit. As a result groundwater from the Balama hills will flow towards the Eastern and Western pits in response to the hydraulic gradient.

When groundwater flows towards the pit (during mining) it inevitably dewaters and lowers the groundwater levels in the surrounding area. As the pit develops, the zone of influence of the groundwater level drawdown migrates and expands as the groundwater system attempts to retain a state of equilibrium.

Two scenarios (Base Case and Scenario 1) were simulated (based on the mine design provided at the time) to predict groundwater inflow rates during the 25 year operation of Balama West pits. Both scenarios simulated were based on the assumption that the fractured aquifer is infinite and a portion of the Mualipue River is the source to water to the fractured aquifer through leakage. The model also assumed minimum leakage from the weathered aquifer to the fractured aquifer. No detailed mine plans were available for Balama East or West Pits and therefore the model assumed only the final mine void and the potential groundwater inflow for such a scenario. Thus, the worst case scenario was modelled and is discussed here.

In the Base Case, the upper fractured aquifer is predicted to contribute a maximum inflow of 1942 m^3/day during the first three years. Inflows from the upper fractured aquifer to the Balama West pits are predicted to stabilise at 1700 m^3/day for the last ten years of the operational life. The inflows from the lower fractured aquifer to the pits are predicted to be negligible throughout the operational life. The majority of the initial inflows into the pits in the Base Case scenario are expected from the weathered aquifer. Groundwater influxes just above 2000 m^3/day are predicted from the weathered aquifer during the first three years. Weathered aquifer influxes will likely tailor down to below 1000 m^3/day from Year 15 onwards.

In Scenario 1, inflows from the weathered aquifer are predicted to decrease from a maximum of 352 m^3/day in the first year and stabilise at 64 m^3/day in the last 10 years of the operational life. The upper fractured aquifer is predicted to contribute inflows between 1300 and 1400 m^3/day during the first years of operational life. The lower fractured aquifer is predicted to contribute very little to nothing to the total inflow during life of mine.

The total inflow in the Base Case scenario is predicted to be higher compared to Scenario 1 inflows as a larger area will be disturbed in the Base Case. Both scenarios are expected to have similar dewatering impacts on the upper fractured aquifer. Scenario 1 mining is expected to have lesser impacts on the weathered aquifer than the Base Case scenario.

Mine dewatering is crucial to keep the pits dry for safe working conditions. The consequence of dewatering drawdown are conceptually the same as those caused by pumping groundwater for other purposes and can therefore generally be analysed in an analogous manner. The basic principles by Theis (1940) clearly show that abstraction from any aquifer will eventually be matched by some combination of the following three responses:

- A decrease in the volume of groundwater in natural storage;
- An increase in the rate of groundwater influx; and
- A decrease in the rate of natural groundwater discharge.

The peculiarity of mine dewatering systems lies in the deliberate maximisation of the first of those three responses, which is principally manifested in the lowering of the water table. The lowering of the water table in the vicinity of water supply, as a result of mine dewatering may lead to an increase in the pumping head (and therefore pumping cost), if not complete drying of boreholes, and a decrease in borehole yield or spring flow.

In the Base Case scenario, the dewatering process is unlikely to lower fractured aquifer water levels in Ntete Town and Nquide Town. Fractured aquifer water levels in Mualia Town and Mualipue Town are predicted to be impacted by the dewatering process. The zone of influence in the upper fractured aquifer is expected to extend 4 km NE towards Ntete Town (refer to Figure 6.1).

An L-shaped zone of influence is predicted for the weathered aquifer. The Mualipue River and the Naconha River will likely limit the extent of the weathered aquifer dewatering zone west and south of the pits respectively. The Balama hills to the east of the proposed Balama West pits are predicted to continually act as a groundwater divide during the operational phase, hence the L-shaped zone of influence.

The L-shaped zone of influence in the weathered aquifer is predicted to extend 3 km to the north. To the west, the zone of influence will likely extend 1 km from the pit boundary towards Mualipue Town. The western zone of influence is not predicted to traverse the Mualipue River; however, the water levels in boreholes Pirira BH2 and Pirira BH3 are predicted to be drawn-down by 12 and 8 m respectively during the operational phase. The zone of influence will likely extend 1.5 km south of the pit boundary and monitoring borehole BBH6 in Mualia Town is predicted to be impacted by the dewatering process.

The L-shaped zone of influence due to Scenario 1 mining is predicted to have negligible impacts on nearby water supply boreholes in Mualipue Town. However since the main water supply aquifer in the area is the upper fractured aquifer, the impacts of Scenario 1 dewatering in the upper fractured aquifer are similar to those of the Base Case scenario. It is predicted that both scenarios will reduce the hydraulic head in water supply boreholes during the operational life.

Mitigation Measures:

- The mine will supply an equal/better quality of water to affected communities that rely on groundwater in the receiving environment, if monitoring proves that there is an impact on specific users;
- Monitor groundwater levels and quality with continuous refinement and updating of the monitoring network to be based on the results obtained. Since the operational phase will take place over a prolonged period compared to the construction phase, more monitoring boreholes will be required (shown in plan 22 of the Hydrogeology report)

Significance Statement:

The impact is considered to be long term, localised, severe and probable, thus resulting in an impact of MODERATE significance. With mitigation measures in place this impact can be reduced to an impact of LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Localised	Severe	Probable	**MODERATE**
With Mitigation	Long Term	Localised	Moderate	Unlikely	**LOW**

Issue 2: Mine water contamination

Cause and Comment:

A tailings storage facility (TSF) and a low grade/waste rock dump will be part of the Balama mine infrastructure. The function of a TSF is the safe, long-term storage of process waste with minimal environmental or social impact. The TSF, as well as the waste rock dumps will be clay lined.

A moderate potential exists for acid mine drainage (AMD) formation from the waste rock dump and TSF due to moderate potential for AMD formation from waste rock dumps (WRD) and tailings storage facility (TSF) as a result of high S content and acid generation potential in 4 of the 6 waste rock samples analysed. As a result of AMD, the potential exist for low pH water, bearing high concentrations of Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, V, Zn and U to seep into the aquifers beneath these facilities during the operational phase. The water quality impacts will however be reduced due to the construction of a clay liner beneath the TSF and waste dumps.

The results from plume migration show that contaminants from the TSF and waste stock pile will likely seep downward to the weathered aquifer beneath these facilities. The contaminants are predicted to migrate further vertically to the underlying fractured aquifer, from where the plume will be directed towards the pits. A portion of the AMD runoff from the waste stock pile will eventually seep to the weathered aquifer at some distance from the waste stock pile. The results of plume migration show that contaminants from the pits and the waste rock dump will preferentially migrate in the fractured aquifer towards Maulia Town. However, a concentration of more than 1% of the initial source concentration is not expected to reach Maulia Town 100 years after mining. Furthermore, vertical and horizontal seepage will be significantly contained as the WRD and TSF will be clay lined.

In the Base Case mining scenario, the fractured aquifer underlying the waste rock dump is not expected to have contaminant concentrations of more than 1 % of initial source concentration. Hence plume migration from the fractured aquifer beneath the TSF will likely be negligible and no water supply borehole is predicted to the impacted due to seepage of AMD water from the TSF. Up to 20 % of the initial concentration is predicted to seep from the toe of the waste stock pile to the fractured aquifer beneath. The resultant plume in the fractured aquifer is predicted to migrate towards the pit centre.

Contaminant plumes in Scenario 1 mining operations will follow a similar migration pattern as predicted for the Base Case scenario. Again, contamination of the fractured aquifer beneath the TSF will be negligible, and up to 15 % of the initial concentration will seep into the fractured aquifer beneath the waste rock dump.

Mitigation Measures:

- Abstraction from boreholes that are close to the mine workings should be avoided so that contaminants will not migrate away from the mine, towards the abstraction boreholes;
- The mine must supply equal/better quality water to affected parties that rely on groundwater in the receiving environment, if proven that there is impact on specific users. Baseline water quality of private boreholes in and around Balama should be used for future comparisons to evaluate if the proposed mine has impacted the groundwater;
- Line the TSF and waste rock dump to significantly reduce seepage;
- Construct diversion channels and sedimentation ponds around and downstream of the waste rock dump and TSF to divert storm water and runoff ;
- Drill seepage interception boreholes downstream of the TSF to intercept and capture any possible seepage that may enter the groundwater system. Pump captured contaminated water back into the TSF;
- Monitor groundwater quality and water levels up and down gradient of TSF, waste rock dump and particularly down gradient of the mine site.
- Continuously refine and update the monitoring network .
- The operational phase will take place over a prolonged period compared to the construction phase and more monitoring boreholes must be established. The positions of the monitoring boreholes are shown in plan **Error! Reference source ot found.**;
- Refine the conceptual and numerical models every six months in the first four years and thereafter every five years based on groundwater monitoring results;
- Undertake annual audits of monitoring and management systems by independent environmental consultants;
- Design mine to target oxidised low sulphur ore;
- The mine will supply an equal/better quality water to systems to be conducted by independent environmental consultants.

Significance Statement:

The impact is considered to be long term, localised, severe and probable, thus resulting in an impact of MODERATE significance. With mitigation measures in place this impact can be reduced to an impact of LOW significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Localised	Severe	Probable	**MODERATE**
With Mitigation	Long Term	Localised	Moderate	Unlikely	**LOW**

Issue 3: Hydrocarbon spillage

Cause and Comment:

Organic solvents, diesel or other organic fluids may be spilled or leak from storage tanks during mine operation. This could have a potential negative impact on groundwater quality. As the water table at Balama is fairly shallow, it is possible that the spilled organic compounds can reach the groundwater. Unlike the construction phase, this could occur over a longer period of time and could have the potential of impacting the environment.

Mitigation Measures:

- Store diesel and hydrocarbons in properly designed bunded storage areas such that if a leak were to occur in the storage vessels it is contained;
- Handle diesel and other chemicals with care to avoid spills;
- If a considerable amount of fluid is accidentally spilled, the contaminated soil will be scraped off and disposed of at an acceptable dumping facility and the excavation to be backfilled with soil of good quality;
- Monitor both groundwater level and quality to detect any changes in water during the construction and operation phase.

Significance Statement:

The impact is considered to be long term, localised, moderate and probable, thus resulting in an impact of MODERATE significance. With mitigation measures in place this impact can be reduced to an impact of LOW significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Localised	Moderate	Probable	**MODERATE**
With Mitigation	Long Term	Localised	Slight	Unlikely	**LOW**

6.4.5 Impacts on the aquatic environment

Issue 1: Habitat Modification

Impact 1.1: Aquatic habitat modification

Cause and Comment:

During the operational phase aquatic habitats both within and adjacent to the project area will be exposed to these impacts. Degradation of upstream aquatic habitats will also impact on downstream reaches. The anticipated influx of work-seekers and the subsequent increase of the local population adjacent to the mine during operation will inevitably result in an increased degradation of the catchment, including clearing of vegetation, particularly in riparian areas, for farming activities and the construction of dwellings. This impact, together with the construction of new roads and upgrading of existing tracks near watercourses, will further degrade riparian zones, leading to increased soil erosion and river bank instability resulting in elevated turbidities and sediment input degrading in-stream habitats. The opportunity for mitigating these impacts and protecting the riparian corridor and river channel will be greater within the designated project area.

Mitigation Measures:

- Demarcate riparian buffer zones (no-development areas) of 30 to 50m on both banks of watercourses within the project area (and adjacent areas if feasible).
- Initiate rehabilitation of riparian areas .

Significance Statement:

Unless mitigated this highly significant, permanent potential impact on riparian and in-stream habitats will definitely occur both within and immediately adjacent to the project area.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Severe	Definite	**HIGH**
With Mitigation	Permanent	Study Area	Moderate	Probable	**MODERATE**

Impact 1.2: Loss of species of special concern

Cause and Comment:

Mining activities and the associated infrastructure will result in the loss of species of special concern, as well as other species that are important to ecosystem functioning.

Mitigation Measures:

Mitigation measures are the same as what is listed for the construction phase, thus refer to Section 6.3.4, Issue 1, Impact 1.2.

Significance Statement:

The significance on a regional or national level of losing these two “new” fish species of special concern is difficult to assess, as their distribution in adjacent rivers is currently not known. If widespread in this region of northern Mozambique, the loss of these two species may not be highly significant. However, as this information is not presently available, a precautionary approach was taken in this assessment.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Study Area	Severe	Probable	**HIGH**
With Mitigation	Long Term	Study Area	Moderate	May Occur	**MODERATE**

Issue 2: Aquatic Habitat Fragmentation

Impact 2.1: In-stream structures blocking migrations (bridges, causeways)

Cause and Comment:

The construction of any poorly designed in-stream structures associated with the project, particularly the new bridge or causeway over the Mehucua River on the new access road to the mine from the R242, or any other stream crossing for ancillary roads or during construction could block natural fish migrations.

Mitigation Measures:

- Ensure the provision of suitably designed bridges across rivers in the study area that allow free movement of fish and other aquatic biota.
- Incorporate suitably designed fishways on any in-stream dams or weirs, as required.

Significance Statement:

Any in-stream barriers to fish migration in these seasonal rivers would have devastating impacts on fish populations, as there would be no recruitment of migratory species into upstream reaches after the dry season. This could result in:

- Reduce breeding success of several fish species that undertake upstream spawning migrations.
- The natural longitudinal movements of fish for feeding, larval development or over-wintering could be blocked, increasing mortalities.
- The isolation of upstream fish populations could result in negative genetic impacts and reduced survival fitness, while the prevention of recolonisation after high mortalities could threaten long-term viability of fish populations upstream of the barrier.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Study Area/ Regional	Severe	Probable	**HIGH**
With Mitigation	Long Term	Study Area/ Regional	Low	May Occur	**LOW**

Issue 3: Fisheries Resource

Impact 3.1: Over-utilization of fish resources

Cause and Comment:

The increase in local population due to the mining project and easy access to the rivers could result in overfishing and depleting of local fish populations. The few refuge pools retaining surface water in the dry season will most likely be very heavily fished.

Mitigation Measures:

- This impact will be very difficult to counter by law-enforcement as this is not a declared fisheries area and currently environmental law-enforcement in this locality is virtually non-existent.
- A series of practical, common sense rules and restrictions to regulate fishing

activities could be developed in consultation with the local Chief, village elders and local fishermen. If these rules are in place before the population increases, it will go a long way to help manage the fisheries resources in a sustainable way.

- The fisheries potential of Chipembe Dam should be investigated and possibly enhanced and developed. This could create work opportunities and catches from Chipembe Dam could provide a more sustainable all-year round source of fish for the local villages.

Significance Statement:

The fisheries resource in the seasonal rivers in the study area is fairly small and provides a seasonal protein source for a relatively small percentage of the local population.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Study Area/ Regional	Severe	Probable	**HIGH**
With Mitigation	Long Term	Study Area/ Regional	Low	May Occur	**LOW**

6.4.6 Impacts on Flora

Issue 1: Disruption of Ecosystem Function and Process

Impact 1.1: Invasion of alien species

Cause and Comment:

The removal of existing vegetation also creates ‘open’ habitats that will inevitably be colonised by pioneer plant species. While this is part of a natural process of regeneration, which would ultimately lead to the re-establishment of a secondary vegetation cover, it also favours the establishment of undesirable species in the area, such as the locally occurring species of Bamboo. These species are introduced along transport lines, and by human and animal movements in the area. Once established, these species are typically very difficult to eradicate and may then invade, posing a threat to the neighbouring ecosystem. This impact is likely to be exacerbated by careless management of the site and its facilities, e.g. seed dispersal via inappropriate organic waste disposal and inadequate monitoring.

Mitigation Measures:

The following mitigation actions will be implemented:

- Prepare an Alien Management Plan
- Eradicate alien plants as they appear;
- Put in place environmentally acceptable procedures for waste management;
- Do not use exotic species that are known to be invasive for rehabilitation purposes but rather use indigenous species and exotic species that are not invasive; and
- Monitor the project area for any new invasive plants.

Significance Statement:

Mining activities associated with the operational phase will probably result in the invasion of alien species into the project area and will have a severe, permanent effect. The environmental significance of this unmitigated impact would be HIGH NEGATIVE. Taking remedial action will reduce the impact to LOW NEGATIVE.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Regional	Severe	Probably	**HIGH**
With Mitigation	Short Term	Localised	Moderate	Probable	**LOW**

Issue 2: Loss of Ecosystem Services

Ecosystem services refer to the benefits derived by humans from ecosystems and biodiversity.

Impact 2.1: Loss of ecosystem services provided by the plant communities identified in the project area

Cause and Comment:

Removal of vegetation communities due to mining activities will result in the loss of ecosystem services associated with each habitat and vegetation type. This is especially relevant since the local communities are heavily reliant on these areas as a source of food and medication, for construction materials and fuel wood and as a source of income through activities such as charcoal production.

Mitigation Measures:

- Align with recommendations made in the Social Impact Assessment to determine alternatives such as improved health care, woodlots for charcoaling, construction materials and fuel wood to offset the loss of ecosystem services to the affected communities. ; and
- Set aside key representative portions of each vegetation type that will provide adequate ecosystem services to the communities within the project area (a Conservation Management Plan will be drawn up and these areas mapped in consultation with stakeholders).

Significance Statement:

Mining activities during the operational phase will definitely result in the loss of ecosystem services provided by the plant communities and will have a severe, permanent impact. The environmental significance of this unmitigated impact would be HIGH negative. With mitigation, this will be reduced to a MODERATE negative impact.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Severe	Definite	**HIGH**
With Mitigation	Long Term	Study Area	Moderate	Probable	**MODERATE**

Impact 2.2: Disruption of ecological systems and functions

Cause and Comment:

Some dust may be generated as a result of operational activities and, in particular, where there is exposed ground. Specific activities that may contribute to release of fugitive dust include excavation of the mine pit and movement of heavy vehicles. The generation of dust may be higher during windy, dry periods. Dust may result in the smothering of vegetation located adjacent to these areas reducing light penetration and, subsequently stunting or inhibiting development and growth.

Mitigation Measures:

Mitigation measures are the same as what is listed for the construction phase, thus refer to Section 6.3.5, Issue 4, Impact 4.2.

Significance Statement:

The impact to terrestrial systems associated with any dust produced during the operation of the mine will probably be a long term, moderate impact. The overall significance would be HIGH negative. This can be reduced to LOW negative if mitigation measures are implemented.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Study Area	Severe	Probable	**HIGH**
With Mitigation	Long Term	Localised	Slight	May Occur	**LOW**

6.4.7 Impacts on fauna

This section presents the issues that may impact terrestrial faunal systems arising from the operation of the mine, the haul road and the mineral concentration plant and associated infrastructure.

Issue 1: Loss of Biodiversity

Impact 1.1: Loss of faunal biodiversity

Cause and Comment:

Impacts of the proposed developments on the surviving fauna will vary for the different groups. Amphibian diversity may be impacted by possible small scale, localized changes in water flow dynamics in the region of the mine path, particularly where it crosses drainage lines and wetlands. However, most frogs in the region are widespread and have rapid colonizing abilities. The reptile fauna comprises some species relatively tolerant of agricultural development. Birds are by far the most speciose vertebrate component in the region, but many species are tolerant of low to medium disturbance. The remaining mammal diversity in the region consists of small mammals. With the exception of introduced rodents and bats, most mammals in the region are poor colonizers and require protected habitats to maintain viable population levels. Due to disturbance resulting from habitat loss there will also be an increase in animal mortality as animals move away from the region.

Mitigation Measures:

- Mitigation of the impact entails protection and where necessary, rehabilitation of adjacent habitats as an environmental off-set, particularly wetland and riparian habitats.
- Avoid clearing or damaging wetlands, and limit river and stream crossings as far as possible. Associated infrastructure, particularly transport linkages, to avoid these areas. Where possible include a buffer distance of 30 m.
- Maintain water quality and flow dynamics.
- Protect abiotic habitats, such as rock outcrops, which shelter many reptile and mammal species.
- Prohibit exploitation of sensitive species e.g. chameleons and birds within the project area and by project staff.
- Educate mine staff about the necessity of faunal groups such as crocodiles and snakes.

Significance Statement:

Impacts associated with the operation of the proposed mine development in the project area will definitely result in a moderate negative impact in the medium-term in the Study Area on faunal biodiversity. The environmental significance of this impact is MODERATE.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	Medium Term	Study Area	Slight	May Occur	**LOW**

Impact 1.2: Loss of Species of Conservation Concern

Cause and Comment:

Mining activities and the associated infrastructure will result in the loss of species of conservation concern, as well as other species that are important to ecosystem functioning.

Mitigation Measures:

Mitigation measures is the same as what is listed for the construction phase, thus refer to Section 6.3.6, Issue 1, Impact 1.5.

Significance statement:

Impacts associated with the operation of the proposed mine development in the project area will definitely result in a moderate negative impact in the medium-term in the Study Area on Species of Special Concern. The environmental significance of this impact is MODERATE.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	Medium Term	Study Area	Slight	Probable	**MODERATE**

Impact 1.3: Introduction of Alien fauna

Cause and Comment:

Developments such as mines and their associated roads create suitable corridors for the introduction of alien species. Introduced urban rodent pests such as the house mouse (*Mus musculus*), house rat (*Rattus rattus*) and the Norwegian rat (*Rattus norvegicus*) are likely to occur in populated areas such as mining villages. These species generally tend to survive alongside human habitation, and don't spread in natural areas.

The most widespread and common alien bird is the House Sparrow (*Passer domesticus*) which is now distributed almost worldwide and was recorded on site.

Mitigation Measures:

- Eradication programs of problem animals to be undertaken in consultation with conservation authorities.

Significance Statement:

Impacts associated with the operation of the proposed mine development in the project area will probably result in a moderate negative impact in the medium-term in the study area from the introduction of alien species. The environmental significance of this impact is LOW.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Slight	May Occur	**LOW**
With Mitigation	Medium Term	Study Area	Slight	May Occur	**LOW**

Issue 2: Habitat impacts

Impact 2.1: Faunal Impact of habitat fragmentation and loss

Cause and Comment:

Habitat fragmentation can have diverse consequences for ecosystems and their fauna and flora. Habitat loss is rarely uniform and usually occurs piecemeal, leaving a mosaic of habitat fragments that may serve as refugia for the surviving fauna. Intervening unsuitable habitat, however, creates artificial barriers to normal migration and prevents or inhibits genetic interchange between the isolated populations. Tolerance of habitat fragmentation depends on numerous factors and will thus affect different faunal groups differently.

Mitigation Measures:

- Where possible ensure minimal fragmentation of sensitive habitats through the planning of the mine path, roads and the location of buildings .

Significance Statement:

Impacts associated with the operation of the proposed mine development in the project area will definitely result in habitat fragmentation and habitat loss resulting in a moderate negative impact in the medium-term in the Study Area on the fauna. The environmental significance of this impact is MODERATE.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	Medium Term	Study Area	Slight	Probable	**LOW**

Impact 2.2: Increased Dust Levels

Cause and Comment:

Increased dust levels during the operational phase will be mainly related to digging activities, crushing and increased vehicular traffic on unpaved surfaces. Dust settling on adjacent vegetation can block plant photosynthesis, respiration and transpiration, in addition to causing physical injuries of plants. Its presence may also make plants unpalatable, thus acting as a possible deterrent to grazing. Dust from road surfaces can also transport chemical pollutants to adjacent regions, thus affecting riparian ecosystems via impacts on water quality.

Mitigation Measures:

- Water down the haul road   to inhibit dust production.
- Limit road speeds especially in sensitive regions e.g. near wetlands, across drainage lines, and during extreme dry climatic conditions, to curtail dust generation.
- and in areas of high dust production road surfaces should be dampened.

Significance Statement:

Impacts associated with the operation of the proposed mine development in the project area will definitely result in increased dust levels resulting in a moderate negative impact in the medium-term in the Study Area on the fauna. The environmental significance of this impact is MODERATE.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	Medium Term	Study Area	Slight	Probable	**MODERATE**

Impact 2.3: Noise Pollution

Cause and Comment:

Mining activities, associated housing developments and greater vehicle traffic will increase noise levels in the study area. This will reduce the abundance of sensitive bird species. Increased noise and motor vibrations in the vicinity of wetlands will also impact amphibian breeding choruses, but these will be localised and many amphibian species are surprisingly tolerant of urban noise.

Mitigation Measures:

- Mitigation of this impact is difficult and unlikely to be effected, but could involve noise reduction measures in sensitive areas (e.g. adjacent to wetlands) at sensitive times (e.g. at night).

Significance Statement:

Impacts associated with the operation of the proposed mine development in the project area will definitely result in increased noise levels resulting in a moderate negative impact in the medium-term in the study area on the fauna. The environmental significance of this impact is MODERATE.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	Medium Term	Study Area	Slight	Probable	**MODERATE**

Impact 2.4: Chemical Pollution

Cause and Comment:

Many faunal groups are sensitive to pollutants. Lead concentrations are higher in small terrestrial mammals collected alongside roads than in bats caught in the same areas. Frog diversity in ponds affected by pollution from road run-off is depressed, and the accumulation of herbicides and their residues in adjacent wetlands can lead to developmental abnormalities in tadpoles and metamorphosing froglets as well as masculinization of female frogs. Pollution may result from periodic accidents, or from a slow, on-going contamination. Operation of the mine particularly in relation to the use of inflammable liquids such as diesel will probably result in periodic accidents. Heavy vehicle traffic is also associated with increased local pollution resulting from exhaust fumes, oil spillage and accumulation of rubber compounds from tyre wear. These pollutants can cause localised impacts. Sensitive wetlands or patches of threatened vegetation may need protection from road surface water run-off containing such pollutants and the application of herbicides to control plant growth alongside roads and around buildings will be monitored.

Mitigation Measures:

Mitigation measures is the same as what is listed for the construction phase, thus refer to Section 6.3.6, Issue 2, Impact 2.3.

Significance Statement:

Impacts associated with the operation of the proposed mine development in the project area will probably result in chemical pollution resulting in a MODERATE negative impact in the medium-term in the study area on the fauna. The environmental significance of this impact is MODERATE. With mitigation measures in place the significance is reduced to LOW.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Moderate	Probable	**MODERATE**
With Mitigation	Medium Term	Localized	Slight	May Occur	**LOW**

Issue 3: Impacts from Product Transport

Impact 3.1: Threats to Animal Movements

Cause and Comment:

Linear developments, such as haul roads and above-surface pipelines, disrupt the movement of species within their normal home ranges or the seasonal movements of migratory species. Habitat fragmentation may require species to make long movements between patches of suitable habitat in search of mates, breeding sites or food. At such times they may suffer increased mortality, either directly by road vehicles, or from their natural predators due to increased exposure.

Reptiles and amphibians do not undertake long distance migrations, but both groups may undertake short seasonal movements. Many snakes undertake movements between winter hibernation sites and their summer foraging areas. Amphibians are known to experience the highest levels of mortalities associated with the presence of roads among vertebrates. This is mainly attributed to en masse seasonal migrations to and from their breeding sites. Some amphibians, particularly toads, are explosive breeders, and move en masse to the breeding ponds. At such times they may suffer heavy casualties whilst crossing roads.

Impacts on animal movements will be significant for all faunal groups. For amphibians this impact will be greatest where the road runs adjacent to wetlands suitable for breeding.

Mitigation Measures:

- Mitigation depends firstly on on-going assessment of the significance of animal road mortalities, levels of which will be monitored during the construction and operational phases.
- Where possible design project structures and transport linkages to avoid sensitive habitat corridors, e.g. drainage lines and wetlands.
- Road designs will incorporate, where possible, underpasses and culverts that allow the movement of animals. This is of particular importance along drainage lines, which form natural corridors for faunal movements.
- Where possible, limit the road traffic after dark, as much of the surviving fauna is nocturnal, e.g. bats, most snakes, small rodents, amphibians, etc. In addition to this dipped headlights to reduce light pollution into adjacent habitat are required, and lower speeds to be enforced. These recommendations will help reduce night driving impacts.
- Limit vehicle speed, and will not exceed 50km/h.
- Educate drivers regarding their role in impacting on animals and the need to minimize collisions with animals at all times.

Significance Statement:

Impacts associated with the operation of the proposed mine development in the project area will definitely result in threats to animal movements resulting in a moderate negative impact in the medium-term in the Study Area on the fauna. The environmental significance of this impact is MODERATE.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium Term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	Medium Term	Study Area	Slight	Probable	**MODERATE**

6.5 Impacts resulting from the decommissioning phase

6.5.1 Impacts on topography and geology

The decommissioning phase impacts on topography and geology are exactly the same as the construction phase impacts (section 6.3.1).

6.5.2 Impacts on soils and agriculture

The decommissioning phase impacts on soils are exactly the same as the construction phase impacts (section 6.3.2). No decommissioning phase impacts on agriculture are anticipated.

6.5.3 Impacts on surface water resources

Issue 1: Water Quality

Impact 1.1: Sedimentation and elevated turbidity in rivers

Cause and Comment:

Inadequate rehabilitation of cleared and de-vegetated areas, contaminated run-off from old mining pits, old mining camps, WRD sites and the TSF and poor maintenance of anti-soil erosion measures, as well as run-off from old roads, particularly at eroded river crossings, may result in sediment input and elevated turbidity levels in adjacent rivers.

Mitigation Measures:

Mitigation measures is the same as what is listed for the construction phase, thus refer to Section 6.3.3

Significance Statement:

During the decommissioning/closure phases of the project, a medium to long term severe impact is definitely anticipated without mitigation. With appropriate mitigation this impact can probably be reduced to MODERATE significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Regional	Severe	Definite	**HIGH**
With Mitigation	Permanent	Regional	Moderate	May Occur	**MODERATE**

Impact 1.2: Contamination from non-ore pollutants

Cause and Comment:

Chemical pollutants from machinery (e.g. hydrocarbons) and workers (faeces, soap) associated with decommissioning and rehabilitation work, as well as seepage from old waste sites, may contaminate groundwater or wash into drainage lines leading to the Mehucua River, downstream of the mine site.

Mitigation Measures:

Mitigation measures is the same as what is listed for the construction phase, thus refer to Section 6.3.3,

Significance Statement:

The decommissioning phase may cause a medium term risk of pollution from chemicals and other hazardous materials, resulting in severe impacts of high significance in the study area without mitigation. Since the proponent is committed to implementing the mitigation measures listed above, the impact is considered to be of LOW significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Regional	Severe	Probable	**MODERATE**
With Mitigation	Permanent	Regional	Moderate	May Occur	**LOW**

Impact 1.3: Ore contamination

Cause and Comment:

The ore deposit to be mined contains sulphide minerals (The sulphide mineral most commonly associated with AMD formation is pyrite, however pyrrhotite behaves in similar chemical manner with the proportion of Fe to S being slightly different. Pyrrhotite was documented in 5 out of the 9 samples send for analysis) that will end up in the tailings stream. Therefore without mitigation it is likely that the tailings storage facility (TSF), as well as the waste rock dumps (WRDs), may generate acid mine drainage (AMD). There is potential for natural AMD neutralisation through carbonates contained in the ore, and a limestone quarry in the vicinity of the mine may be a source for further neutralisation if required. Correct exploitation of these “natural” neutralising pathways should significantly minimize the potential for AMD generation and downstream contamination of water bodies. Contamination by metals present in the ore body is also a possibility if AMD is not mitigated. Unless adequate precautions and long-term maintenance programmes are put in place AMD water could seep into groundwater or flow out of old mine pits, containment dams, the TSF and old WRD sites and wash into the adjacent river systems.

Mitigation Measures:

Mitigation measures is the same as what is listed for the construction phase, thus refer to Section 6.3.3.

Significance Statement:

The decommissioning phase may cause a permanent risk of pollution from AMD, resulting in severe impacts of high significance in the study area without mitigation. With appropriate mitigation this impact should be reduced to LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Regional	Severe	May Occur	**MODERATE**
With Mitigation	Permanent	Regional	Moderate	Unlikely	**LOW**

Issue 2: Hydrology

6.5.4 Impacts on groundwater resources

Issue 1: Mine water contamination

Cause and Comment:

Groundwater levels will recover during the decommissioning and post-closure phase, due to the cessation of mine dewatering. This will lead to the re-establishment of groundwater levels, flow directions and flow gradients to near pre-mining levels and water will accumulate in the pits. Pit lakes will develop. The groundwater levels will initially recover at a faster rate, due to higher flow gradients. Groundwater level in the pit will rise quickly during the years following the cessation of dewatering due to the pit shell shape and then stabilise at around 533 to 536 mamsl, approximately at the level of the hydraulic head of the fractured aquifer.

Chemical reactions could occur between the pit lake water and the (relatively) freshly exposed rocks of the pit walls. Products of these reactions could enter the pit waters. Fracturing in the pit walls will result in an increased reactive surface area. This could significantly increase the mass of acidity produced by AMD processes. Thermal processes resulting from seasonal temperature variations might lead to "turn-over" of the water in the pit lake, thereby thoroughly mixing it. Evaporation of pit water might lead to increased concentration of chemicals in the pit lake water.

At the WRD, uncontrolled leachates that emanates will flow down-gradient as surface runoff until it percolates into the weathered soil profile. The distance that such surface runoff covers before entering the underlying aquifer is dependent on the seepage volume, permeability of the underlying material and the topographic slope in the immediate vicinity of the dump.

The result of plume migration show that contaminants from the pits and the waste stock pile from the Base Case and Scenario 1 mining will preferentially migrate in the fractured aquifer towards Maulia Town. However, concentrations of more than 1% of the initial source concentration are not expected to reach Maulia Town. At the moment the TSF is not predicted to pose a major threat to the post closure environment.

Mitigation Measures:

- All the mitigation methods proposed during the operation phase are applicable for the decommissioning phase;
- A low oxygen permeability (diffusion) clay cover will be used to encapsulate the waste stock pile and TSF to inhibit water and oxygen ingress thus reducing both oxidation rate and product transport;
- The establishment of a permanent wetland on the TSF may be used as an effective cover for the post closure environment. Once the available oxygen in the water is consumed, the rate of reaction is reduced and the rate of oxygen replacement will be relatively slow. The resultant diminished availability of oxygen is the single most effective inhibitor to sulphide oxidation;
- To avoid AMD, the deposition of neutralising materials may be the best available option to manage sulphide oxidation in the post closure environment. To diminish the available oxygen pits should be flooded with water to at least 15 m depth.; and
- If AMD is present at mine closure then mine water monitoring will continue for a minimum of 10 years after closure. Monitoring requirement needs after 10 years will be determined by the monitoring results from the first 10 years.

Significance Statement:

The impact is considered to be long term, localised, severe and probable, thus resulting in an impact of MODERATE significance. With mitigation measures in place this impact can be reduced to an impact of LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Localised	Severe	Probable	**MODERATE**
With Mitigation	Long Term	Localised	Moderate	Unlikely	**LOW**

Issue 2: Mine decant

Cause and Comment:

Model simulations show the mine is unlikely to decant as the water levels in the pit will reside between 533 and 535 mamsl, 100 years after closure. It is only if rainfall and surface water runoff from the surrounding area raises the pit lake level to above the lowest surface elevation of the pit shell that decant would occur.

Mitigation Measures:

No decant mitigation is required, since no decanting is expected to occur. Should decanting occur, then passive or active treatment plans will be considered for treatment before the decant joins the streams. With the implementation of such precautionary mitigation methods in place, the environmental impacts of any potential decants (if they occur) can be reduced to Negligible.

Significance Statement:

The impact is considered to be permanent, localised, severe and unlikely, thus resulting in an impact of MODERATE significance. With mitigation measures in place this impact can be reduced to an impact of LOW significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Localised	Severe	Unlikely	**MODERATE**
With Mitigation	Long Term	Localised	Moderate	Unlikely	**LOW**

6.5.5 Impacts on the aquatic environment

Issue 1: Habitat Modification

Impact 1.1: Aquatic habitat modification

Cause and Comment:

Even after mine closure, the pressure of the increased population and associated negative environmental impacts will probably continue unless comprehensive rehabilitation plans are put in place.

Mitigation Measures:

Mitigation measures is the same as what is listed for the construction phase, thus refer to Section 6.3.4, Issue 1, Impact 1.1.

Significance Statement:

This highly significant, long-term potential impact on riparian and instream habitats will definitely occur both within and immediately adjacent to the project area, unless mitigated.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Study Area	Severe	Definite	**HIGH**
With Mitigation	Short Term	Study Area	Moderate	Probable	**LOW**

Impact 1.2: Loss of species of special concern

Cause and Comment:

Cause and comment is the same as what is listed for the construction phase, thus refer to Section 6.3.4, Issue 1, Impact 1.2.

Mitigation Measures:

Mitigation measures is the same as what is listed for the construction phase, thus refer to Section 6.3.4, Issue 1, Impact 1.2.

Significance Statement:

The significance on a regional or national level of losing these two “new” fish species of special concern is difficult to assess, as their distribution in adjacent rivers is currently not known. If widespread in this region of northern Mozambique, the loss of these two species may not be highly significant. However, as this information is not presently available, a precautionary approach was taken in this assessment.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Study Area	Moderate	Probable	**MODERATE**
With Mitigation	Short Term	Study Area	Moderate	Probable	**MODERATE**

Issue 2: Fisheries Resource

Impact 2.1: Over-utilization of fish resources

Cause and Comment:

The increase in local population due to the mining project and easy access to the rivers could result in overfishing and depleting of local fish populations. The few refuge pools retaining surface water in the dry season will most likely be very heavily fished.

Mitigation Measures:

Mitigation measures is the same as what is listed for the construction phase, thus refer to Section 6.3.4, Issue 3, Impact 3.1.

Significance Statement:

The fisheries resource in the seasonal rivers in the study area is fairly small and provides a seasonal protein source for a relatively small percentage of the local population.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Study Area/ Regional	Severe	Probable	**MODERATE**
With Mitigation	Short Term	Study Area/ Regional	Low	May Occur	**LOW**

6.5.6 Impacts on flora

The decommissioning of the project could have a high positive impact on the natural vegetation, if the areas of high sensitivity are restored to their natural state and areas of moderate and low sensitivity are appropriately rehabilitated to a near-natural state. However, detailed baseline monitoring will be required to refine the alpha diversity and indicator species, as well as to confirm and augment the list of SSCs (especially geophytes, the majority of which flower in the early wet season, and which may not have been identified during the late-wet season sampling), in order to more precisely characterise the pre-mining ecological conditions. It will also be necessary to establish nurseries to determine which of the naturally occurring plant species can be successfully propagated for rehabilitating areas disturbed by mining activities.

However, rehabilitating disturbed areas to a natural or near-natural condition may not meet the livelihood requirements of the project-affected communities, whose needs may be better served by reinstating the land to agriculture or woodlots. Accordingly, prior to commencing any rehabilitation activities it will be necessary to undertake a programme of stakeholder engagement to assess the needs of the communities. In this case the decommissioning phase will result in a net loss of biodiversity, in as much as natural vegetation will be replaced by species of direct economic value to the communities, and thus this will be considered to be a negative ecological impact.

As a Rehabilitation Plan has not yet been prepared for the proposed development, the decommissioning phase impacts cannot be realistically assessed at this stage.

Small residual impacts as a result of the decommissioning phase will be similar to those listed for the construction phase and will include:

- Increased dust levels
- Increased access (along the haul road)
- Loss of ecosystem services as a result of increased access

6.5.7 Impacts on fauna

A variety of impacts are likely to result from the decommissioning of the various components of the mine. General decommissioning operations may cause chemical pollution, raise dust levels, increase noise and light levels and lead to changes in fire regimes.

Impact 1: Increased Dust Levels

Cause and comment:

Increased dust levels are common during decommissioning. Dust settling on adjacent vegetation can block plant photosynthesis, respiration and transpiration, in addition to causing physical injuries of plants (Farmer, 1993). Its presence may also make plants unpalatable, thus acting as a possible deterrent to grazing (Trombulak and Frissel, 2000).

Mitigation Measures:

- Areas cleared of vegetation will be watered down during periods of high wind conditions to reduce dust.

Significance Statement:

Dust levels will be raised during the decommissioning of the mine and will definitely result in a moderate negative impact in the medium-term in the study area. The environmental significance of this unmitigated impact would be MODERATE, but with mitigation would reduce to LOW.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Definite	Moderate	**MODERATE**
With Mitigation	Medium Term	Study Area	May Occur	Slight	**LOW**

Impact 2: Chemical Pollution

Cause and Comment:

Many faunal groups are sensitive to pollutants. Pollution may result from periodic accidents, or from a slow, ongoing contamination. Decommissioning of the mine particularly in relation to the use of inflammable liquids such as diesel will probably result in periodic accidents. Heavy vehicle traffic is also associated with increased local pollution resulting from exhaust fumes, oil spillage and accumulation of rubber compounds from tyre wear. These pollutants can cause localised impacts.

Mitigation Measures:

- Design chemical storage facilities so that in the event of spillage their contents are fully contained within the bunds for decontamination.
- The use of insecticides and herbicides will be monitored with dosages and applications detailed in the EMP.
- Chemical control of mosquitos will be selective and only government approved insecticides will be used.

Significance Statement:

Chemical pollution will definitely result in a moderate negative impact in the medium-term in the study area. The environmental significance of this unmitigated impact would be MODERATE, but with mitigation would reduce to LOW.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Study Area	Definite	Moderate	**MODERATE**
With Mitigation	Medium Term	Study Area	May Occur	Slight	**LOW**

Impact 3: Noise Pollution

Cause and Comment:

Decommissioning activities, will increase noise levels in the study area. This will reduce the abundance of sensitive bird species, particularly forest birds. Increased noise and motor vibrations in the vicinity of wetlands will also impact amphibian breeding choruses, but these will be localised and many amphibian species are surprisingly tolerant of urban noise.

Mitigation Measures:

Mitigation of this impact is difficult and unlikely to be effective, but could involve noise reduction measures in sensitive areas (e.g. adjacent to wetlands) at sensitive times (e.g. at night).

Significance Statement:

Increased noise and vibration levels in the mining area will definitely result in a moderate negative impact in the medium to long-term in the study area. The environmental significance of this unmitigated impact would be MODERATE, but with mitigation would reduce to LOW.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium Term	Study Area	Definite	Moderate	**MODERATE**
With Mitigation	Medium Term	Study Area	May Occur	Slight	**LOW**

6.6 Cumulative Impacts

6.6.1 Impacts on topography and geology

There are currently no other developments proposed for the project affected area and thus no cumulative impacts on topography and geology are anticipated.

6.6.2 Impacts on soils and agriculture

There are currently no other developments proposed for the project affected area and thus no cumulative impacts on soils and agriculture are anticipated.

6.6.3 Impacts on surface and groundwater resources

In terms of deterioration of water quality in watercourses downslope of the mine the cumulative impacts of the various operations associated with the mining (e.g. AMD, hydrocarbons, litter, sedimentation, etc.) could potentially all combine to exacerbate the individual impacts. These individual impacts include increased sedimentation and turbidity, pollution from chemicals or hazardous substances used in mining and acid mine drainage originating from mine ore.

Additional factors that will tend to increase the severity of the water quality issues include:

a) Reduction in runoff to rivers (e.g. due to dewatering for the mine pit) will tend to increase the impact of any pollution event due to the reduction in the beneficial effects of dilution, and

b) The clearing of riparian vegetation and reducing the width and density of the riparian buffer zone would reduce the important function this habitat plays in absorbing and filtering polluted run-off before it can enter the river channel.

6.6.4 Impacts on the aquatic environment

The cumulative impacts listed for water quality above may result in loss of fish and aquatic biodiversity due to synergistic effects.

6.6.5 Impacts on flora

Since Mozambique’s economy is growing rapidly due to foreign investments, it is highly probable that additional large scale projects/developments will occur adjacent to the mine during the lifespan of the project. Consequently, the following cumulative impacts for this scenario have been identified:

- Loss of vegetation communities (i.e. dambos, Miombo woodland etc) through direct (clearing) and indirect (displacement of agriculture) will be exacerbated; and
- Loss of Species of Special concern will be exacerbated to the point where local extinctions in the area could be expected.

6.6.6 Impacts on fauna

The following cumulative impacts could be associated with fauna:

- Exploitation by locals, with influx and improved road conditions.
- If water quality will be affected, this will have an impact on the fauna (especially amphibians).
- Increase vehicle collusions and road kills.

7. ASSESSMENT OF SOCIO ECONOMIC IMPACTS

7.1 Introduction

The following chapter identifies the potential impacts (both negative and positive) of the proposed project on the Project-Affected Communities (PACs), as well as broader district and region. By so doing, it provides mitigation and/or enhancement measures for the mine to reduce possible project-induced negative impacts, but also to enhance the positive impacts of the project. These impacts have been identified after consultation with the PACs through focus group discussions, the Socio-Economic Baseline Survey (SEBS), the Health Impact Assessment, as well as a study of secondary literature and data sources.

7.2 Planning and Design Phase Impacts

Activities associated with the design and pre construction phase pertain mostly to exploration. As the project has a mining concession impacts associated with exploration and the mitigation of these impacts were included in the Exploration EMP compiled to obtain this concession and will therefore not be repeated in this section.

7.3 Impacts resulting from the existing land use / no-go options

7.3.1 Socio-economic impacts

There are currently no identified impacts on the social environment.

7.3.2 Health related impacts

The main existing impact on health within the area is the fact that health care is limited within the project affected area. This issue can be summarised as follows:

- There are only two health facilities within the immediate vicinity of the project. These are Balama Hospital and Ntete Health Centre.
- Complicated cases are usually referred to Montepuez, then Pemba and then Nampula.
- Most people live far away from a health facility and do not have immediate access to one. The costs for consultation are 1 Metical and 5 Metical for medicine.
- Most of the health facilities in the district lack a stable water supply, a maternity ward, electricity and ambulances. These were identified as the critical needs of the health facilities.
- There is only one medical doctor in the whole district. All other health facilities are manned by nurses.
- The district health authorities reported that there is generally a good stock and supply of drugs and consumables.

7.3.3 Impacts on natural resources

Natural resources provided by the flora and fauna as well as the rivers surrounding the proposed development site are an important component of the livelihoods of the potentially affected communities. As in many parts of Africa, the local communities around these forests and woodlands rely heavily on the resources offered by the natural environment for their livelihoods and survival. The area has numerous resources including, fuelwood, wild fruit and vegetables, medicinal plants, wild bird and bush meat, fuel for slash and burn agriculture, wood for charcoal, and timber. The local rivers provide fish and drinking water for local communities. Demand for natural resources is great, and the ecological systems are stressed and over utilized in the area. The majority of the project area has been cleared for agricultural purposes (mainly through slash and burn practices – Figure 7.1). The majority of the remaining vegetation is considered to be degraded, partly as a result of natural resource utilisation such as charcoaling.

7.4 Impacts resulting from the construction phase

7.4.1 Socio-economic impacts

Issue 1: Employment Opportunities and the Stimulation of Economic Growth

The area has a significantly large youth population, who might demand local employment. The area also lacks real employment opportunities or economic growth, and the mining development could provide a much needed economic thrust in terms of sourcing material and services locally, stimulating the area's general economy.

Therefore, there is a strong possibility that the prospective mining operation will draw migrant labour in search of employment opportunities. Surrounding villages are poor and uneducated, which means that more educated and skilled labour will certainly be needed from areas such as Balama, Montepeuz or even Pemba. Villagers in rural Mozambique are known to be migrators, and provided that mining operations are expanding in the district, a steady increase in migrants is foreseen. Such an influx can either cause some of these villages (especially Pirira and/or Maputo) to expand significantly, or cause a temporary increase in labour.

As with most social impacts, in-migration may also have a positive impact in terms of providing locals with small business opportunities due to an increased demand for local produce and other goods, as well as opportunities for cultural exchange.

Two impacts are discussed below, namely employment, skills training and scholarships, as well as temporary or permanent in-migration by outsiders in search of job opportunities.

Impact 1.1: Employment, Skills Training and Scholarships

Cause and Comment:

The mine will need highly skilled workers with graduate degrees or experience in mine-related tasks. Nevertheless, many of the tasks can be performed by local labour, and the developer will, as far as reasonably possible, increase such opportunities, in accordance with local recruitment procedures. If sufficient employment opportunities are not provided to the local populace, a significant influx of labourers into the area could occur, causing pressure on local resources and possibly conflict with the local population. Another consequence might also be local resistance to the project, or even tension between the locals and the developer.

Mitigation Measures:

The following enhancement measures are proposed:

- Develop industry specific and appropriate Human Resources (HR) policies and procedures;
- Establish a labour desk/employment committee to design and implement an Employment Enhancement Plan. This will ensure that recruitment is done in a fair

and transparent way, and that job creation opportunities are maximised;

- Provide scholarships and work apprenticeships to the local population (especially the youth);
- Support the primary schools and, especially, learners who need financial support (such as bursaries) to allow them to enrol in higher education institutes;
- Adhere to the recommendations contained in IFC PS 2 (Labour and Working Conditions) in developing the following labour policy and operational guidelines:
    - Developing appropriate HR policies and procedures (Nr 8);
    - Establishing appropriate working conditions (Nr 10);
    - Ensuring non-discrimination and providing equal opportunities (Nr 15);
    - Establishing a Grievance Mechanism for labour issues (Nr 20);
    - Protecting the work force (Nr 21-22); and
    - Occupational Health and Safety (Nr 23).
- Adhere to the following International Labour Organisation (ILO) conventions:
    - ILO Convention 87 on freedom of association and protection of the right to organise;
    - ILO Convention 98 on the right to organise and collective bargaining;
    - ILO Convention 29 on forced labour;
    - ILO Convention 105 on the abolition of forced labour;
    - ILO Convention 138 on the minimum age of employment;
    - ILO Convention 182 on child labour;
    - ILO Convention 100 on equal remuneration; and
    - ILO Convention 111 on discrimination.
- As far as possible, incorporate labourers involved in the construction phase as permanent staff for the operational phase;
- Ensure there are employment opportunities for women and disabled persons;
- Consider differential treatment for villages which are differentially affected by the project. Directly affected residents should be given first priority in job offers and training opportunities; and
- As far as reasonably possible, develop and implement a plan for gradual replacement of expats and outsiders by local people.

Significance Statement:

Should these mitigation and/or enhancement measures not be implemented, the significance of employment would only be moderate positive during the construction phase. With enhanced employment opportunities the significance during the construction phase would be highly positive.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short-term	Study area	Moderate Beneficial	Probable	**MODERATE**
With Mitigation	Short-term	Study area	Very beneficial	Definite	**HIGH**

Impact 1.2: Temporary or permanent in-migration in search of job opportunities

Cause and Comment:

Although influx is considered outside the control of project developers, the IFC guidelines on project-induced in-migration suggest that influx can threaten ‘project security’ and that it should be managed as a project threat (*cf.* IFC, 2009). The direct and indirect impacts associated with an influx of labourers (outsiders) are likely to have significant impacts on these villages, as it usually result in many social, cultural, economic and political changes. Some of these include (but are not limited to):

- Creating tension and conflicts between locals and migrants concerning natural resources, land and employment opportunities;
- Inflating local food and produce prices;
- Placing increased pressure on already limited social and natural resources;
- Increasing the incidence of so-called ‘social ills’, including prostitution, alcohol abuse, and crime;
- Increasing the prevalence of communicable diseases, such as diarrheal diseases, vector-borne diseases, such as malaria, and sexually transmitted infections (refer to section 7.4.2 below); and
- The creation of ‘poverty gaps’, such as inequalities in terms of income and wealth accumulation between locals and migrants.

Mitigation Measures:

The developer will explore opportunities to manage and mitigate the negative impacts associated with an influx of workers by developing appropriate management plans. Some of these options include:

- Developing a Labour, Recruitment and Influx Management Plan. The following guidelines may be used in developing such a plan:
- *Information dissemination:* Employment opportunities need to be advertised, however the procurement and procedures for such employment needs to be made available to the public. Regular briefings are necessary.
- *Recruitment and supply chain transparency:* Recruitment and procurement rules and opportunities have to be transparent and, most importantly, accessible to the public. This will be the responsibility of the community liaison officer, as well as the human resource manager. *Influx management and security arrangements:* While the need for project security is understandable, such security measures can have further implications on the surrounding villagers’ safety and mobility. A mechanism needs to be implemented to allow free access to their surrounding villages, while still restricting the uncontrolled influx of job seekers. Regular engagements with the local villagers and the security personnel through workshops and meetings should build a relationship between these parties.

Significance Statement:

If no plans are developed and implemented, the impact of in-migration might be highly negative for the construction phase, as this phase of the mining development can cause a significant influx of job seekers in the short-term, restricted to the study area. The likelihood of this is probable and the effect might be very severe on the local populations and their culture.

With mitigation measures in place, the impact should be low negative on the affected villages during the construction phase, as the mine could stimulate the local skills base and limit the number of outside workers required.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short-term	Study area	Very severe	Probable	**HIGH**
With Mitigation	Short-term	Study area	Severe	Slight	**LOW**

Issue 2: Land Acquisition

As indicated by the findings of this SIA, all the PACs are engaged in subsistence agricultural farming (98.4% of those who farm have *machambas*). Since many shift their cultivation from one field to the other, ample land, and importantly, different types of land, is needed to sustain their livelihood and food security. Although cash income from agricultural production is small, in many cases, it is the only income received by households. In addition, many farmers are part of larger cotton and maize production out-grower schemes (such as Plexus), where companies assist smallholder farmers with seeds, in exchange for locals selling their cotton and maize to the companies. This means that any loss of land will reduce the farmers' potential to participate in the cotton and maize industries - incomes which are significant, not only to individual households, but also to villages.

If this issue is not mitigated, it might have multi-dimensional and far-reaching consequences, such as increasing food insecurity, reduced income, as well as a change in the livelihood opportunities of these residents.

Two related impacts are discussed below, namely a reduction in access to productive land and economic displacement and heightened food insecurity. Please note that even though this impact is assessed in the SIA for both the construction and operational phases, this is considered to be mainly a construction phase impact, as economic resettlement and compensation will take place during the construction phase of the project. For this reason it is only discussed in this section of the ESHIA.

Impact 2.1: Reduced access to Agricultural Land

Cause and Comment:

There is a concern that the mine will reduce access to productive land within the mining footprint (mine exclusion zones) and lead to a significant loss of *machambas*. According to the Resettlement Action Plan over 200 *mashambas* totalling 400 hectares will be lost. Reduced access to land is coupled with economic displacement (i.e. where productive or future farmland is lost to the mine), as well as an increase in erosion.

Local farming practices mean that relatively large areas of land are needed for villagers to rotate their fields and obtain sufficient yields for future food security. The loss of productive land and natural resources is likely to be the impact of greatest concern to the villagers. Access to land and the resources that flow from this land are of critical importance to sustaining livelihoods in villages that are extremely vulnerable as a result of poverty and their isolation from cash income-generating activities. Vulnerable households will be more significantly affected, such as female-headed households, or households with disabled and/or elder members.

Apart from compensation for crop and tree losses, international best practice increasingly advocates the provision of alternative land with the same potential, *in lieu* of providing cash compensation for land-loss. As part of the RAP process, discussions will be held with the affected farmers to establish appropriate mitigation measures, as well as their preferences for alternative land.

Syrah must provide alternative land, a land for land compensation strategy, as is required by the resettlement regulations in Mozambique (2012).

Mitigation Measures:

- Households that are affected by economic resettlement have to be identified through a consultative process (this has been completed as part of the Resettlement Action Plan, please refer to Part 6 of the ESIA reports);
- As part of the RAP, a detailed asset and agricultural inventory has been undertaken with each affected household to develop appropriate compensation and development strategies to be developed with mutual consensus;
- During the RAP process, a Technical Working Group (TWG) has been established with the affected villages . The TWG has representation from the affected villages, relevant Mozambique ministries and developer representatives [as per the Regulations for the Resettlement Process resulting from Economic Activities (Government of Mozambique, 2012)]. The role for the affected villages is to discuss future resettlement and displacement issues with the developer, and to establish ways to deal with project impacts (in the case of the Syrah Balama Project only economic displacement is required); and
- As part of this RAP, village access to natural resources has been considered, and mine infrastructure designed in order to ensure continued access to such resources (this has already been done);
- Livelihood restoration strategies is to be considered, aimed at assisting households with re-establishing and improving their livelihoods. As the villagers are primarily involved in subsistence agriculture, it makes sense to provide agricultural support and/or training as a livelihood restoration strategy. Options are being considered by the developer;
- In compliance with IFC PS 5, a grievance mechanism has been established through which the affected villages can engage with the developer throughout the RAP process.
- In accordance with the IFC PS 5, the RAP needs to include a detailed agricultural valuation of all the affected farmlands and owners’ possessions in order to develop appropriate compensation strategies and entitlement matrixes. This will be included in the RAP (this has been completed as part of the Resettlement Action Plan, please refer to Part 6 of this report)
- Prior to acquiring land for the mine development, those farmers or households affected by the loss of farms will be assisted by the developer and Ministry of Agriculture with alternative farmland This also ensures compliance with the IFC under its PS 5 which is called ‘transitional support’; and
- An established TWG is the primary vehicle for engagements between the developer and the affected households and farmers and will be used to establish crop and tree compensation rates, the provision of alternative agricultural land, as well as livelihood restoration/development strategies (such as agricultural programmes, for example). As part of this TWG, the relevant Mozambique ministries will be part of the process, as per the Regulations for the Resettlement Process resulting from Economic Activities (Government of Mozambique, 2012).

Significance Statement:

If no mitigation or enhancement measures are implemented, the significance of reduced access to productive land and economic displacement due to establishing a mine will be

VERY HIGH negative. Land loss is a significant issue which, even with mitigation measures, remains a serious concern and threat to the livelihoods and food security of rural villagers. With mitigation and enhancement measures implemented, the mine could still have a probable severe long-term negative effect at the scale of the study area, of MODERATE significance. The reason for this high rating really relates to the number of farms and amount of land that will be lost (the RAP estimated over 200 *mashambas* totalling 400 hectares will be lost – CES, 2014).

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long-term	Study area	Very severe	Definite	**VERY HIGH**
With Mitigation	Long-term	Study area	Severe	Probable	**MOD**

Impact 2.2: Increased Food Insecurity

Cause and Comment:

Coupled with the issue of economic displacement and reduced farmland, is the impact of food insecurity. As noted, nearly all the villagers are subsistence farmers. An insignificant number of household members are formally employed.

Food insecurity might become a serious issue for several reasons. One reason is that the mine development will lead to the loss of many *machambas*, It is therefore important to ensure that those affected receive alternative land of the same value and same productive potential, with new fields that can be adequately prepared for beneficiary farmers to have a first harvest for food security prior to the acquisition of land by Another reason is that erratic and changing weather conditions affect households' agricultural harvests which is compounded by a lack of fertile land that may result in households being forced to diversify (or change) their income-earning livelihoods. Even though many might become dependent on employment on the mine, limited employment opportunities in the area could impede the villagers' ability to sustain their households' nutritional needs.

Mitigation Measures:

The following mitigation measures are proposed:

- Compensate affected households for lost crops and trees and assist the affected households with alternative farming land of at least the same quality;
- Discourage affected villagers from discontinuing their agricultural practices, despite the possibility of employment opportunities. Assist farmers with their new farms, through the provision of agricultural extension services as part of a Farmers Development Programme (FDP), discussed in the RAP report;
- No farmland will be acquired before allowing the affected farmer and/or household to harvest the field or alternatively before the farmer and/or household has been compensated with equivalent produce for the crops already planted; and lastly
- In the future implement a food security/nutritional monitoring programme with a sample of households. This monitoring programme will have a key focus on determining the farmers' ability to re-establish themselves on their new land, and to ensure on-going food security at least at the same level of food security prior to being moved. As part of the proponent's obligations under the RAP to provide transitional support through the new land allocation process, a Farmers Development Programme (FDP) is currently being implemented and managed by the

proponent. The objectives of this programme are for the mine to allocate alternative land to each affected farmer, to deliver entitlement (seeds/structures) and to provide temporary agricultural transitional support. The programme is intended to ultimately ensure that those households who received alternative land actually utilise this land, whilst asisting the economically displaced during the land acquisition period with preparing their replacement land.

Significance Statement:

Without mitigation, food insecurity amongst the PACs will become a serious impact of the project and should be viewed in a very serious light. Food insecurity might also result in a strained relationship between the project developer and its PACs, and might even evoke violence.

With mitigation measures in place, the impact will be HIGH negative. With appropriate mitigation measures, the impact should have a LOW positive impact.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Regional	Very severe	May occur	**HIGH**
With Mitigation	Short-term	Regional	Slight beneficial	Probable	**LOW**

Impact 2.3: Reduced Access to Natural Resources

Cause and Comment:

Natural resources are widely used as essential ecosystem services by a relatively large population. The data indicated that little cash income is actually received by households from these resources. However, of the income received, charcoal and local trading (such as in bush meat, wood or wild plants) are substantial components of livelihood strategies. Even though the footprint of the mine's natural resource extraction will be limited, the resources offered by these two mountains is significant (refer to the Botanical Specialist Survey Report, 2013).

Mitigation Measures:

The following mitigation measures are proposed:

- A RAP is currently being conducted by CES. As part of this RAP, village access to natural resources will be documented and specific sites and/or trees that are used by villagers will be recorded;
- According to international guidelines, the loss of access to natural resources is seen as economic displacement, especially if local residents derive an income from such resources (IFC, 2012). Consequently, through discussions with the TWG, the RAP has established compensation and entitlement frameworks for such losses in consultation with the MoA (represented at district-level by the District Services of Economic Activities);
- As part of a RAP, a grievance mechanism was established, through which the affected villages and farmers can engage with the developer throughout the RAP process and lodge complaints;
- A TWG has already been established with representation from the affected villages, relevant Mozambique ministries (such as the MoA) as well as a representative from

the developer. The role of the TWG would be for the affected villages and farmers to discuss future resettlement and displacement issues with the developer, and to establish mitigation measures for such losses (including livelihood restoration strategies and project benefits); and

- Offset the impacts of reduced access to natural resources by providing agricultural services to the affected villages and farmers.

Significance Statement:

The significance of this impact would be HIGH negative if no mitigation measures are in place. Access to natural resources will become restricted, which will reduce the sustainability of villagers' livelihoods and might increase villagers' dependence on economic opportunities in the region (which are lacking).Food insecurity might also be an associated impact. Mitigation measures would be able to off-set this impact to MODERATE significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long-term	Study area	Severe	Definite	**HIGH**
With Mitigation	Short-term	Study area	Moderate	Probable	**MODERATE**

Impact 2.4: Loss of Sacred and Culturally Significant Sites

Cause and Comment:

In the mine lease area, there are a number of culturally important sites, including sacred trees and forests. Should any of these sites be disturbed or access denied or restricted, the developer will have to engage with the affected villagers with regard to compensation packages (e.g. religious ceremonies). The RAP recorded all these sites. These sites are clearly marked by the mine in order for the project, as far as possible, to avoid these areas (refer to the RAP report).

Mitigation Measures:

Some of the mitigation measures which should reduce the significance of this impact include:

- This SIA already recorded all the affected villages' sacred and cultural sites, and indicated whether the current mine layout plans should be re-considered and amended to avoid these sites entirely. Subsequent to the compilation of this report, the developer has amended the mine's infrastructural layout plans with due consideration of the sacred sites identified;
- A Grievance Mechanism is already in place to allow the affected villagers to voice their concerns; a mechanism which should allow for the developer to take appropriate mitigation measures in accordance with the issues and/or concerns of the villages;
- As part of the RAP, compensation measures have been established between the developer and the GoM through open and transparent engagements with the villages, interested parties and relevant stakeholders; and lastly
- Develop a Cultural Heritage Management Plan in consultation with the affected villages. This plan proposes to:
    - Protect the cultural heritage of the area;

  - Identify all sacred sites in the area and propose ways to protect and/or relocate these sites; and
  - Assist the developer to understand the cultural norms and values of the locals in the area.

Significance Statement:

If no mitigation measures are in place, villagers might permanently lose their sacred sites, or have only limited access to such sites in the future. This impact would be restricted to the study area, but would be severe. This could cause significant, and on-going, dissatisfaction among the affected people. These sites are highly intertwined with the cultural fabric of these villages, and culture should be protected.

With appropriate measures in place (such as to avoid mining in areas that are culturally significant), the affected villages' sacred sites might be protected.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study area	Severe	May occur	**HIGH**
With Mitigation	Permanent	Study area	Slight	Probable	**LOW**

Impact 2.5: Loss of Graveyards/Cemeteries

Cause and Comment:

Several graves and cemeteries have been identified and clearly marked through the RAP process. As far as possible, the mine's layout will avoid these areas. Still, there is the possibility that some graves and/or cemeteries might be affected/disturbed during the construction phase.

Mitigation Measures:

- The RAP recorded each affected graveyard and gravesite in the area with the assistance of the villagers;

The following mitigation measures are applicable:

- As explained, as part of the RAP, a TWG and grievance mechanism has been established. After consultation with those affected families, the mine will bear the costs for grave exhumation and reburial, as well as for traditional ceremonies. No compensation will be paid, as this is against their culture. This is covered in the RAP.
- Develop a Cultural Heritage Management Plan in consultation with affected villages;
- Engagement with affected villages must have already taken place and all agreements must be in place prior to land clearing or preparation. During engagement, the affected villages need to be sensitised to the new areas to be cleared and prepared, and discussions with regard to the possible relocation of graves or compensation for the removal of such graves will need to be entered into between the affected villagers and the developer. Aspects to consider would include preparing new burial sites and appropriate means of transporting and re-interring the dead.

Significance Statement:

Graveyards and gravesites are central to the African religious practice, as they embody the spirits of ancestors and represent physical places of sacred value. Removing such sites has permanent, far-reaching consequences, as it directly affects core values and patterns of relationships at the heart of these villagers' lives. Any disruption to these sites without adhering to the established and agreed upon protocol and relocation strategy will be seen as very serious.

Disruption of graves or gravesites, save for one, has been avoided. However, the additional mitigation measures provided above should enable villagers to voice their concerns and have an input into the planning and implementation stages of the project. This should allow affected villagers to feel part of the project, and have a meaningfully contribution to how their graves might be removed and/or relocated.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study area	Very severe	Probable	**VERY HIGH**
With Mitigation	Permanent	Study area	Slight	Unlikely	**LOW**

Issue 3: Community Safety Risk

Cause and Comment:

With any development initiative, there are health, safety and security risks. Impacts related to the possible pollution of water resources are discussed in the Groundwater Specialist Assessment as well as in Chapter 6 of this report and are thus not assessed here. Traffic-related impacts, such as an increased risk of accidents due to increased traffic volumes and the use of heavy machinery are discussed in the Transport Specialist Assessment as well as in Chapter 8 of this report.

The mine area will be fenced for safety considerations. However, depending on the mine's final layout plans, routes such as the bypass road from the R242 to Ntete and the Chipembe Dam need to remain accessible to the local villagers who are dependent on these passageways. With the introduction of security personnel at any entrance gates, conflict sometimes exists between the security personnel and the local villagers. This may arise if security personnel are inadequately trained in using force, or abuse their position of power.

Mitigation Measures:

- A Grievance Mechanism has been established during the RAP through which affected villagers can voice their concerns to the developer;
- Training of security personnel will be to high standards and will take into account local traditions.

The IFC is very specific when it comes to mitigation measures related to project security personnel (*cf.* PS 4). Several measures are proposed:

- If a private security company is used, the developer will sign an agreement with the private security company which will allow for the following:
    - Security personnel need to be properly trained in the use of force and, most importantly, appropriate conduct towards local residents;

  - Instant dismissal for any security personnel involved in theft or abuse; when appropriate evidence can be produced;
  - A code of conduct must be developed for the security personnel;
  - The above-mentioned code of conduct must be consistent with the United Nation's (UN) Code of Conduct for Law Enforcement Officials, and the UN Basic Principles on the Use of Force and Firearms by Law Enforcement Officials; and
- Reported incidences need to be assessed by the developer who will implement appropriate measures;
- All the PACs need to be informed about the roles and responsibilities of the security personnel.

Significance Statement:

This is potentially a serious impact, and failing to implement mitigation measures might result in fractious relationships between the developer and the PACs. Without mitigation, this impact will have a moderately negative impact. The project should have no effect on the surrounding villagers if appropriate protocols are implemented.

Impact	Effect			Risk or likelihood	Significance
	Temporal scale	Spatial scale	Severity of impact		
Construction phase					
Without mitigation	Short-term	Study area	Severe	May occur	**MOD -**
With mitigation	No impact				

Issue 4: Stakeholder and Community Engagement

Cause and Comment:

Effective stakeholder and community engagement is of pivotal importance. Syrah are committed to stakeholder and community engagement and will continue having structured and regular engagements with stakeholders and affected villagers. Doing so will mitigate potential serious implications for the project by delivering on sound constructive communication methods and opportunities. These communications should also mitigate any potential for social unrest and or tensions between the company and the affected communities

Mitigation Measures:

- A Stakeholder Engagement Plan (SEP) has been drafted and implemented

The following measures are proposed:
- Implementation of the Social and Environmental Management System (SEMS);
- Implement two separate grievance mechanisms for labour and for community issues (a community Grievance Mechanism has been introduced as part of the RAP).

Significance Statement:

Without implementing enhancement measures related to regularly engaging with the affected villagers, the significance of the project could potentially have a moderate negative impact on the affected villagers. The reason for this is that poor stakeholder engagement could cause considerable tension between the project development and community members, especially if villagers are not informed of the project and regular project related activities.

With enhancement measures implemented during the construction phase, the significance would be moderately positive.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short-term	Localised	Severe	Probable	**MODERATE**
With Mitigation	Short-term	Localised	Beneficial	Probable	**MODERATE**

7.4.2 Health related impacts

Issue 1: Communicable Diseases linked to Housing Design

Impact 1.1: Transmission of communicable diseases due to overcrowding

Cause and Comment:
TB is endemic in Mozambique. The capacity of the health care services to manage TB is limited, especially in case detection. Moreover, the link with HIV is a growing problem and this increases the challenge in monitoring for any negative impact related to increased transmission from the disease. The project will inherit this as well as the poor socio-economic and housing conditions as described in the SIA and HIA.

Respiratory tract infections, from a viral and bacterial origin are important to consider. This can include seasonal influenza and pandemic strains that the local communities may be naïve to due to their isolation. Vulnerable groups in these communities, especially the elderly and those with underlying disease, are particularly susceptible as their immune systems are often weakened. Any management plans for respiratory diseases developed by the project must consider community health as this may affect business continuity and reputation, where the project runs the risk for being blamed for disease outbreaks especially with movements of people in and out of area.

Mitigation Measures:

The following mitigation measures are proposed:

- Support community based information campaigns related to TB symptoms and the need to seek care. The campaign will aim to address the risk of co-infection between HIV and TB. This can be managed through community-based peer health educators;
- Labour policies will aim to encourage hiring of local staff to avoid job seeking migrants. The project will not hire at the front gate but consider a recruitment office at an off-site location;
- Influx management and advice with regards to town planning to prevent overcrowding;
- Develop partnerships to support the community based TB control programs in conjunction with the authorities and any agencies/NGO. These partnerships aim to include case detection, management and surveillance activities under the national TB program policy and strategy;

- Support the health management information system and collect longitudinal data on key TB indicators. This will require health systems strengthening to get this essential data;
- Support improvements in the capacity of local TB case management. This will include training of health care staff, appropriate diagnostics for case detection and a referral system for effective treatment. This can be through support of a local NGO and/or the national program. This will assist in addressing case surveillance and in ensuring that the TB situation does not deteriorate in the area.

Significance Statement:

Without mitigation this impact is considered to be long term, severe and probable and thus of HIGH negative significance. With mitigation measures in place this impact is considered to be moderately positive.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Study Area	Severe	Probable	**HIGH**
With Mitigation	Long term	Study Area	Moderately Beneficial	Probable	**MODERATE**

Issue 2: Vector-related diseases

Impact 2.1: Malaria burden

Cause and Comment:

Malaria is the most significant public health threat and cause of mortality in the project area. Malaria was mentioned as the most important disease in the focus group discussions at the local community level. However, there is good knowledge and understanding of malaria transmission and prevention. Ownership of Insecticide-treated Bed Nets (ITNs) is good, although it is difficult to assess proper utilisation. There are also good diagnostic and treatment mechanisms in the area, with consistent use of Rapid Diagnostic Tests (RDTs) to diagnose malaria as well as adequate stock of Artemisinin-based Combination Therapy (ACT) which is standard treatment. This is also coupled with good health seeking behaviour amongst community members.

Very little is described on the entomology in the area. This includes the vector complexes, their breeding preferences and behaviour (resting and feeding), as well as susceptibility patterns to different classes of insecticide. This is vitally important for the project to describe as it will influence the type of mitigation measures required from a source reduction and control perspective.

While the malaria burden is high in the communities, and there is obviously a suitable environment for mosquito breeding and disease transmission to occur, the project does have the potential to impact malaria transmission. This will require mitigation; interventions may differ based on seasonal and land use practices. Modification of the environment frequently changes the habitat for mosquitoes to breed in. The presence of a dam in the project area strongly increases the malaria risk during the rainy season.

Influx of individuals may also play a role in increased disease transmission. More people from outside the area may increase the naturally occurring parasite pool and changes in land use may also alter the environment. This is challenging for the project to manage as their responsibility, as it is already part of the baseline conditions.

The health of the workforce also needs to be considered, especially as some of the workforce will come from the local community. The risk of the disease could have significant health and economic impacts to the project if not mitigated properly. Malaria can have the following impacts at the workplace level:

- *Absenteeism through repeated infections*: This will have a significant impact on productivity and increased costs. It is estimated that an expatriate non-immune employee will take 5-7 days to reach optimal productivity after an uncomplicated case of malaria and a semi-immune local employee 2-3 days.
- *Health and safety risks*: Patients with malaria who still work may pose a risk to fellow employees and themselves. The effects of the disease and the treatment drugs may decrease alertness. The medications may also reduce hearing sensitivity.
- *Increase cost of overall health care*: The cost of malaria management through large case-loads can become significant even if managed at the local site medical service. An uncomplicated case of malaria may cost about $15 to manage, without considering human resource and capital expenses (Asante and Asenso-Okyere, 2003). The impact of a complicated case of malaria, that may require medical evacuation and extended hospitalisation in an intensive care unit (ICU), can be very costly, and may run into hundreds or thousands of dollars.
- *Increased burden on the medical service*: High case loads of malaria will take a significant amount of time in the medical service and limit the effectiveness of other health programs, such as occupational health.
- *Employee turnover and attractiveness*: Exposure to risk may decrease the ability to attract skilled staff to work in the area. Repeat infections and decreased morale from the risks related to the disease may also increase employee turnover.
- *Employer liability*: The risk exists for an employer to be held liable for complications that may arise from an infection, especially if mitigation measures have not been implemented.

In summary, the way malaria transmission will be influenced by the project will depend on determinants such as the epidemiological setting, local vector behaviour and management, change in land use related to vector activity, socio-economic conditions and health seeking behaviours. The highly endemic nature of the disease means that the project is unlikely to significantly add to the already high disease burden of the community during the wet season. However, during the dry season, the increased potential for breeding sites will play a major role and change the normal epidemiology of the disease vectors. The behaviour of the vector is not known and may need to be described and understood to determine if land use will alter the behaviour and lifecycles of the vectors. In spite of these potential unknown factors, mitigation measures are warranted and are likely to play a significant beneficial role to the community if well planned and executed.

Mitigation Measures:

- Collect baseline data that will inform planning related to the integrated programs. Develop monitoring and evaluation programs based on this data. The following data should be collected:
    - Entomology survey including the most common mosquito species complex, their feeding and resting habits as well as their susceptibility to the different classes of insecticides;

  - Baseline malaria indicator survey in the communities (people aged 6-59 months) to determine the burden of malaria in the community, and also serve as an indicator to monitor the impact of the disease and interventions; and
  - A knowledge, attitude and practice (KAP) study in the community to support the design and implementation of information, education and communication programs to promote behaviour change and monitor interventions.
- Ensure project designs reduce the potential for sources of vector breeding;
- Develop community based programs in partnership with the local authorities and based on the strategy of the national malaria control program e.g. ITN distribution;
- Any workplace malaria and vector control program to include measures for reducing the potential for increasing vector densities and thus decrease disease transmission in the communities;
- Extend the workplace program into the community program to ensure maximal positive benefits and reduction in workplace risk. The sustainability of these interventions will need to be closely considered given the duration of the project; and
- Encourage source reduction in communities through environmental control mechanisms based on community work groups. These activities can assist with the reduction in other vector related diseases.

Significance Statement:

Without mitigation this impact is considered to be long term, severe and probable and thus of HIGH negative significance. With mitigation measures in place this impact is considered to be highly positive.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Study Area	Severe	Probable	**HIGH**
With Mitigation	Long term	Regional	Very Beneficial	Probable	**HIGH**

Issue 3: Sexually Transmitted Infections, including HIV/AIDS

Impact 3.1: Transmission of STIs and HIV/AIDS

HIV/AIDS and STI are significant existing public health challenges nationally and within the immediate project area. Although the HIV prevalence in the project area is low, it is still of public health concern. STIs, if present and untreated, have been found to increase the risk of transmission of HIV, if one partner is infected. HIV's link with TB and its importance has been discussed above (impact 1.1).

Influx or/and movement of labour into the area will pose an increased risk for STIs. There will be more disposable income either as a direct or indirect consequence of the project. Commercial sex workers are more likely to establish in Montepuez, but may also be attracted to the immediate project area, where local community may be vulnerable to opportunistic sexual liaisons. The likely effect of the project employing a number of relatively well-paid employees may also increase the risk for transactional sex, especially if they are away from their normal family unit. Economic upliftment and settlement in the project area may also lead to the adoption of "urban" values and lifestyle changes, which may also play a role in casual sexual engagement.

Women and young girls are extremely vulnerable and have limited negotiating power for safe practices and family planning. Gender based sexual violence is common and while there are NGO's active in the area there is very little support for victims. It is important to recognize the role gender plays in sexuality and its effects on HIV transmission and prevention especially when considering the higher burden of disease in women compared to men in Mozambique.

HIV/AIDS should be considered a major risk for the project and the community and interventions should be implemented on a broad base in the workforce and the community. It may also be influenced by considering the **4M's** detailed below (International Food Policy Research Institute (IFPRI), 2005):

- *Mobility*: The transport corridors which will be improved with the development of the project will increase traffic to the area. Transport drivers are well known to engage in casual sexual practices as they are often away from family units. This can not only result in high risk sexual activity along the whole transport route but also in Balama as an end destination. The migration of people into the project area in search of work may cause similar consequences. The contract workforce also needs to be considered. This workforce may come from areas where the HIV prevalence rates are significantly higher and also carry different viral strains. They may have also worked in remote settings away from their normal partners for extended periods and thus causal sexual relations become the norm.
- *Money:* There will be adequate amounts of disposable income in the area which will increase during the duration of the project. People who benefit directly and indirectly from the project may have more money available to partake in forms of transactional sex. These include local hires as well as semi-skilled contract workers and even senior expatriates.
- *Men:* Men play a predominant role in the local society and will form the bulk of the workforce due to the physical demands from mining. Transport workers and the construction work-force are also generally men.
- *Mixing*: This is strongly linked into mobility. In-migration of outsiders, returning migrants, the construction workforce and the transport workers are all different population groups that may mix with the present indigenous population. This may result in mixing of people with high prevalence with those with low prevalence of disease, and also introduce different virus strains.

There was no confirmed accurate data on HIV prevalence and very little in the way of data to understand practices and behaviour linked to HIV. The cumulative impacts of HIV, STIs and TB need to be considered.

Mitigation Measures:

- Develop a HIV/AIDS policy that incorporates both the workplace and community considerations;
- Develop an integrated HIV management program that considers both the workplace and the community but with different levels of intervention. The workplace should include a comprehensive program while the community program should have a focus on awareness and prevention activities. TB and STI must be integrated into this;
- Conduct a KAP study to understand levels of awareness and knowledge in both the workplace and community. This needs to have an emphasis on practices so that appropriate behaviour change programs are developed;
- Conduct a sero-prevalence study in the area in partnership with the local health authorities;
- Support the local health authorities in extending care and treatment programs in the area. Support the local health authorities with the establishment of Voluntary Counselling and Testing (VCT) centres in the area;

- Support information campaigns and community based peer educator programs in both the workforce and community. These need to use locally acceptable tools and based on the finding of the KAP study. These must serve as indicators to monitor the impact of the behaviour change and must have a gender focus. Community based peer health educators will play a key role;
- Develop an Influx Management Plan that also considers HIV;
- Support equal employment opportunities for women and support livelihood programs;
- Support NGO groups active in area on gender-based sexual violence;
- Prevent fraternization of external contractors with the community through codes of conduct and reduce the number of external people sleeping in the community at night.
- Support the development and extension of prevention of mother to child transmission programs;
- Support community based condom distribution centres; and
- Support health services in area with improved infection control and medical waste management.

Significance Statement:

Without mitigation this impact is considered to be permanent, very severe and definite and thus of VERY HIGH negative significance. With mitigation measures in place this impact is considered to be moderately positive.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Regional	Very Severe	Definite	**VERY HIGH**
With Mitigation	Long term	Regional	Moderately Beneficial	Probable	**MODERATE**

Issue 4: Soil, water and waste-related diseases

Impact 4.1: Soil, water and waste related diseases

Cause and Comment:

The communities in the project area have limited access to clean/improved water supplies. There is a heavy reliance on non-protected wells as a primary source of drinking water.

Influx may also play a role in availability of water due to increased demand, which may ultimately negatively affect water quality. Water-borne diseases such as diarrhoea are common and are linked to contaminated water and poor sanitary conditions. Water-washed diseases such as eye and skin infections are common. These are linked to poor hygiene.

Sanitation services in the area are limited and the prevalence of indicators for sanitation such as soil-transmitted diseases and schistosomiasis may suggest a high-level burden of disease. Chipembe Dam may also have the potential to increase the prevalence of schistosomiasis in the area. A study conducted in Mozambique by the International Water Management Institute (IWMI) found that the transmission of urinary schistosomiasis increased after the construction of dams, especially in the semi-arid northern areas of the country. This is because reservoirs provide perennial water bodies in the area for the intermediate snail host. The prevalence of urinary schistosomiasis in villages with and without dams was found to be statistically significant (Boelee et al., 2009). There is also no formal waste disposal system.

The project may influence water and waste related diseases in the following ways:

- *Development of water storage facilities*: The project will develop water storage dams for water use in the plant and to store excess water pumped from Chipembe Dam or underground sources. The community will not have access to these.
- *Access to water*: Other than resettlement or restriction of movement the project should not reduce access to community water supplies.
- *Quantity of water*: The project will require water for the plant operations. The planned low rate of abstraction of water from Chipembe Dam means that there may not be any significant impact on the quantity of water available.
- *Quality of water*: The project may have an impact on community water quality through domestic use on site and from plant operations. The potential pollution of surface water from the discharge of water from the sewerage treatment plant that will need to be developed to support the working camps will be limited if recommendations related to waste management (refer to Chapter 8) are implemented.
- *In-migration and unplanned settlements*: Pressure on existing limited services in terms of water supply and sanitation could dramatically increase the risk of water related diseases. There is little data on basic water and sanitation practices or burden of disease linked to specific water and sanitation indicators. There is the potential for the project to be accused of polluting the water bodies in the surrounding communities from plant or domestic water and thus it is important to establish firm baselines for mitigation. Water and sanitation are significant existing needs in the community and if BGM supports any initiatives they should be linked to specific indicators to measure impact. Due to influx into the area and the indirect pressure it will cause on available sanitation services, the project is likely to have an impact on the sanitation situation in the area. However, improving the sanitation situation is likely to have major beneficial impacts in the communities and improve their overall quality of life.

Mitigation Measures:

- The quality of groundwater and surface water will be monitored to ensure that the project does not have any detrimental effects on community water sources;
- Influx management of migrant workers;
- Restrict access to project created water bodies;
- Conduct baseline water and sanitation studies on practices based on accepted health indicators;
- Perform end user analysis of water quality. This serves as an indicator for monitoring water quality where it is consumed and determines the level of general sanitation and hygiene even if water is collected from clean sources;
- Conduct baseline soil transmitted helminths and schistosomiasis studies to provide an indicator for monitoring sanitation in the communities. This will be used to inform a proper baseline in the communities so the potential impact of increasing the disease burden from schistosomiasis can be monitored. Soil Transmitted Helminthiasis (STH) are a good indicator for the baseline status of sanitation in the area and an important cause for co-morbidity;
- Ensure proper disposal of human waste that is generated from the project. There must be proper waste water treatment plants with the capacity to manage the expected throughput with required contingencies. The design should be such that if

there is a failure that the risk of direct exposure to communities and their water sources is minimised;

- Ensure proper waste management from project generated waste according to waste management principles;
- Support the local authorities and other partners in improving water and sanitation services;
- Establish water and sanitation committees in the communities to manage their own water and sanitation services. This will improve sustainability of any outreach support;
- Promote and support local authorities in improved collection and disposal of waste in communities;
- Support information campaigns in the community on water use, hygiene and general sanitation; and
- Depending on the results of the baseline study, support the government's school deworming programme in partnership with local authorities. Schools should be supported with VIP latrines.

Significance Statement:

Without mitigation this impact is considered to be long term, severe and definite and thus of HIGH negative significance. With mitigation measures in place this impact is considered to be highly positive.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Localised	Severe	Definite	**HIGH**
With Mitigation	Long term	Regional	Very Beneficial	Probable	**HIGH**

Issue 5: Food and nutrition related issues

Impact 5.1: Malnutrition

Cause and Comment:

Malnutrition is extremely common in Mozambique and a big problem in the project area. More than a half of the children in Cabo Delgado Province were found to be stunted in 2010 (Institut National de la Statistique et de la Démographie (INSD) et al., 2011).

Reasons for malnutrition include a lack of food due to poor yields of crops, challenging farming techniques with lack of mechanisation, limited variety in diet, expense of food and also poor feeding practices.

Food security in Mozambique is currently a national challenge. Feeding practices and general diet is not that well understood, although reports suggest that women are poorly educated on proper feeding practices. Feeding practices are extremely important to address as these are problematic and simply having adequate supply of food will not ensure adequate nutrition.

Influx of people into the area will put a strain on existing land and yields may reduce. Inflation could reduce food security in a situation of already high food prices that communities cannot afford.

Changes in practices also need to be considered over the medium term. The community may start buying more food in the form of refined products as a result of economic upliftment. A reduction in physical exertion may also result as a result of changing livelihoods. Ironically, the final result could be an increased incidence of obesity.

Mitigation Measures:

- Perform a baseline nutritional assessment through anthropometric measures in children under 5 and also micronutrient deficiencies (anaemia as an indicator). Perform surveillance on nutritional status through this data set as means to track well-being;
- Reduce project related communicable diseases that may impact nutrition;
- Minimise agricultural land loss through resettlement programmes;
- Favour local procurement of food items in combination with incentives to increase local production;
- Support mitigation measures for communicable diseases such as malaria, diarrhoea and respiratory infection to reduce the co-morbidity created by malnutrition;
- Support sustainable livelihood programs through increased use of agriculture. The financial benefit of farming over other practices will be essential to support;
- Promote access to education and schooling for women;
- Health systems strengthening for recognition and management of nutritional disorders;
- IEC programs that promote proper feeding practices at relevant age groups including improved complementary feeding;
- Support maternal and child health programs. This can include supporting the promotion of antenatal care, breastfeeding practices, food preparation/hygiene, and family planning; and
- Support any nutritional activities in partnership with the government or NGO in the project area.

Significance Statement:

Without mitigation this impact is considered to be long term, moderate and probable and thus of MODERATE negative significance. With mitigation measures in place this impact is considered to be moderately positive.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Localised	Moderate	Probable	**MODERATE**
With Mitigation	Long term	Localised	Moderately Beneficial	May Occur	**MODERATE**

Issue 6: Accidents/Injuries

Impact 6.1: Road traffic accidents and other accidental injuries

Road traffic accidents (RTA) are the most common form of accidental injury. These are common on the road between Balama and Montepuez. Other injuries are reported from farming activities. This could change with the further development of the project as the area is likely to see a large increase in the number and size of vehicles passing in and around the project area (transport of goods and personnel). The conditions of the roads are also likely to improve which will allow people to drive faster. The roadworthiness of the vehicles, the lack of driving skills and traffic regulation enforcement will mean that RTA will be a major hazard moving forward. At present domestic transport is mainly pedestrian or with bicycles and neither of these groups is aware of the risk of road accidents and road users are unlikely to respect the safety of these groups.

Some community members may be relatively naïve to risks from road traffic accidents and the larger volumes of traffic may increase their exposure risk. This is especially relevant for small children. Community members have expressed concerns that their children and animals are most vulnerable to the construction of the access road connecting the 242 main road to site and the utilization of the 242 main road by haul trucks.

The health facilities along the 242 main road have very limited capacity to respond and manage any form of complex trauma or multiple casualty situations. In addition, there are limited emergency services so delays to care can be significant and inappropriate movement has the potential to exacerbate injuries.

Mitigation Measures:

- Develop community security and safety management plans for the project related to the different activities. This will include emergency response plans for both community related accidents and also for the workplace. This must include a fire, rescue and chemical spill response capability, as well as medical emergency response strategies;
- Conduct a traffic impact assessment to assess the impact of increased traffic within the project area (this has been completed and forms part of the specialist volume, i.e. Part 5 of this document);
- Develop a clear policy for the management of emergencies or accidents in the community as a direct result of the projects activities;
- Support with local safety and security;
- Support the refurbishment of the local health facilities to support any injuries or trauma. This will be limited to first aid and stabilisation prior to transport. This can also include emergency care training of the local health care practitioners; and
- In partnership with the local authorities and police coordinate information campaigns about responsible driving including speed management and vehicle safety. Educational efforts on road safety should also be supported through the school system.

Significance Statement:

Without mitigation this impact is considered to be long term, severe and probable and thus of MODERATE negative significance. With mitigation measures in place this impact is considered to be moderately positive.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Localised	Severe	Probable	**MODERATE**
With Mitigation	Long term	Localised	Moderately Beneficial	Probable	**MODERATE**

Issue 7: Hazardous Materials, Noise and Malodours

Impact 7.1: Air pollution, noise and mal-odours

Cause and Comment:

The health impacts of noise are well described at both a physical and psychosocial level. Noise at the plant site will need to be managed with worker health and safety requirements and as a minimum must meet IFC guidelines to reduce ambient noise that may affect surrounding communities.

Dust generation was highlighted in the air quality assessment as a potential impact especially in operations linked to crushing and drying of the graphite.

Mitigation Measures:

- Evaluate and manage air, water and noise issues as part of the environmental impact assessment and environmental management plan requirements. Human health considerations will be considered based on results of the surveillance activity;
- Collect data on a longitudinal basis from the local health centres on incidence of increased respiratory disease- especially upper respiratory tract infections that could be ascribed to dust. While these may not be specifically ascribed to the project the prevailing trends are useful to monitor so that any concerns could be addressed. This may require health systems strengthening to support recording; and
- Develop transport management plans to minimise dust exposure.

Significance Statement:

Without mitigation this impact is considered to be long term, moderate and probable and thus of MODERATE negative significance. With mitigation measures in place this impact is considered to be LOW positive.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Localised	Moderate	Probable	**MODERATE**
With Mitigation	Long term	Localised	Moderately Beneficial	May Occur	**LOW**

Impact 7.2: Chemicals, pesticides and heavy metals

Cause and Comment:

No obvious dangerous chemicals or agents are likely to be used in the construction phase of the project. Cement will be used but should not pose any community health threats. Hydrocarbon fuels pose a risk to water bodies and need to be controlled.

Pesticides are likely to be used in general camp management and possibly for vector control programs. These will need to be managed to ensure that they do not have a negative impact on human health and the environment. The project will adopt a pest management approach so that minimal pesticides are utilised at the project. The Food and Agricultural Organisation (FAO) has developed an International Code of Conduct on the Distribution and Use of Pesticides that focuses on risk reduction, protection of human health and the environmental, and support for sustainable agricultural development by using pesticides in an effective manner and applying integrated pest management strategies (WHO and FAO, 2010).

The potential for acid rock drainage from waste rock with more heavy metals being available for leaching will need to be considered. However, the WRD will be clayed lined, thus reducing the risk of AMD. Whilst heavy metal exposure is not one of the major potential impacts of the project, there is no adequate biological baseline data on heavy metal exposures in the area and key informants in the health services reported that they would not be able to accurately diagnose any heavy metal exposures.

The operational phase will involve flocculants, and some may be flammable and hazardous in high concentrations.

Mitigation Measures:

- Hazardous chemical substance management is required as part of the environmental management plan requirements;
- Determine baseline values of arsenic and mercury in PACs. These will be sampled in communities across similar exposure groups to determine background community exposures. Hair samples are preferred but otherwise urine is considered to be adequate;
- Water monitoring as proposed in the environmental management plan will include surveillance for heavy metals;
- Background naturally occurring radiation levels (NORM) will be measured; and
- Ensure the project complies to IFC Performance Standard 3: Pollution prevention and abatement. These standards will apply to the planned integrated vector control programs. The least hazardous product is to be chosen for control and selected based on the World Health Organization Recommended Classification of Pesticides by Hazard Class. The guidelines of the FAO will be followed for procurement, storage, application and disposal of insecticides for malaria control.

Significance Statement:

Without mitigation this impact is considered to be long term, very severe and probable and thus of MODERATE negative significance. With mitigation measures in place this impact is considered to be LOW.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Localised	Severe	Probable	**MODERATE**
With Mitigation	Long term	Localised	Slight	Probable	**LOW**

Issue 8: Social determinants of health

Impact 8.1: Gender-based violence, alcohol and drugs

Cause and Comment:

Gender-based violence occurs commonly and is often related to substance abuse. Women and young girls are often the most vulnerable.

While drug and alcohol abuse are currently not a major problem, these have the potential to increase during the lifespan of the project.

Influx and development of make-shift structure and settlements may be important to consider, although these may not alter the baseline significantly.

Mitigation Measures:

- Social management plans and recommendations as part of the social impact assessment to be implemented;
- Gender empowerment to be considered through these programs.
- Support information programs in the community on domestic violence, role of men and support of women, alcoholism and drug abuse; and
- Support local authorities with improved policing and criminal justice system for gender-based violence.

Significance Statement:

Without mitigation this impact is considered to be long term, very severe and may occur and thus of HIGH negative significance. With mitigation measures in place this impact is considered to be moderately positive.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Localised	Very Severe	May Occur	**HIGH**
With Mitigation	Medium term	Localised	Very Beneficial	Probable	**MODERATE**

Impact 8.2: Social cohesion and well-being

Cause and Comment:

Influx into the project area will play a major role in lifestyle and perceptions of wellbeing. Education is a major existing need in the community. The level of education in the project area is described as low. It was cited as a priority developmental need in the community. Women’s literacy is extremely important to enhance health needs in the family unit as they are the gatekeepers to health.

Individuals from the local population will be employed as unskilled labour for the construction phase and selected individuals possibly up-skilled to be employed for the the operational phase. Syrah resources will however need to make use of skilled migrant workers, as training may be too complex. Once the mine becomes operational, several permanent jobs will be created for skilled, semi-skilled and unskilled labourers. Many of the highly-skilled workers may come from outside of the project area which may lead to community tension.

It is not the intention of the HIA to address social issues in detail as this has been covered in more detail in the social impact assessment. However, it is important to recognise the well-being and perceptions on quality of life have both a social and health basis.

Mitigation Measures:

- Many elements will be addressed in the social management plan including influx management and resettlement management. It is essential that where possible health is integrated into social programs;
- Extensive communication and management of expectations will need to be conducted with stakeholders. Community expectations will need to be managed carefully;
- Supporting education programs with a gender equity focus;
- Support cultural activities and sports especially in schools;
- Support vulnerable groups; and
- Support graduate training programs for the youth in the community.

Significance Statement:

Without mitigation this impact is considered to be long term, very severe and may occur and thus of HIGH negative significance. With mitigation measures in place this impact is considered to be moderately positive.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Localised	Very Severe	May Occur	**HIGH**
With Mitigation	Long term	Localised	Very Beneficial	May Occur	**MODERATE**

Issue 9: Health systems issues

Impact 9.1: Health system strengthening

Cause and Comment:

There are two health facilities within the project area with one of these being the district hospital in Balama. However, there remain challenges in the accessibility to the health facilities, as well as the capacity of these facilities.

There are also a few NGOs which support health infrastructure and health system strengthening programs. *Medicus Mundi International* has been providing consumables for health facilities in the local community while *Medecins Sans Frontieres* assist in transportation of sick people to Montepuez or Pemba.

In terms of project impacts, influx may create increased demand for what is already a scarce resource. This has the potential to create tension.

Health information management is generally good in the health facilities that surround the project. This data is limited by the fact that diagnostics and human resource capacity is basic. However, it serves as the best form of health surveillance for the monitoring of health impacts if supported and managed well. Strategic investment in local health facilities can support this.

Mitigation Measures:

- Influx management and supporting already limited health facilities to cope with the increased population, if this is related to the project, is required;
- Support community volunteer programs through expansion of the community based peer health educator group;
- Support the health information management system at the local health facilities as a means of supporting the monitoring of specific health impacts. This will provide a longitudinal tool to track specific health conditions and through the partnership provide access to information. The project should set up a basic monitoring tool with support of the local health facilities;
- Develop a plan to support health infrastructure in the project area. This strategic investment should consider the existing health needs of the community and be designed in such a way as to evolve with likely future health needs. Even minimal support with the local health infrastructure will result in significant positive impacts;
- The needs and the location of the facilities need to be discussed and agreed with the communities so that the projects are community owned and supported. This will be done cautiously so that expectations are managed and disparities are not created;
- Develop a memorandum of understanding (MoU) with the government for the mutual support of the health facilities in the project area. The project does not intend to become the de-facto government as this will create an unsustainable situation. The project will support upgrading of facilities and eventually with the development of new ones (e.g. a mobile clinic) to a level that supports the needs of the community and supports the planned mitigation and enhancement activities. The community leaders must be part of this MoU;
- The following model is proposed in the event that a new health facility is developed:
    - The communities provide land and labour to construct facilities. This will be based on government standards;
    - The project will provide materials and construction supervisory support;
    - The project will equip the facility through an NGO agreement; and
    - The government must provide staff and supply of essential drugs and consumables.
- The local health authorities meet with all health oriented NGOs working in the project area regularly, and this serves as an ideal opportunity for the project to seek to engage NGO partners, and to do so in collaboration with the local health authorities;
- Support outreach services to local communities through support or partnership with programs e.g. vaccination and logistics support; and
- Support the health information management system through the following mechanisms:
    - Improve information technology through education of staff and providing computers;
    - Ensure adequate diagnostic equipment;
    - Support training on the national system to ensure accurate reporting; and
    - Develop a basic site based monitoring program to track key health trends.

Significance Statement:

Without mitigation the influx of people will exacerbate an already difficult situation, and without any health system strengthening this impact will continue to be long term, severe and definite and thus of HIGH negative significance. With mitigation measures in place this impact is considered to be highly positive.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Study Area	Severe	Definite	**HIGH**
With Mitigation	Long term	Study Area	Very Beneficial	Probable	**HIGH**

Issue 10: Non-communicable diseases

Impact 10.1: Non-communicable diseases

Cause and Comment:

These diseases are poorly described in the country and district. This is due to the high burden of communicable diseases in the country that have focussed the human and economic resources to this sector.

NCD may play a major role in the economics of the country as it is well recognised that poor adult health negatively effects economic well-being at an individual and household level, but also at a macro level. Labour productivity will fall, and the social and medical costs of managing chronic diseases as well as an ageing population, will increase.

The project will in all likelihood enhance the socio-economic conditions in the area either from direct or cumulative benefits. As the project starts to uplift health programs in the area through direct or indirect means, it will hopefully increase the life expectancy in the area and also the productive time of breadwinners. The short term effects may be an increased spending ability and adoption of more western sedentary lifestyle and diet. With prosperity and organised settlement may come a degree of urbanism with associated changes in values and behaviour, which predisposes the community to an increase in lifestyle related diseases such as obesity, hypertension, diabetes, dental caries and some forms of cancers. This may place an additional burden on the local health care facilities that may not have an ability to diagnose and appropriately manage these conditions.

The project will employ a number of permanent and temporary workers. Diet and lifestyle will need to be monitored in this sector as they will have access to increased incomes and at least one free meal a day on the project site. This is a workplace health as well as a community health concern.

In terms of the significance of the project on the communities the following can be considered:

- Reduction in traditional lifestyle and values;
- Social and environmental factors that increase stress and unhealthy behaviours; and
- Increase pressure on existing health care facilities that only practice limited preventive health care.

These conditions are chronic in nature and difficult to predict at the local level. The cumulative impacts of the economic upliftment of the country will need to be considered and as such the impacts cannot solely be ascribed to the project. Mitigation and management at the local level is however important.

Mitigation Measures:

- Collect indicator data on NCD in the area. Focus on hypertension and diabetes as most common conditions;
- Support health education programs as part of a community based peer health educator program. These should focus on lifestyle risk factors such as diet, exercise, smoking and alcohol consumption.
- Support the district health authorities implement a local integrated non-communicable disease intervention program possibly based on the WHO Stepwise program. This seeks to reduce risk factors in the community, enhancing the preventive practices of the health care personnel and ensuring provision of correct diagnostics and treatment. This may need to be a strategy that develops over time due to local policy priorities;
- Support the local health care personnel with training on disease management programs and the recognition of NCD symptoms and associated management. This is to include integrated management to include proper management strategies for hypertension and high cholesterol; and
- Support with diagnostic medical hardware.

Significance Statement:

Without mitigation this impact is considered to be long term, moderately severe and probable and thus of MODERATE negative significance. With mitigation measures in place this impact is considered to be moderately positive.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Study Area	Moderately Severe	Probable	**MODERATE**
With Mitigation	Long term	Study Area	Moderately Beneficial	Probable	**MODERATE**

7.4.3 Impacts on natural resources

Natural resources are defined as materials and components that occur naturally within the natural environment. A natural resource may exist as separate entities such as fresh water and air, as well as living organisms such as animals or fish, or it may exist in an alternate form which must be processed to obtain the resource such as metal ores, oil, and most forms of energy.

Natural resources currently used in the Syrah Balama concession include:

- Water
- Wood
- Medicinal and food plants
- Grasses
- Soil and mud

Impact 1.1: Construction of new mining infrastructure may result in permanent loss of fruit trees, wood sources and other natural resources.

Cause and Comment:

Approximately 350 ha of vegetation will be cleared for the construction of the mine and associated infrastructure This will result in significant impacts on natural resource use since these resources provide households with building materials, food, medicine and income (i.e. charcoal production).

Mitigation Measures:

- A RAP has been drafted to include a detailed agricultural valuation of all the affected farmlands and owners' possessions in order to develop appropriate compensation strategies and entitlement matrixes;
- Livelihood restoration strategies will be considered, aimed at assisting households with re-establishing and improving their livelihoods. As the villagers are primarily involved in subsistence agriculture, it makes sense to provide agricultural support and/or training as a livelihood restoration strategy. Options include supporting the cotton and maize production capacity of the area by investing in market access, seed provision and agricultural training programmes. A key focus of such programmes needs to be the empowerment of vulnerable children and youth, as well as women (especially female-headed households);
- Villagers will have controlled access to the proposed mining area prior to clearing commencing to harvest all available resources.
- The implementation of measures that would allow local residents to access the forest resources that are cleared will also help to meet local needs and reduce the pressure on the remaining forest resources in the short term.
- Any rehabilitation programmes will involve a stakeholder engagement process to determine the needs of the local communities and how these can be integrated into rehabilitation programmes.
- As part of the social corporate responsibility some funding is to be made available for the initiation of community projects such as a bee keeping project, woodlots, etc. These projects will be established in degraded areas in close proximity to villages and not in indigenous forest. This will also help to alleviate existing impacts on natural resources.

Significance Statement:

The removal of vegetation will be required for the construction of the mine and associated infrastructure. The nature of the impact would be long term as this is an open cut mine and thus rehabilitation options are limited. The impact is of moderate severity and of MODERATE significance as it is anticipated that under the no-go situation these areas will be regularly harvested and even cleared for agricultural purposes. With mitigation measures in place this impact could be reduced to that of LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Study Area	Moderate	Definite	**MODERATE**
With Mitigation	Long term	Study Area	Low	Definite	**LOW**

Impact 1.2: Increasing demand for natural resources

Cause and Comment:

The proposed development is likely to result in the in-migration of job seekers, the employment and accommodation of mine staff, increased tourism (linked to improvements in infrastructure and increased demand for accommodation, meals and entertainment by mine staff), and increased trading opportunities. This influx of people needing accommodation, meals and entertainment and improved infrastructure is likely to increase the demand for charcoal, building materials, thatch and other natural resources. It should be noted that according to the land, natural resource and agriculture assessment, harvesting of natural resources is currently mainly taking place in degraded areas. This may change if there is a significant increase in the demand of these resources.

Mitigation Measures:

- An influx management plan will be developed for the proposed project to deal with the issue of in-migration in its entirety.

Significance Statement:

It is *probable* that there will be in-migration to the area due to the potential for employment. The nature of this secondary impact would be long term and severe and of HIGH significance. The mitigation measures provided would reduce the likelihood of clearing and the severity, resulting in a MODERATE post-significance rating of the impact.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Study Area	Severe	Probable	**HIGH**
With Mitigation	Long term	Study Area	Moderate	May Occur	**MODERATE**

7.5 Impacts resulting from the operational phase

7.5.1 Socio-economic impacts

Issue 1: Employment Opportunities and the Stimulation of Economic Growth

The area has a significantly large youth population, who might demand local employment. The area also lacks real employment opportunities or economic growth, and the mining development could provide a much needed economic thrust in terms of sourcing material and services locally, stimulating the area's general economy. With this possibility of providing employment opportunities, there is a strong possibility that the prospective mining operation will draw migrant labour in search of employment opportunities. Surrounding villages are poor and uneducated, which means that more educated and skilled labour will certainly be needed from areas such as Balama, Montepeuz or even Pemba. Villagers in rural Mozambique are known to be migrators, and provided that mining operations are expanding in the district, a steady increase in migrants is foreseen. Such an influx can either cause some of these villages (especially Pirira and/or Maputo) to expand significantly, or cause a temporary increase in labour.

As with most social impacts, in-migration may also have a positive impact in terms of providing locals with small business opportunities due to an increased demand for local produce and other goods, as well as opportunities for cultural exchange.

Two impacts are discussed below, namely temporary or permanent in-migration of migrants in search of job opportunities, as well as employment, skills training and scholarships.

Impact 1.1: Temporary or permanent in-migration in search of job opportunities

Cause and Comment:

Cause and comment is the same as what is listed for the construction phase, thus refer to Section 2.4.1, Issue 1, Impact 1.1.

Mitigation Measures:

Mitigation measures is the same as what is listed for the construction phase, thus refer to Section 7.4.1, Issue 1, Impact 1.1.

Significance Statement:

If no plans are developed and implemented, the impact of in-migration might be highly negative for the operational phase, as this phase of the mining development can cause a significant influx of job seekers in the long-term. The likelihood of this is probable and the effect might be very severe on the local populations and their culture.

With a commitment to implementing mitigation measures, the impact would be moderately negative on the affected villages during the operational phase, as the mine will stimulate the local skills base and limit the number of outside workers required.

Impact	Effect			Risk or likelihood	Significance
	Temporal scale	Spatial scale	Severity of impact		
Operation phase					
Without mitigation	Long-term	Regional	Very Severe	Probable	**HIGH -**
With mitigation	Long-term	Regional	Slight	May occur	**LOW -**

Impact 1.2: Employment, Skills Training and Scholarships

Cause and Comment:

Cause and comment is the same as what is listed for the construction phase, thus refer to Section 2.4.1, Issue 1, Impact 1.1.

Mitigation Measures:

Mitigation measures is the same as what is listed for the construction phase, thus refer to Section 2.4.1, Issue 1, Impact 1.1.

Significance Statement:

Should these mitigation and/or enhancement measures not be implemented, the significance of employment would only be moderate positive during the construction and operational phases. With employment opportunities, households can have a regular source of income.

This could assist many households to diversify their income-earning opportunities, or even to buy the necessary equipment to bolster their farming practices.

Impact	Effect			Risk or likelihood	Significance
	Temporal scale	Spatial scale	Severity of impact		
Operation phase					
Without mitigation	Long-term	Study area	Moderate Beneficial	Probable	**MODERATE +**
With mitigation	Long-term	Study area	Very beneficial	Definite	**HIGH +**

Issue 2: Land Acquisition

Although land will only be acquired during the mine's construction phase, there is the possibility that additional land could be affected by the mine's operational phase as well, especially related to nuisance impacts or farms which might still be too close to the operation.

Impact 2.1: Reduced Access to Natural Resources

Cause and Comment:

Cause and comment is the same as what is listed for the construction phase, thus refer to Section 2.4.1, Issue 2, Impact 2.3..

Mitigation Measures:

Mitigation measures is the same as what is listed for the construction phase, thus refer to Section 2.4.1, Issue 2, Impact 2.3..

Significance Statement:

The significance of this impact would be HIGH negative if no mitigation measures are in place. Access to natural resources will become restricted, which will reduce the sustainability of villagers' livelihoods. A restriction in natural resources might also increase villagers' dependence on economic opportunities in the region (which are lacking), whilst food insecurity might also be an associated impact. Mitigation measures would be able to off-set this impact to one of MODERATE significance, provided agricultural services are offered to the affected communities.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study area	Very severe	Definite	**HIGH**
With Mitigation	Permanent	Study area	Moderate	Probable	**MODERATE**

Issue 3: Community Safety Risk

With any development initiative, there are health, safety and security risks. Impacts related to the possible pollution of water resources are discussed in the Groundwater Specialist Assessment as well as in Chapter 6 of this report and are thus not assessed here. Traffic-related impacts, such as an increased risk of accidents due to increased traffic volumes and the use of heavy machinery are discussed in the Transport Specialist Assessment as well as in Chapter 8 of this report.

Impact 3.1: Community Safety Risk

Cause and Comment:

Cause and comment is the same as what is listed for the construction phase, thus refer to Section 2.4.1, Issue 3.

Mitigation Measures:

Mitigation measures is the same as what is listed for the construction phase, thus refer to Section 2.4.1, Issue 3.

Significance Statement:

This is potentially a serious impact, and failing to implement mitigation measures might result in fractious relationships between the developer and the PACs. Without mitigation, this impact will have a moderately negative impact. The project should have no effect on the surrounding villagers if appropriate protocols are implemented.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long-term	Study area	Severe	May occur	**MODERATE**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

Issue 4: Stakeholder and Community Engagement

Cause and Comment:

Cause and comment is the same as what is listed for the construction phase, thus refer to Section 2.4.1, Issue 4.

Mitigation Measures:

Mitigation measures is the same as what is listed for the construction phase, thus refer to Section 2.4.1, Issue 4.

Significance Statement:

Without implementing enhancement measures related to regularly engaging with the affected villagers, the significance of the project could potentially have a moderate negative impact on the affected villagers. The reason for this is that poor stakeholder engagement could cause considerable tension between the project development and community members, especially if villagers are not informed of the project and regular project related activities.

As enhancement measures will be implemented during the operational phase, the significance would be highly positive.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long-term	Regional	Moderate	Probable	**MODERATE**
With Mitigation	Long-term	Regional	Beneficial	Probable	**MOD**

7.5.2 Health related impacts

The majority of health related impacts as a result of the project can be ascribed to the influx of job seekers into the overall area. As discussed previously this impact usually occurs through all phases of the project life, thus the project related health impacts for the operational phase will be the same as those listed for the construction phase in Section 7.4.2 above.

7.5.3 Impacts on natural resources

Impact 1.1: Increasing demand for natural resources

Cause and Comment:

The proposed development is likely to result in the in-migration of job seekers, the employment and accommodation of mine staff, increased tourism (linked to improvements in infrastructure and increased demand for accommodation, meals and entertainment by mine staff), and increase trading opportunities. This influx of people needing accommodation, meals and entertainment and improved infrastructure is likely to increase the demand for charcoal, building materials, thatch and other natural resources. It should be noted that according to the land, natural resource and agriculture assessment, harvesting of natural resources is currently mainly taking place in degraded areas. This may change if there is a significant increase in the demand of these resources.

Mitigation Measures:

- An influx management plan will be developed for the proposed project to deal with the issue of in-migration in its entirety.

Significance Statement:

It is *probable* that there will be in-migration to the area due to the potential for employment. The nature of this secondary impact would be long term and severe and of HIGH significance. The mitigation measures provided would reduce the likelihood of clearing and the severity, resulting in a MODERATE post-significance rating of the impact.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Study Area	Severe	Probable	**HIGH**
With Mitigation	Long term	Study Area	Moderate	May Occur	**MODERATE**

7.6 Impacts resulting from the decommissioning phase

7.6.1 Socio-economic impacts

Issue 1: Loss of social services

Cause and Comment:

During the decommissioning of the mine various social projects initiated during the various phases of the proposed project such as educational projects, agricultural projects, etc. may be lost.

Mitigation Measures

Ensure that the project is undertaken in a sustainable manner so that it can continue within the region post mine closure, i.e. include basic business training.

Significance Statement:

This impact is considered to be of MODERATE negative significance and will remain moderately negative with mitigation measures employed.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Study Area	Severe	May Occur	**MODERATE**
With Mitigation	Permanent	Study Area	Severe	Unlikely	**MODERATE**

Issue 2: Retrenchment

Cause and comment

During the decommissioning phase of the proposed project the majority of staff previously employed will be retrenched as all mining activities has ceased.

Mitigation measures

A retrenchment policy will be in place prior to any retrenchment activities being undertaken.

If the proposed project continues onto Phase 2, employees appointed for Phase 1 of the development will be maintained for the second phase which would reduce the amount of staff to be retrenched.

Significance Statement:

This impact is considered to be of VERY HIGH negative significance but can be reduced to moderately negative with mitigation measures employed.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Very Severe	Definite	**VERY HIGH**
With Mitigation	Permanent	Study Area	Moderate	May Occur	**MODERATE**

7.6.2 Health related impacts

The majority of health related impacts as a result of the project can be ascribed to the influx of job seekers into the overall area. As discussed previously this impact usually occurs through all phases of the project life, thus the project related health impacts for the decommissioning phase will be the same as those listed for the construction phase in Section 7.4.2 above.

7.6.3 Impacts on natural resources

Impact 1.1: Loss of fauna and flora due to increased access along the haul road

Cause and Comment:

The proposed haul road could be handed to the appropriate government departments (i.e. Department of Roads) and could potentially be utilised by the local communities once mining has been completed. This would result in increased access by the local communities to faunal and floral species for natural resource harvesting in the project area. It should however be noted that a large number of tracks are present within the overall project area and although the existence of the haul road may result in increased access it will by no means create new access within the area.

Mitigation Measures:

- There are no real mitigation measures for this impact.

Significance Statement

The haul road would provide increased access for the local residents to the areas directly adjacent to the road. Left uncontrolled, this will result in further removal and extirpation of biodiversity within the area. The environmental significance of this impact would be severe permanent, and of HIGH significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Severe	Definite	**HIGH**
With Mitigation	N/A	N/A	N/A	N/A	**N/A**

7.7 Cumulative impacts

7.7.1 Socio-economic impacts

Due to the fact that there are no additional projects planned for the proposed project area, it is unlikely that there will be any cumulative impacts related to the socio-economic environment.

7.7.2 Health related impacts

Due to the fact that there are no additional projects planned for the proposed project area, it is unlikely that there will be any cumulative impacts related to the health of local residents.

7.7.3 Impacts on natural resources

Due to the fact that there are no additional projects planned for the proposed project area, it is unlikely that there will be any cumulative impacts related to natural resource use.

8. ASSESSMENT OF INFRASTRUCTURE, WASTE AND PROCESS RELATED ISSUES

8.1 Planning and Design Phase Impacts

Activities associated with the design and pre construction phase pertains mostly to exploration. As the project has a mining concession impacts associated with exploration and the mitigation of these impacts were included in the Exploration EMP compiled to obtain this concession and will therefore not be repeated in this section.

8.2 Impacts resulting from the existing land use / no-go options

8.2.1 Impacts related to waste and wastewater

Typically the final destination of solid waste in Mozambique is simple open air rubbish dumps, where waste is burnt, buried or compacted, causing certain environmental and health concerns. Recycling is rare and generally only practised in the larger cities, where a market exists for collected recyclables. Sanitation systems and sewage treatment facilities are not present in the project area. Should the project not go ahead, waste and sewage will continue to be disposed in the surrounding environment, causing environmental damage in the long term.

8.2.2 Impacts related to traffic and transport

Roads in the project area currently have only light volumes of traffic. The biggest contributor to traffic are small, two-axle trucks delivering consumables to the rural villages, and returning with goods produced in the villages, for example, charcoal, cotton and cassava. Light passenger vehicles are few in number. Bicycles and motorbikes, travelling between villages, are common, as are pedestrians. Should the project not proceed, conditions as they are would be expected to persist.

8.2.3 Impacts related to noise

The existing noise sources in the immediate area of the proposed project are limited to agricultural activities, as well as infrequent vehicular movement on the surrounding road infrastructure.

8.2.4 Impacts related to air quality

The area is a greenfields site devoid of industry and sources that would have significant impacts on air pollution. In the area, subsistence farming is predominant and the associated bush burning from such agricultural practices will contribute to ambient air pollution. In September 2013, sampling revealed dust deposition rates at Nquide and Pirira of 1061 $mg/m^2/day$ and 850 $mg/m^2/day$ respectively. Although the sampling procedure may have been slightly flawed, the elevated level of dust observed during the dry season might not be far from the ambient dust deposition rates in the area. The proposed mine operation and associated activities will add to the background ambient particulate loading in the area.

8.3 Impacts resulting from the construction phase

8.3.1 Impacts related to waste and wastewater

Issue 1: Management of non-process general and hazardous wastes (Construction, Operation and Decommissioning)

Impact 1.1: Pollution of land and water

Cause and Comment:

Inappropriate storage of wastes, particularly those exhibiting harmful properties (i.e. hazardous wastes), can result in the contamination of land and water resources. As a result of rainfall events, leachate may be formed as water percolates through the solid waste, and this leachate may contain nutrients and a variety of toxic compounds, including metals. As such, it could result in the contamination of water and land. In extreme cases, release of large quantities of nutrients to a water body can result in eutrophication. The presence of certain toxic compounds in water as a result of pollution by wastes may have significant long-term negative impacts on the aquatic ecosystems and render the water unsuitable for certain applications including human consumption.

Mitigation Measures (General wastes):

- Manage wastes according to the requirements of Mozambican legislation and, preferably, the requirements of the IFC General EHS Guidelines (2007);
- General wastes that cannot be reused or recycled to be stored temporarily in a dedicated area and then transported regularly to the proposed landfill for disposal;
- The proposed general landfill site will be sited, designed and operated to international standards in order to isolate the wastes and prevent environmental contamination, particularly groundwater contamination (EHS Guidelines for Waste Management Facilities 2007 and EPA 2000) and will be licenced by the developer early in the construction phase. Until such time as this facility is fully operational, all general waste produced during the construction phase will be stored on site in a secure access control area, in a legally-compliant manner that minimises environmental impacts;
- It will be essential to implement a ground water monitoring system in the vicinity of the constructed landfill site in order to detect any changes to the quality of sub-surface water;
- Cover bins for temporary storage of waste that are located outdoors to prevent ingress of water and access by animals;
- Develop a comprehensive Integrated Waste Management Plan for the site and include Key Performance Indicators (KPIs) against which the management of wastes can be audited;
- Inform employees, contractors and visitors to the site of correct waste management procedures, including separation of general and hazardous waste at source;
- Locate waste storage and disposal areas at least 100m from surface water resources or important drainage lines.

Mitigation Measures (Hazardous wastes):

- Cover the management of hazardous wastes within the Integrated Waste Management Plan for the facility;

- Prior to safe disposal, all hazardous wastes will be temporarily stored at the temporary hazardous waste storage facility. This facility will be designed to include secondary containment lined and covered to protect the contents from weather (sunlight and rain). If wastes are corrosive, the base of the storage facility will be lined with an acid-resistant coating;
- Return, where possible, empty containers for hazardous chemicals to suppliers. Where empty containers for hazardous chemicals (hydrocarbons, pesticides, laboratory chemicals, degreasing agents etc.) cannot be returned to the suppliers, they will be triple-rinsed, punctured and stored in a secure area until such time as they can be disposed of safely. Rinse water will not be discharged directly to the environment;
- Dispose of empty pesticide containers according to the Food and Agricultural Organisation’s Guidelines on Management Options for Empty Pesticide Containers (Food and Agriculture Organisation (FAO) 2008);
- A hydrocarbon management Operating Procedure should be designed and implemented. Copies of this document should be made available at designated facilities where hydrocarbons are used or stored. The purpose of this procedure is to provide for the proper storage and handling of hydrocarbons, including waste hydrocarbons, on site and hence prevent any form of contamination;
- Remove and dispose of soil contaminated with hydrocarbon at a soil bioremediation facility on site or else disposed of as hazardous waste;
- MSDS for all chemicals will be readily available on site and the precautions stipulated in these will be adhered to. Staff to be trained on the correct management of bunded facilities, including the discharge of collected liquids;
- Spill kits will be readily available at strategic points throughout the site and staff to be trained on the correct use of these kits;
- No hazardous wastes will be disposed of into drains as this may impact negatively on the performance of the septic tanks;
- There are two potential disposal options for medical waste which will be managed according to the management procedure described in Annex 3 of the ICRC Medical Waste Management (2011) and the requirements of the Mozambican legislation. The first is to transport this material to the Balama regional clinic for safe disposal. The second is to incinerate the material on site to render it harmless and then dispose of it at the on-site landfill.

Significance Statement:

Impacts associated with the management of general (non-hazardous) solid waste may occur and the impacts are potentially long-term. The extent of the impacts (excluding potential impacts to water resources which are assumed to be covered in the Surface Water specialist report) are likely to be limited to the study area. Without mitigation the impacts will definitely occur and should probably be regarded as moderately severe. With the recommended mitigation the severity could be reduced to slight. The overall significance of the impact without mitigation would be MODERATE but with mitigation would be LOW.

Based on the most likely nature of non-process hazardous wastes, impacts may occur and, due to the potential for certain hazardous substances to accumulate in the environment, are potentially permanent. Due to potential transport of these substances into water, their impact may be of significance to the district. Without mitigation the impacts will definitely occur and would probably be regarded as very severe and of VERY HIGH significance. However, with mitigation the severity could be reduced to moderate and the overall significance of the impact would be MODERATE.

General Non-Hazardous Waste:

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Study area	Moderately Severe	Probable	**MODERATE**
With Mitigation	Long term	Study area	Slight	Probable	**LOW**

Hazardous Waste:

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	District	Very Severe	Probable	**VERY HIGH**
With Mitigation	Permanent	District	Moderate	Probable	**MODERATE**

Impact 1.2: Nuisance impact (Production of odours, visual impact and attraction of pests and vermin)

Cause and Comment

The uncontrolled storage of solid waste, in particular food waste, can attract vermin and pests including rodents, birds and flies. These vermin / pests may pose a nuisance to adjacent communities of Nquide, Ntete, Maputo and Pirira and may act as vectors for disease. The uncontrolled storage of solid waste can result in the release of unpleasant odours which may be regarded as a nuisance to adjacent land-users, particularly those down-wind of the material. Odorous compounds are also released from relatively well-managed solid waste disposal facilities. The presence of large quantities of litter around the facility or at the proposed landfill may constitute a visual impact to employees and local communities.

Mitigation Measures:

Refer to mitigation measures for Impact 1.1 (above).

Significance Statement:

Nuisance impacts associated with the management of solid waste will probably occur and the impacts are potentially long-term but limited to the study area. Without mitigation the impacts should probably be regarded as moderately severe but with mitigation the severity could be reduced to slight. The overall significance of the impact without mitigation would be MODERATE but with mitigation would be LOW.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	District	Moderately Severe	Probable	**MODERATE**
With Mitigation	Long Term	District	Slight	Probable	**LOW**

Issue 2: Disposal of domestic wastewater and sewage sludge

Impact 2.1: Pollution of soil and water
Cause and Comment:

Domestic sewage is characterised by a high concentration of nutrients, high organic matter and a variety of pathogens. As such, it must be properly treated prior to discharge to the environment to avoid negative impacts to human health and the environment. If untreated sewage is discharged to the environment, the high nutrient concentration could lead to eutrophication of surface water resources and subsequent disruption of ecological function within the aquatic environment. The sewage sludge from sanitary treatment facilities would have to be removed periodically. Sewage sludge also contains high concentrations of nutrients and may have a similar impact on water resources if not stored and disposed of in a manner that minimises the likelihood of migration of contaminants from the sludge to water resources.

Mitigation Measures:

- Domestic wash water and sewage will be diverted to the septic tanks or packaged sewage treatment plants for treatment. Discharge from these facilities will meet discharge standards prior to release into the process water pond. Sewage sludge from these facilities will be managed as described in the EHS Guidelines for Water and Sanitation (2007). This includes to stabilize by drying in purpose-built beds or composting. The stabilized sludge can then be dried and either disposed at the proposed landfill or alternatively, applied as a soil conditioner during rehabilitation of the mine, provided that levels of toxic constituents is sufficiently low. If soil application is adopted, soil contamination will be avoided and the soil standard prescribed by the AfDB (African Development Bank, 1995) will be adhered to.
- Pre-treat oil and grease containing effluents from canteens with a grease trap prior to discharge into sewage treatment facilities;
- If possible Chemical toilets will not be used during the construction period unless the contents can be disposed of in a manner that does not pose a threat to the environment. Instead, alternatives such as VIPs, composting toilets or similar will be considered as preferred alternatives;
- If VIPs are used, they will be lined, maintained and sited in a way that minimises the risk of contamination of surface and sub-surface water resources;
- All sewage treatment facilities will be well maintained. To this end, at least one employee on site will be trained to maintain the system(s);
- The performance of the sewage treatment systems will be monitored regularly. Where a system is found to be performing poorly, the cause of the poor performance will be investigated timeously and remediation measures put in place to restore performance;
- In the event that sludge has to be removed from the system(s), it will be disposed in a manner that minimises potential risk to human health and the environment and will comply with the National legislation;
- The environmental monitoring programme for the facility must incorporate monitoring points that are able to detect a negative impact on water quality (surface and groundwater) and the correct parameters for monitoring potential impacts related to the discharge of treated sewage.

Significance Statement:

Environmental impacts associated with the disposal of sewage will definitely occur. As the proposed project will be operational for approximately 25 years, impacts associated with the release of untreated effluent and poor sludge management are potentially long-term and may affect the study area. Without mitigation the impacts on soil and water would probably be moderately severe and of MODERATE significance. However, with implementation of the recommended mitigation measures the severity of the impacts would be slight and of LOW significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Study Area	Moderately Severe	Probable	**MODERATE**
With Mitigation	Long Term	Study Area	Slight	Probable	**LOW**

Impact 2.2: Health impacts to employees and communities

Cause and Comment:

Sewage and sewage sludge is normally characterised by high concentrations of pathogenic microorganisms (viruses and bacteria) and helminths. Exposure to untreated effluent, either directly or through contaminated water resources, can result in the spread of numerous diseases including cholera.

Mitigation Measures:

Refer to mitigation measures for Impact 2.1 above. In addition, the following mitigation measures are applicable:

- Any employees tasked with management of sewage and sanitation systems will be vaccinated against key diseases associated with these waste streams.

Significance Statement:

Pathogenic microorganisms are commonly found in untreated sewage and release of these organisms to water bodies used for irrigation, drinking, recreation or fishing can result in the spread of disease such as cholera. The health impacts associated with the release of untreated sewage effluent and poor sludge management are potentially long-term and may affect the district. Without mitigation the associated health impacts would probably be severe and of HIGH significance. However, with implementation of the recommended mitigation measures the impacts would be of slight severity and of LOW significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	District	Severe	Probable	**MODERATE**
With Mitigation	Long Term	District	Slight	Probable	**LOW**

Impact 2.3: Nuisance impacts (odour and flies)

Cause and Comment:

Raw sewage, sewage sludge and sewage treatment facilities are frequently associated with the release of unpleasant odours and may attract large numbers of insect pests such as flies. The persistent odours and presence of insect pests would most likely be regarded as a nuisance to employees and local community members. If sewage is managed correctly, the level of these nuisance factors can normally be reduced significantly.

Mitigation Measures:

Refer to mitigation measures for Impact 2.1 above.

Significance Statement:

The management of sewage will definitely be associated with odours and insect pests and, due to the influence of wind, the impact on any one receptor would probably be short-term. The treatment plant will, however be relatively small and so the impact is likely to be confined to the study area. There are also currently no communities in the immediately vicinity of the mine. Without mitigation the impacts would probably be Moderately Severe and of MODERATE significance. However, with implementation of the recommended mitigation measures the impacts would probably be of slight severity and of LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short Term	Study Area	Moderately Severe	Probable	**MODERATE**
With Mitigation	Short Term	Study Area	Slight	Probable	**LOW**

Issue 3: Disposal of run-off / storm water

Impact 3.1: Pollution of land and water

Cause and Comment:

Run-off water is likely to be generated on site as a result of the high rainfall, washing of machinery (including vehicles) and, possibly, dust suppression activities. As this water migrates across the site it has the potential to pick up various pollutants such as hydrocarbons and small solid particles. Furthermore, the run-off from machine washing activities is also likely to contain hydrocarbons. If this water is discharged without treatment, chemicals (hydrocarbons, pesticides etc.) and sediment could be transported into surface and sub-surface water bodies, resulting in ecological disruption.

Mitigation Measures:

- The management of all run-off will comply, as a minimum, with the requirements of Mozambican legislation but preferably with the requirements of the IFC's General EHS Guidelines (2007);

- Develop a Storm Water Management Plan for the mine and incorporate measures to divert clean storm water away from stockpiles, waste storage and disposal areas and other operation areas;
- Aimto reduce contact between storm water and hazardous chemicals. This will be considered during the planning of the storm water drainage system for the mine facilities;
- In terms of minimising discharge of pollutants and run-off quantity requiring treatment, storm water run-off must be properly segregating and clean water run-off diverted to prevent it mixing with water containing a high solids content, to minimize the volume of water to be treated prior to release;
- Run-off from machine wash areas will pass through an oil trap. Other run-off water will pass through a sediment trap to remove the majority of suspended solids prior to discharge to the environment. All settled material will be disposed of at the landfill; and
- The quality of liquid waste streams discharged from the site, including storm water, will be monitored regularly to ensure compliance with the requirements of relevant legislation and standards.

Significance Statement:

Impacts associated with the disposal of run-off may occur and the impacts are possibly Long-term and, considering the relatively dry climate, impacts may be of significance to the study area. Without mitigation the impacts should be regarded as moderately severe but with mitigation the severity could be reduced to slight. The overall significance of the impact without mitigation would be MODERATE but with mitigation would be LOW.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Study Area	Moderately Severe	Possible	**MODERATE**
With Mitigation	Long Term	Study Area	Slight	Possible	**LOW**

8.3.2 Impacts related to traffic and transport

Impact 1: Increase in traffic frequency through villages

Cause and Comment:

Currently, the route EN106 from Pemba to Metoro and the EN242 from Metoro to Montepuez, are relatively quiet roads. The EN242 from Montepuez to Balama has even less activity, due to the poor condition of the road. From Montepuez to Balama, the road is mainly used by pedestrians on bicycles, motorbikes, and on foot. The volumes of existing vehicular traffic are relatively low, much of this due to transport trucks delivering goods to towns and villages along the route, and picking up agricultural produce such as cotton and cashew nuts for sale elsewhere. There are a total of 27 villages (excluding Montepuez) of various size and states of activity located between the project site and Pemba. Some of these towns, especially Namanhumbir and Nanhupo, have very busy markets located on both sides of the road. Pedestrians frequently cross the road or, due to the sheer number of people in the market, are forced to walk in the road in order to make headway. In other villages, hitchhikers, playing children and motorbike repairmen utilise the side of the road for their activities. In most villages, there will be at least a few stalls selling merchandise such as timber poles, straw or clothes. It is obvious that without proper management, the risk of accidents involving pedestrians could be quite high.

Mitigation Measures:

It is essential for drivers to obey the speed limits in force in these settlements. Drivers must be strongly encouraged to proceed slowly and with patience through villages. Schedules for deliveries should be reasonable, and take account of road, and local pedestrian and vehicular traffic conditions en route, so that drivers can travel within speed limits, and exercise due patience when travelling through for instance, trading areas. Drivers should also be encouraged to use their hooter liberally.

A Construction Emergency Preparedness and Response Plan must be developed and implemented that includes provisions to deal with traffic accidents, particularly accidents involving personal injuries, and all drivers must be made aware of the procedures to be followed.

Significance Statement:

The impact will take place at a regional scale and would be severe and of MODERATE significance. Without mitigation the impact may occur, but with mitigation the risk or likelihood of an accident taking place is reduced to unlikely. The residual impact is still MODERATE.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short term	Regional	Severe	May occur	**MODERATE**
With Mitigation	Short term	Regional	Severe	Unlikely	**MODERATE**

Impact 2: Transport of abnormal loads

Cause and Comment:

Although not certain, it is likely that some abnormally sized plant components will need to be transported from either the port of Pemba or Nacala to the project site. An abnormal load will require two escort vehicles (one behind and one in front) to warn other road users of the hazard ahead. The vehicle will also be slow moving relative to other traffic, which could cause delays. There are no road obstacles which could be envisaged to halt an abnormal load. The bridge referred to as bridge number 2 in the Specialist Traffic and Transport Assessment (see Plate 4.3, page 18 of the specialist report) would need to have its structural integrity assessed by an expert before passing any heavy loads over it. Also, there are three 90-degree turns within Montepuez where the delivery truck will be likely to need the entire road in order to make the turn. It would need to be arranged with local traffic authorities for the roads around the turns to be blocked for 10 minutes while the truck passes through.

Mitigation Measures:

Trucks with abnormal loads will be escorted by at least two vehicles (one before and one behind). The truck should consider pulling off the road periodically to allow trailing vehicles to overtake. Bridge number 2 is to have its structural integrity assessed prior to passing heavy loads over it. Traffic authorities are to be consulted with regards to the passing of these large trucks through Pemba / Nacala and Montepuez, if these trucks need two lanes to turn.

Significance statement

Any impacts will take be of short term duration but take place at a regional scale. Impacts will be of *slight* severity and of LOW significance. Without mitigation the impact may occur, but with mitigation the risk or likelihood of an accident taking place is reduced to unlikely. The residual impact is LOW.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short term	Regional	Slight	May occur	**LOW**
With Mitigation	Short term	Regional	Slight	Unlikely	**LOW**

Impact 3: Dust generation

Cause and Comment:

This impact only applies to the unpaved section of the EN242 from Montepuez to Balama. There are four sizable villages along this route: Maputo, Nacole, Mapupulo and Massaspi. There are also smaller unnamed settlements. In most cases, houses are built with their front facing the road, and in many cases little further than 10 metres from the road edge. The increase in traffic along this unpaved road is certain to cause fugitive dust emissions from dust entrained in the wheels of vehicles, which will coat the surrounding houses, including the vegetables and merchandise of traders.

Mitigation Measures:

Methods that could be employed to reduce dust levels generated within the villages include:

- The road could be surfaced with gravel, if this can be sourced locally, although this is still likely to result in some dust impacts;;
- Surface the road with bitumen (CMC is in the process of upgrading the road (July2013));
- The road could be treated with chemical binders.

Significance Statement:

These impacts of short term duration will take place at a regional scale. The impact without mitigation is *severe* and may occur, resulting in an impact of MODERATE significance. With mitigation the likelihood of the impact taking place is reduced to may occur and if bitumen is added to road sections through villages, the residual impact will be LOW.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short term	Regional	Severe	May occur	**MODERATE**
With Mitigation	Short term	Regional	Slight	Unlikely	**LOW**

8.3.3 Impacts related to noise

Impact 1: Impact of noise on surrounding noise sensitive receptors in terms of annoyance during the construction phase.

Cause and Comment:

The equipment and machinery involved, such as excavators, pneumatic tools, bulldozers and haul trucks may impact on the surrounding ambient noise levels at the noise sensitive receptors near the project area.

Mitigation Measures:

Standard mitigation measures to ensure vehicle noise is kept within acceptable limits:
- Keep vehicles in good repair and use standard exhaust and silencing equipment.
- Stick to designated speed limits.
- Keep roads in good condition..
- If possible enclose fixed noise sources such as generators.
- Switch off equipment when not in use.

Additional mitigation measures may include:

- If fixed noise producing sources such as generators, pump stations and crushers are not housed in enclosures, then put up barriers around the noise source. The barriers to be installed between the noise source and sensitive noise receptor, as close to the noise source as possible. Barriers may be in the form of soil berms.

Significance Statement:

Impacts before mitigation are severe but of short term duration at the scale of the study area. They will definitely occur, and result in MODERATE impact. After mitigation the residual impact will be of LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short term	Study area	Severe	Definite	**MODERATE**
With Mitigation	Short term	Localised	Moderate	May occur	**LOW**

8.3.4 Impacts related to air quality

Impact 1: Site Clearing: removal of topsoil and vegetation and stockpiling of overburden topsoil

Cause and Comment:

A number of operations take place at and during this phase, such as land clearing, topsoil removal, loading of material, hauling, grading, stockpiling, bulldozing and compaction. Initially, topsoil and subsoil will be removed with large scrapers. The topsoil will be stockpiled for rehabilitation. Each of these operations has its own duration and potential for dust generation. Fugitive dust (containing TSP (Total Suspended Particulate) will give rise to nuisance impacts as fallout dust, as well as PM_{10} and $PM_{2.5}$ (dust with a size less than 10 micron, and dust with a size less than 2.5 micron) giving rise to health impacts. It is anticipated that the extent of dust emissions would vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing meteorological conditions. This activity will be short-term, be localised, and will have a low impact that will cease once the construction activities are finalised.

Mitigation Measures:

- Limit removal of topsoil to non-windy months in order to reduce exposure of loose surface material to wind erosion.
- Minimise the area of disturbance and avoid unnecessary clearing of vegetation.
- Minimise drop heights when loading soil into trucks or on stockpiles,
- Keep topsoil as clods, fine matter erodes easier.
- Cementation can be used as a means of controlling dust. This is done by alternate wetting and drying of the soils thus forming the crust. This crust becomes stable and resists erosion.
- Grow and maintain vegetation over topsoil stockpiles.
- Water or a binding agent can be used for dust suppression on roads.
- When using bulldozers and graders, it will be necessary to minimise travel speed and distance, as this equipment generates a large amount of dust.

Significance Statement:

Impacts before mitigation are slight and of short term duration at a localised scale. They will definitely occur, and result in a MODERATE impact. After mitigation the residual impact will be of LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short term	Local	Slight	Definite	**MODERATE**
With Mitigation	Short term	Local	Slight	Probable	**LOW**

Impact 2: Construction of any surface infrastructure

Cause and Comment:

This involves the construction of any surface infrastructure e.g. main offices, access roads, haul roads, pipes and temporary facilities for the contractors. There is movement of the workforce, vehicle activity on access roads, levelling and compacting of surfaces. These activities will result in fugitive dust emissions containing TSP, as well as PM_{10} and $PM_{2.5}$.

Mitigation Measures:

Measures applicable to Impact 1 (site clearing) are applicable to this impact as well.

Significance Statement:

Impacts before mitigation are moderate and of short term duration at a localised scale. They will definitely occur, and result in a MODERATE impact. After mitigation the residual impact will be of LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short term	Local	Moderate	Definite	**MODERATE**
With Mitigation	Short term	Local	Slight	Probable	**LOW**

Impact 3: Transportation of materials and workers to site

Cause and Comment:

During this activity, there is transportation of workers and materials to and from site. This often leads to the production of fugitive dust containing TSP, as well as PM_{10} and $PM_{2.5}$. This activity will be short-term, localised, and will have low impacts on the atmospheric environment and will cease once the construction activities are finalised.

Mitigation Measures:

- Apply a dust suppressant, such as water on the dirt road to avoid the generation of dust. The amount of dust generated is directly proportional to vehicle speed. For Example, reducing the average vehicle speeds from 64.4km/h to 48.3km/h will reduce dust emissions by 40% (Wisconsin Transportation Bulletin, 1997).

Significance Statement:

Impacts before mitigation are slight and of short term duration at a localised scale. They will definitely occur, and result in a MODERATE impact. After mitigation the residual impact will be of LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short term	Local	Slight	Definite	**MODERATE**
With Mitigation	Short term	Local	Slight	Probable	**LOW**

Impact 4: Temporary storage of hazardous products

Cause and Comment:

These hazardous products include fuel, explosives, waste and sewage. The impacts of the hazardous materials and waste management are related to the types and amount of equipment and machinery used during construction and the waste produced. Impacts anticipated include evaporation of diesel fuel and heavy fuel from temporary storage tanks and possible spills on site during re-fuelling of heavy machinery and trucks.

Mitigation Measures:

- Develop a hazardous products and waste management plan. It is to identify the following
    - Anticipated waste streams
    - Inspection
    - Waste minimisation
    - Storage locations
    - Waste-specific management; and
    - Disposal requirements
    - A recycling strategy.

Significance Statement:

Impacts before mitigation are slight and of short term duration at a localised scale. They will probably occur, and result in a MODERATE impact. After mitigation the residual impact will be of LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short term	Local	Slight	Probable	**MODERATE**
With Mitigation	Short term	Local	Slight	May occur	**LOW**

8.3.5 Geochemistry related impacts

Impacts related to geochemistry are only applicable to the operations phase. Environmental risks are associated with the Waste Rock Dumps (WRD), Tailings Storage Facility (TSF), and the ore material (Graphite).

8.3.6 Radiation related impacts

Impacts related to radiation exposure will be most significant in the operations phase. Therefore, all impacts and mitigation measures are presented in the operations phase section (section 8.4.6).

8.4 Impacts resulting from the operation phase

8.4.1 Impacts related to waste and wastewater

Impacts associated with process wastes

Issue 1: Disposal of waste rock and tailings

Tailings and waste rock will be generated from the graphite mine throughout the life of the mine.

Impact 1.1: Health and safety of employees and local communities

Cause and Comment:

The TSF will be designed by an independent globally recognised expert in tailings dam design and will be managed according to best practice. However, the communities of Nquide, Ntete, Maputo and Pirira are within the footprint of the project site, with Pirira located close to the West Pit. In the highly unlikely event of a TSF failure, unstable tailings material could pose a risk to members of nearby communities. In addition, there is also a chance of small scale instability events on the slopes of the rock dumps which may result in injury to employees working at the dumps. However, these risks would normally be managed along with other routine occupational health and safety risks.

Mitigation Measures:

- The management of waste rock and tailings will conform to the requirements of the IFC’s EHS Guidelines for Mining (IFC, 2007);
- Develop practices in terms of design and operation to prevent sediment run-off, inclusive of cut-off drains.
- As above, as far as practical, the waste rock dump and TSF must be sited in a location such that in the event of failure, pollution of soil and water as well as physical risk to communities is minimised;
- The integrity of the waste rock dump and tailings facility must be inspected regularly by suitably qualified personnel throughout the life of the mine;
- Access to the TSF and waste rock dump should be restricted as far as practical and all local communities will be informed of the potential risks associated with these facilities through site notices and community meetings.

Significance Statement:

A long term impact may occur within the study area and due to the potential for harm to individuals, including possible fatalities; the severity of the impact is regarded as high. Without mitigation, significance will be HIGH and with mitigation, this could be reduced to LOW significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Localized	High	May Occur	**HIGH**
With Mitigation	Long Term	Localized	Slight	May Occur	**LOW**

Issue 2: Spillage of Run of Mine while Trucking

Impact 2.1: Disruption of ecological function

Cause and Comment:

The transportation of extracted ore by trucking to the processing facility is anticipated to result in the some spillage of the ore materials along the haul route. The ore material contains heavy metals that would be dispersed during transportation. Over time, this would accumulate resulting in the heavy metal contamination of soil (http://medbib.com/Graphite). Spilled material could also result in increased turbidity of water bodies and smother plants.

Mitigation Measures:

- Avoid overloading the trucks with ore;
- Clean-up significant spillages, as soon as possible;

Significance Statement:

Heavy metals have the tendency to accumulate within living organisms and can interfere with normal physiological processes leading to disruption of ecosystems. The disruption of ecosystems by heavy metals was determined to be localized. Without mitigation the significance was considered MODERATE and with mitigation it was considered to be LOW.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Localized	Moderate	May Occur	**MODERATE**
With Mitigation	Long Term	Localized	Slight	May Occur	**LOW**

Issue 3: Storage of effluent in the process water pond and TSF

The Process Water Pond will serve as the collection point for the decant water from the tails, regrind mill and process overflows. This effluent water is anticipated to contain some levels of process feed. The effluent water in the Process Water Pond will be diluted with water make-up from the environment and re-circulated to the plant raw water system for crusher dust suppression, reagent mixing, flocculant make-up, and to the plant water supply system.

It is anticipated that the re-circulated water in the Process Water Pond will contain at least low concentrations of heavy metals and frothers. Over time, the re-circulation and evaporation may result in an increase in the concentration of the abovementioned compounds. The presence of a large process water pond containing potentially harmful substances could pose a threat from environmental contamination, particularly if the pond was to overflow after a period of heavy rainfall.

Impact 3.1: Pollution of soil and water resources

Cause and Comment:

In the event that the pond overflows or is otherwise compromised, the accidental release of stored process water and associated sediment, could lead to pollution of water resources and soil and an increase in the turbidity of nearby water bodies. The potential consequences of increased turbidity include reduced light penetration and growth of aquatic plants. This could have subsequent, long-term negative impacts on local ecosystems and human health.

Mitigation Measures:

- The TSF and process water storage pond to be fenced off and the gate locked at all times to limit unauthorised access;
- As drowning from falling into the water is a heightened risk employees should wear a floatation device when working within the fenced off area. In addition, flotation devices must be readily available at the facility;
- Incorporate water body risks into the the Health & Safety induction training;
- Conduct periodic inspections of the integrity of the TSF and Process Water Pond by an independent and suitably qualified and experienced engineer;
- Ensure the operation of all facilities containing water maintains sufficient freeboard to ensure that the ponds do not overflow;
- Monitor the quality of the stored process water so that in the event of accidental discharge, the contaminants released into the environment are known.
- Place warning notices and “do not enter” signage around such facilities.

Significance Statement:

The impact of the pond water released into the ecosystem without mitigation was considered to be very severe with a MODERATE significance. With mitigation it was considered to be LOW with a slight severity.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Localized	Very Severe	Unlikely	**MODERATE**
With Mitigation	Medium Term	Localized	Severe	Unlikely	**LOW**

Impact 3.2: Risk to Health and Safety of Employees

Cause and Comment:

Water from the TSF will be pumped to the process pond prior to blending with the input process water to the plant. The presence of a large pond containing process water which contains potentially harmful substances will pose a threat to the health and safety of employees. Access to the pond by individuals who are not able to swim may result in drowning.

Mitigation Measures:

- The TSF and process water storage pond will be fenced off and the gate locked at all times to limit unauthorised access;

- Flotation devices will be readily available around the facility;
- The Health & Safety induction training should incorporate these risks;
- The integrity of the TSF must be inspected regularly by an independent and suitably qualified and experienced engineer;
- The operation of the facility must ensure sufficient freeboard to ensure that the pond does not overflow;
- The quality of the stored process water should be monitored so that in the event of accidental discharge, the contaminants released into the environment are known.
- Warning notices should be placed around such facilities.

Significance Statement:

It is possible that without mitigation, an employee could fall into the TSF/pond and drown. As such, the impact to human health and safety without mitigation was considered to be *very severe* with a HIGH significance. The likelihood of the impact occurring could be reduced through implementation of mitigation measures. With mitigation, the overall significance of the impact is expected to be LOW.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Medium Term	Localized	Severe	May occur	**HIGH**
With Mitigation	Medium Term	Localized	Slight	Unlikely	**LOW**

Issue 4: Disposal of potentially hazardous process chemicals

Impact 4.1: Risk to health and safety of employees

Cause and Comment:

Certain of the bulk chemicals used in the process, such as paraffin as flotation agent and associated wastes, are classified as hazardous (SANS 10234:2008). They will be managed according to the IFC's General EHS Guidelines (2007).

Mitigation Measures:

Please see mitigation measures described above

Significance Statement:

The storage of process-related hazardous chemicals (paraffin) and associated wastes constitutes a risk to the safety of employees, but this risk can be reduced relatively easily through operational procedures. With and without mitigation it was deemed to be of MODERATE and VERY HIGH significance, respectively.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Localized	Severe	May Occur	**VERY HIGH**
With Mitigation	Long Term	Localized	Slight	May Occur	**MODERATE**

Impact 4.2: Pollution of water resources and soil

Cause and Comment:

The release of hazardous chemicals such as paraffin to the environment will result in the pollution of soil and water resources (including surface and groundwater), which are used by local communities in the proximity of the project area. Pollution may arise from the accidental release of stored chemicals or uncontrolled storage and disposal of empty chemical containers.

Mitigation Measures:

- All chemicals used on site must be stored and disposed of according to the legislation and good practice;
- Chemicals to be stored in secure, bunded and designated areas;
- Material Safety Data Sheets (MSDS) to be readily available for all chemicals at the point of storage and use;
- An Operational Procedure - Hazardous Chemical Management to be developed for the facility and will include detailed spill response procedures;
- Chemicals that may react in a dangerous manner are not be stored within the same bunded area;
- The compatibility of chemicals to be confirmed prior to storage and signage showing the chemical names and hazardous properties of the chemicals to be visible in the designated temporary storage area;
- An Emergency Preparedness and Response Operating Procedure to be developed for the facility;
- Any facility for the bulk storage of flammable liquids, including fuels, to be designed and operated according to good practice;
- All hazardous chemicals of a volume equal to or greater than 250 litres to be stored in a bunded facility that complies with the legislative requirement and good practice;
- An Operational Procedure - Waste Management to be developed for the facility which includes measures to ensure that all chemical wastes and empty chemical containers are managed and disposed of according to the requirements of legislation and good practice.

Significance Statement

The negative impacts, including death of fauna and flora and, potentially humans, may be long term. With and without mitigation it was deemed to be of MODERATE and VERY HIGH significance, respectively.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long Term	Localized	Severe	May Occur	**VERY HIGH**
With Mitigation	Long Term	Localized	Slight	May Occur	**MODERATE**

8.4.2 Impacts related to traffic and transport

Impact 1: Increase in traffic frequency through villages and Nacala

Cause and Comment:

For the construction phase, it was not possible to provide an accurate estimate of vehicle numbers to be generated, but estimates have been made for the operations phase. Vehicle trips are presented in the table below.

Purpose	Vehicle type	Number of trips	Route
Graphite product transport	4- and 6-axle trucks	90 per day; 2,790 per month*	Site to Pemba
Labour transport	Bus	28 per day (6 days a week); 672 per month	Between site and surrounding villages
Transport of staff	Double cab Toyota Hilux or similar	5 per week; 20 per month	Site to Pemba
Delivery of production supplies	2- & 3- axle trucks	±2 per week <10 per month	Pemba to site
Delivery of domestic supplies	2-axle delivery truck	8 per week; 32 per month	Pemba to site

The same potential concerns as are applicable during the construction phase, are applicable during the operations phase. These concerns relate to the movement of a large number of mine vehicles through often crowded and chaotic market villages. Heavy transport trucks entering Pemba will need to make their way through the crowded centre of Pemba in order to reach the port and deliver the graphite concentrate. Some of the turns are sharp, the traffic is chaotic, cables hang quite low over the road, roads are in poor condition, and numerous pedestrians are present. The movement of 26 trucks a day, 360 days a year, containing graphite through the centre of Pemba, and their return after offloading (52 vehicle movements), is seen as a significant impact.

Mitigation Measures:

There is little that can be done to mitigate this impact, as the graphite that is produced needs to be delivered to the port for export. The busiest section of the route is the last 3 kilometers of the double lane EN106, before it reaches the Avenida Eduardo Mondlane. The best that can be suggested is that trucks attempt to turn left off the EN106 before this stretch of the road, drive south and then turn right on the Rua No. III, a relatively quiet road which will take the trucks to the port. Whichever route within Pemba is decided upon, it will be necessary to consult with local traffic authorities. Deliveries to the Port should also be scheduled to avoid typical peak traffic times of 7 – 8:30 am and 5 – 6 pm. All drivers must observe all traffic regulations in terms of speed limits and should be trained in defensive driving techniques.

Significance Statement:

The impact will occur for the entire operations phase of the mine. It will affect the road system and villages between Balama and Pemba, a distance of approximately 270 km. It will be moderately severe impact, due to the additional of significant traffic volume to the roads and the impacts associated with this. The impact will definitely occur, but some thoughtful planning could lessen this possibility.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Moderate	Definite	**HIGH**
With Mitigation	Long term	Regional	Moderate	Probable	**HIGH**

8.4.3 Impacts related to noise

Impact 1: Impact of noise on surrounding noise sensitive receptors in terms of annoyance during the operational phase

Cause and Comment:

All mining related machinery, tools and vehicles as well as associated ore beneficiation activities may impact on the surrounding ambient noise levels at the noise sensitive receptors near the project area.

Mitigation Measures:

- Implement applicable mitigation measures from the construction phase.

- Construct earth berms around the opencast areas, especially the west pit operations.
- processing plants have been located away from any communities.

Additional mitigation measures include:
- Earth berms to be constructed around the east operations to attenuate the noise towards the villages.
- The noise barrier should be as tall as the line-of-sight between the noise source and the receptor, plus 30%. So for example if the line-of-sight is 10m high, then the barrier should be at least 13m tall for best performance (Sound Fighter Systems, 2007). It is therefore recommended that the berm around the pit operations be constructed to a height of at least six meters.

Significance Statement:

Impacts before mitigation are severe and of long term duration at a regional scale. It is definite that this impact will occur. The impact is considered to be HIGH. After mitigation the residual impact will be of MODERATE significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Severe	Definite	**HIGH**
With Mitigation	Long term	Study area	Moderate	May occur	**MODERATE**

8.4.4 Impacts related to air quality

Impact 1: Removal of ore material (opencast mining process) and ROM Stockpile

Cause and Comment:

The excavation, removal and transportation of waste rock and ore material will result in the incessant release of fugitive dust. Diesel trucks will be used to load the graphite ore onto the ROM stockpile. A front end loader is then used to load ore onto the conveyor belts, to the crushers, and then the conveyor will transport the sized ore to the plant for processing. Fugitive dust will be released containing TSP, PM_{10} and $PM_{2.5.}$

Mitigation Measures:

Haul roads will be used for transporting waste rock and ore, therefore there is a need for the application of water or dust suppressant on the well-defined truck routes. Common dust suppressants are calcium chloride and magnesium chloride solutions (75% to 80% of the time). The hygroscopic (water attracting) nature of these suppressants increases the moisture content of the surface by attracting moisture from the atmosphere. It is worth mentioning that different mines follow widely varying maintenance schedules depending upon needs and past experience. The frequency of haul road cleaning/regrading and repairing is mine specific.

This helps form a crust and hold the road fines into the aggregate surface. In addition, calcium chloride retards the evaporation of moisture and tightens the compacted soil, strengthening the road. These inorganic chemicals are environmentally safe and fairly economical. While their performance depends on temperature, relative humidity, and traffic, the effectiveness generally lasts 6 to 12 months. However, calcium chloride has a corrosive effect on vehicles and application equipment, and can create a slippery surface when applied. Because it is soluble in water, it is easily leached away. When dissolving solid calcium chloride to make your own liquid, be very careful of the tremendous heat that is generated.

Petroleum products and lignin sulfonate (a residue of paper production) can be used as well. These are adhesives and binders that physically glue soil particles together. These products, which are used about 20% of the time, form a hard crust. They are also waterproof which helps stabilize soil. In this category are also organic and petroleum resins, vegetable oils including soybean soapstocks, and hybrid products like a bitumen-lignin mix (Wisconsin Transportation Bulletin, 1997). An independent assessor can do a thorough evaluation of dirt and haul roads within and outside the mine concession area so as to provide a tailored solution with regards to dust suppression. This should then be incorporated into an operational plan that will be adopted by the mine.

To reduce dust released from ore during transport: consider modifications to trucks to reduce wind contact with ore during transport, or stabilisers can be applied to loads upon exit from their loading points. Loads should not exceed the height of the sides of the transport trucks.

The conveyor belt should ideally be enclosed to avoid contact with wind and the subsequent release of fine material to the atmosphere. Due to the amount of material handled and the operating hours, if not covered, this source can be a substantial contributor of particulate matter to the surrounding atmosphere.

Significance Statement:

Impacts before mitigation are severe and permanent at a localised scale. It is definite that this impact will occur. The impact is considered to be MODERATE. After mitigation the residual impact will be of LOW significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Local	Severe	Definite	**MODERATE**
With Mitigation	Permanent	Local	Moderate	Probable	**LOW**

Impact 2: Operation of infrastructure

Cause and Comment:

Traffic on haul roads will generate fugitive dust, including PM_{10} and $PM_{2.5.}$ The magnitude of dust emissions from vehicular traffic during this activity depends on a number of factors, such as the level of exposure of the open dirt roads to air moving at high speeds and the road surface conditions. The will also be emissions from the crushers, conveyor belts, and transfer areas.

Mitigation Measures:

Mitigation measures to reduce dust emissions on the haul roads have been described previously.

Mitigation measures applied to the crusher and conveyor belts in the processing plant are as follows:

- Feed side of the crusher must be enclosed
- Spray the entire width of conveyer belts transporting material with water (if this is feasible)
- Material on conveyor belts should be kept to the centre
- Scrape and wash the belt regularly
- Fall heights of the transfer points should be reduced though the use of spiral chutes.

The following monitoring programmes for air quality should be implemented:

- Dust Monitoring Programme – to collect dust deposition data.
- PM_{10} Monitoring programme - fine particulate monitoring programme, which should include one particulate instrument to monitor PM_{10} and preferably $PM_{2.5}$ from the open pits and the material handling area.
- Gaseous Monitoring Programme – to determine the concentration of criteria pollutants (NO_2, SO_2, CO, CO_2, TSP)
- Meteorological station – to collect data on wind speed and direction, ambient temperature, relative humidity, barometric pressure, solar radiation, and precipitation.

Significance Statement:

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Local	Moderate	Probable	**MODERATE**
With Mitigation	Permanent	Local	Slight	May occur	**LOW**

Impact 3: Storage, handling and treatment of hazardous products

Cause and Comment:

Most significant wastes are produced from the operational phase as the demand and consumption increases. Hazardous materials and waste impacts are related to the types and amount of equipment and machinery used. Impacts include evaporation of diesel fuel and heavy fuel from temporary tanks and possible spills during loading of fuel from tanks on site that are used for re-fuelling of heavy machinery and trucks. Some of the waste produced includes waste oils, chemicals and hazardous chemicals.

Mitigation Measures:

The recycling procedures implemented during the construction phase should be continued in the operation phase.

Hazardous substances should be stored and handled in accordance with the local regulations and chemicals must be stored in clearly labelled containers. Employees should be trained on the hazards of handling and storing hazardous chemicals. There is a need to understand the processes that generate waste, and monitor these constantly to observe if there are changes in the waste or the waste characteristics. It is essential to ensure regular training of staff on the emergency procedures. *The mitigation measures suggested by the Waste Report prepared for this project, and included in the relevant section of this report, will include these suggested mitigation measures as well.*

Significance Statement:

Impacts before mitigation are severe and permanent at a localised scale. It is probable that this impact will occur. The impact is considered to be MODERATE. After mitigation the residual impact will be of LOW significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Local	Severe	Probable	**MODERATE**
With Mitigation	Permanent	Local	Sever	May occur	**LOW**

8.4.5 Geochemistry related impacts

Impact 1: Moderate potential for Acid Mine Drainage (AMD) formation from Waste Rock Dumps (WRD) and Tailings Storage Facility (TSF)

Cause and Comment:

From the waste rock analysis the following potential impacts were identified:

- A moderate potential exists for AMD formation from the WRD and TSF due to the high S-content and acid generation potential in 4 of the 6 waste rock samples;
- A potential radioactivity risk from the graphite zone with high trace element concentrations of U, Sr, Se and Rb posing a possible human health risk; and
- A potential trace element contamination risk as a result of the WRD seeping into the receiving environment with high concentrations of Mn, Fe, Ni and U.

Mitigation Measures:

The following mitigation measures are proposed:

- Undertaking further test work during the detailed design phase to quantify the potential for the TSF and WRD to generate AMD. Based on these results, a decision to line the WRD and TSF to prevent contaminated seepage entering the groundwater systems will need to be made. This decision will require input from an environmental specialist;
- Storm water runoff management through diversion channels and sedimentation ponds is required around and downstream of the WRD and TSF. Details of this must be included in a Storm Water Management Plan, to be developed during the detailed design phase;
- Monitoring boreholes upstream and downstream of the TSF and WRD;
- Seepage interception boreholes downstream of the TSF, if monitoring determines that this is required, will need to be established to intercept and capture any seepage, which must then should be pumped back into the TSF; and
- Rehabilitation of the TSF and WRD post-closure.

Significance Statement:

The post mitigation impact is rated as LOW, and assumes that either further test work determines a low potential for AMD formation, or that the TSF and WRD are lined in the event that potential for AMD is high.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Local	Very severe	Probable	**MODERATE**
With Mitigation	Long term	Local	Moderate	Possible	**LOW**

Impact 2: Potential trace element contamination from the WRD seepage into the receiving environment with high concentrations of Mn, Fe, Ni and U

Cause and Comment:

The same cause and comment as for Impact 1.

Mitigation Measures:

The same mitigation measures as proposed for Impact 1.

Significance statement

The post mitigation impact is rated as LOW, and assumes that either further test work determines a low potential for AMD formation, or that the TSF and WRD are lined in the event that potential for AMD is high.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	Local	Very severe	Probable	**MODERATE**
With Mitigation	Long term	Local	Moderate	Possible	**LOW**

Impact 3: High potential for AMD formation (Source: ore material)
Cause and Comment:

From the graphite analysis the following potential impacts were identified:

- A High potential for AMD formation with high S-concentrations and lower pH values leading to leachate water with a low pH value and high metal concentrations;
- Trace element contamination is possible from stock piles and exposed ore zones with a high potential of metal contamination with high concentrations of Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, V, Zn and U entering the receiving environment; and
- Potential for radioactivity impacts from the graphite with high trace element concentrations of U, Sr, Se and Rb posing a human health risk.

Mitigation Measures:

The following mitigation measures are proposed:

- Lining of stockpiles with an impermeable clay layer to prevent seepage from the stockpiles in the short term;
- Back-filling of pit post-closure;
- Storm water management to divert water away from stock piles; and
- In-pit sumps to capture seepage and runoff which must be pumped to dirty water dams and treated before being discharged into the environment.

Significance Statement:

Impacts before mitigation are severe and permanent. It is probable that this impact will occur. The impact is considered to be HIGH. After mitigation the residual impact will be of MODERATE significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Severe	Probable	**HIGH**
With Mitigation	Medium term	Study Area	Moderately severe	May occur	**MODERATE**

Impact 4: Trace element contamination from stock piles and exposed ore zones with a high potential of metal contamination with concentrations of Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, V, Zn and U entering the receiving environment

Cause and Comment:

The same cause and comment as for Impact 3.

Mitigation Measures:

The same mitigation measures as for Impact 3.

Significance statement

Impacts before mitigation are severe and permanent. It is probable that this impact will occur. The impact is considered to be HIGH. After mitigation the residual impact will be of MODERATE significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Study Area	Severe	Probable	**HIGH**
With Mitigation	Medium term	Study Area	Moderately severe	May occur	**MODERATE**

8.4.6 Radiation related impacts

A screening level radiological contamination and dose rate survey was performed on site in May 2014. The purpose of the survey was to determine whether certain areas may exhibit enhanced radiation levels, and what risks these might pose to staff and the public.

Measurements were taken at the core shed, Balama East and Balama West. The measurements taken indicated enhanced levels of radioactivity (in the order of 3 to 10 times the background level) across all field locations where measurements were taken, with a core originating from 18 metre depth (drill hole BMDD0123) exhibiting a contamination value about 30 times background. It must be noted that these were only spot measurements taken at randomly selected positions, and are not representative of the different areas. Also, these measurements and findings do not factor in exposure time. If the vegetation were cleared, and all sites were accessible, a properly constructed grid survey of selected areas would provide a better overview of the radiation status of the site.

The measurements exhibiting enhanced levels of radioactivity indicated that the drilling, mining, processing, storage, transport and handling of the material currently and into the future, can pose a radiation exposure risk to workers and members of the public. However, due to the limited amount of time that workers currently spend in areas where enhanced levels of radioactivity was found, and their proximity to those materials, it is unlikely that the radiation exposure of workers currently would exceed radiation dose limits.

From the measurements taken on the cores, a significant variance in the radioactivity levels on the same type of materials at different depths was noticeable. For example, the radioactivity levels in fresh high grade graphite varied by almost a factor of 5.

Enhanced levels of radioactivity were also observed on only a section of a specific core piece (originating from drill hole BMDD0123 at a depth of 18m) and again on only one side of a piece of material that forms part of a thin horizon between other layers.

Samples are currently being analysed at a laboratory to determine their radioactive properties. If the results indicate that the radiological status of the samples is above the safe threshold indicated by the International Atomic Energy Agency (IAEA), then a baseline survey should be conducted.

The following mitigation measures are suggested:

1. A comprehensive radiation baseline survey should be conducted to address all the mining and associated aspects prior to the commencement of any mining operations on the site, but subsequent to the clearance of the vegetation on these areas, to allow easy access;
2. Prior to the commencement of mining and processing activities on site, a prospective worker safety assessment should be performed to identify the potential radiation exposure to workers, and to establish and implement appropriate mitigation measures. This assessment should be repeated once operations have commenced;
3. All redundant equipment (valves, pipes, pumps, flanges, etc. to be generated during mining operations) should be identified and monitored, specifically on the inside, for any concentrations of radioactive material. Should any contamination above background be detected, the equipment should be isolated from the rest and be stored in a dedicated and secured storage area, such as a dedicated container. The container should be signposted with radiation signs and access must be controlled. Records should be kept of all items stored inside the container. Items that had been exposed to the process and which will need to be repaired in future, could also be contaminated, and need to be identified and handled in the same way as contaminated redundant scrap;
4. Core samples that exhibit enhanced levels of uranium should be stored separately from the rest of the cores to prevent access to such cores and the unauthorized removal of such cores;
5. Provide a Radiation Protection Officer and Radiation Protection Monitor training to specific individuals, and alternates, to perform the duties in their absence. Appropriate courses are presented in South Africa. It would be beneficial to have mine staff available to be able to monitor for radiation once mining operations commence, and to establish and implement a suitable radiation protection programme;
6. Appropriate radiation monitoring instruments should be purchased. These instruments should be able to monitor all the potential pathways of exposure that would be encountered at the mine, e.g. alpha, beta contamination, long-lived alpha and dose rate.

The possible radiation exposure of members of the public living adjacent to the site should also be assessed. Only a few laboratories worldwide, including one in South Africa have been accredited to do full spectrum radio analytical analyses. The same samples that would be taken for ground and surface water, foodstuff and dust fallout, could be used for these analyses.

Mitigation Measures:

1. Various strategies, as described above, will need to be implemented to ensure that exposures of the public by the mine are limited to a level of 1 milli Sievert (mSv) per annum from all sources, as recommended by South African radiation legislation. To allow for the possibility of exposure from other sources, operators are required to apply constraints to the exposure levels and limit the annual public exposure to 0.25 mSv per annum from their operation.
2. A Radiation Management Plan is required, and must prescribe the conditions to be followed to ensure that work force exposure does not exceed national limits. Depending on the results of further data collection and analyses, the plant may require a Certificate of Registration (COR) and the completion of hazard assessments at various stages of the project, leading to a formal radiation protection program might be required.

Significance Statement (Public Exposure):

Impacts before mitigation are moderate and of long term duration at a localised scale. They will definitely occur, and result in a MODERATE impact. After mitigation the residual impact will be of LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Local	Moderate	Definite	**MODERATE**
With Mitigation	Long term	Local	Slight	Probable	**LOW**

Significance Statement (Worker Exposure):

Impacts before mitigation are moderate and of long term duration at a localised scale. It is currently uncertain whether this impact will occur. The impact is considered to be MODERATE. After mitigation the residual impact will be of LOW significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Local	Moderate	Definite	**MODERATE**
With Mitigation	Long term	Local	Slight	Unsure	**LOW**

8.5 Impacts resulting from the decommissioning phase

8.5.1 Impacts related to waste and wastewater

Issue 1: Management of non-process general and hazardous waste (construction, operation and decommissioning)

Impact 1.1: Pollution of land and water

Cause and comment, mitigation measures, and significance statement already discussed under construction phase impacts.

Impact 1.2: Nuisance impacts (odours visual, pests)

Cause and comment, mitigation measures, and significance statement already discussed under construction phase impacts.

Issue 2: Disposal of domestic wastewater and sewage sludge (construction, operation and decommissioning)

Impact 2.1: Pollution of soil and groundwater

Cause and comment, mitigation measures, and significance statement already discussed under construction phase impacts.

Impact 2.2: Health impacts to employees and communities

Cause and comment, mitigation measures, and significance statement already discussed under construction phase impacts.

Impact 2.3: Nuisance impacts

Cause and comment, mitigation measures, and significance statement already discussed under construction phase impacts.

Issue 3: Disposal of run-off / storm water

Impact 3.1: Pollution of land and water

Cause and comment, mitigation measures, and significance statement already discussed under construction phase impacts.

8.5.2 Impacts related to traffic and transport

Impact 1: Mine decommissioning

Cause and Comment:

Mine decommissioning would essentially be the construction phase in reverse, but on a lesser scale and over a longer time period which would result in less significant impacts. It would be on a lesser scale because infrastructure components may, in the future, be refurbished and sold to another similar development in the region, should one come into existence. Otherwise steel would be scrapped and transported to Pemba, from where it would be exported to ready markets in Asia (in current economic conditions). But the transport of aggregates and cement would not be a feature of the decommissioning phase. It would be on a lesser timescale, because it is expected that as the mine's operations taper down, infrastructure will be disassembled in phases and scrapped or sold. So the decommissioning phase would be spread out over a longer timeframe than the construction phase.

Mitigation Measures:

The mitigation measures associated with product transport, and general road safety (as applicable to the construction and operation phase) will be sufficient to mitigate any impacts associated with decommissioning.

Significance Statement:

The impact will be of short term duration (less than 5 years). It will affect the road system and villages between Balama and Pemba. It could have a moderately severe impact if mitigation measures are not applied, and these will only be slight if mitigation measures are applied. The mine will definitely need to be decommissioned, so the likelihood of the impact occurring is definite.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short term	Regional	Moderate	Definite	**MODERATE**
With Mitigation	Short term	Regional	Slight	Definite	**LOW**

8.5.3 Impacts related to noise

Impact 1: Impact of noise on surrounding noise sensitive receptors in terms of annoyance during the decommissioning phase

Cause and Comment:

The equipment and machinery involved such as excavators, pneumatic tools, bulldozers and haul trucks may impact on the surrounding ambient noise levels at the noise sensitive receptors near the project area.

Mitigation Measures:

Decommissioning activities should be undertaken in daylight hours only.

Applicable mitigation measures, suggested for the construction and operation phases, should continue to be implemented during decommissioning.

Significance statement

Increased noise levels will occur for a short time period while the mine is decommissioned. Only the local area will be impacted. It is unlikely to be severe.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short term	Localised	Slight	Unlikely	**LOW**
With Mitigation	Short term	Localised	Slight	Unlikely	**LOW**

8.5.4 Impacts related to air quality

Impact 1: Demolition and removal of all infrastructure

Cause and Comment:

This activity will involve the removal of buildings and foundations, cleaning-up of workshops, fuels and reagents, removal of power and water supply networks (unless an alternative arrangement is made that may be beneficial to the community), and removal of haul and access roads. Potential for impacts during this phase will depend on the extent of demolition and rehabilitation efforts. The impacts on the atmospheric environment during the decommissioning phase will be similar to the impacts during the construction phase. The process includes dismantling and demolition of existing infrastructure, and the transporting and handling of topsoil on unpaved roads in order to bring the site to its initial/rehabilitated state. Demolition and removal of all infrastructure will cause fugitive dust emissions. The impacts will be short-term, localised, with low impact. These will cease once the activities are finalised.

Mitigation Measures:

Mitigation measures suggested for the construction phase will continue to be applicable for this impact.

Significance Statement:

Increased dust levels will occur for a short time period while the mine is decommissioned. Only the local area will be impacted. It is unlikely to be severe.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short term	Local	Slight	Probable	**MODERATE**
With Mitigation	Short term	Local	Slight	May occur	**LOW**

Impact 2: Rehabilitation (spreading of soil, re-vegetation and profiling/contouring)

Cause and Comment:

This activity involves the reshaping and restructuring of the landscape. The soil from the topsoil stockpile will be used to reconstruct the soil structure. There is more transfer of soil from one area to another and therefore high chances of fugitive dust generation through wind erosion.

Mitigation Measures:

Reshaping and restructuring of the landscape and spreading of soil must be performed on less windy days. The bare soil will be prone to wind erosion so there is a need to reduce the velocity near the surface of the soil by re-vegetation. Leaving the surface of the soil in a coarse condition reduces wind erosion and ultimately reduces the dust levels. Additional mitigation measures include applying dust suppressant, keeping the soil moist using sprays or water tanks – the frequency is dependent on the traffic and season. The best time to re-vegetate the area must be linked to the distribution and reliability of the rainfall.

Significance Statement:

Increased dust levels will occur for a short time period while the mine is decommissioned. Only the local area will be impacted. It is unlikely to be severe.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short term	Local	Severe	Probable	**MODERATE**
With Mitigation	Short term	Local	Slight	May occur	**LOW**

Impact 3: Storage, handling and treatment of hazardous products (fuel, explosives, oil) and waste activities (waste, sewage, discard)

Cause and Comment:

This includes fuel, explosives, chemicals and solid waste from the destruction of structures. Impacts are related to the types and amount of equipment and machinery used during the decommissioning phase. It includes evaporation of diesel fuel and heavy fuel from temporary storage tanks on site that are used for re-fuelling of heavy machinery and trucks, as well as possible spills during loading of fuel from tankers to tanks. Some of the wastes include waste oils, chemicals and hazardous chemicals.

Mitigation Measures:

The recycling strategy employed during the construction and operation phases should be continued. Other measures related to the handling of hazardous waste, continue to be applicable during the decommissioning phase.

Significance Statement:

Production of hazardous wastes will occur for a short period of time during the decommissioning phase. It will impact the local area only. If not managed correctly, the impact will be severe. With mitigation measures applied, it will be moderately severe only.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Short term	Local	Severe	Probable	**MODERATE**
With Mitigation	Short term	Local	Moderate	May occur	**LOW**

Impact 4: Post-closure monitoring and rehabilitation

Cause and Comment:

Re-vegetation of the remaining footprint of the mine must be done after the reclamation. The impacts on the atmospheric environment during rehabilitation will be limited to the vehicular activity during spreading of soil and profiling/contouring. The impact will be very limited on spatial scale, with a limited damage to the area in term of severity.

Mitigation Measures:

It is recommended that the rehabilitation by vegetating should begin during the operational phase. The objective is to minimise the area subjected to wind erosion, and to re-instate productive ecosystems.

Significance Statement:

A short term impact, localised and of slight significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Local	Slight	Probable	**MODERATE**
With Mitigation	Short term	Local	Slight	Probable	**LOW**

8.5.5 Geochemistry related impacts

Chemical reactions will inevitably occur between the pit lake water and the (relatively) freshly exposed rocks of the pit walls. Products of these reactions will enter the pit waters. Fracturing in the pit walls will result in an increased reactive surface area. This could significantly increase the mass of acidity produced by AMD processes. Thermal processes resulting from seasonal temperature variations might lead to "turn-over" of the water in the pit lake, thereby thoroughly mixing it. Evaporation of pit water might lead to increased concentration of chemicals in the pit lake water. This impact has already been discussed in detail in Chapter 6, Section 6.5.4. Mitigation measures are provided in that section too.

The impact is considered to be long term, localised, severe and probable, thus resulting in an impact of MODERATE significance. With mitigation measures in place this impact can be reduced to an impact of LOW significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long Term	Localised	Severe	Probable	**MODERATE**
With Mitigation	Long Term	Localised	Moderate	Unlikely	**LOW**

8.5.6 Radiation related impacts

Mitigation measures already suggested for the construction and operation phase will continue to be implemented, until all radioactive material has been exported or disposed of appropriately.

8.6 Cumulative Impacts

8.6.1 Impacts related to waste and wastewater

Issue 1: Regional waste profiles and community awareness

In addition to consideration of direct impacts associated with the production of waste streams by the proposed development, it is also necessary to consider the cumulative impacts which may manifest as a consequence of multiple large-scale commercial developments within the region. With respect to waste management, key considerations are the change in the profile of waste streams produced by local communities and awareness of local community members about the management wastes. Each of these is discussed in more detail below.

Impact 1.1: Local knowledge of waste management practices

Cause and Comment:

Based on available information, there appears to be a lack of well-designed and operated waste management infrastructure, including disposal facilities, and recycling initiatives in the Cabo Delgado Province. The knowledge amongst local community members of the need for and best practice regarding management of waste streams is expected to be limited. While a limited knowledge of waste management may not pose a significant risk while communities subsist largely off agriculture and use of natural resources, the potential risks to environmental and human health are expected to increase as communities become more affluent and densely populated and the waste profile changes to resemble those more commonly associated with urban societies. In particular, the quantity of waste may increase and waste streams may start to include a greater proportion of non-biodegradable materials and even small quantities of hazardous wastes (e.g. batteries).

It is expected that a significant proportion of the employees at the developer’s mine will come from local communities. In addition, other individuals from the same villages may be employed at other large-scale developments proposed for the area. Through their employment at such operations, these local community members will be trained on a range of environmental issues, including the correct management of waste. This knowledge may then be transferred to other members of the local communities, thus resulting in a general increased awareness of the importance of waste management, and potential opportunities for recycling, within the local communities.

Mitigation Measures:

- Train all employees on the importance of proper management of waste streams and sanitation;
- Consider options to facilitate improved management of solid waste in local communities. This may include allowing local communities to dispose of their solid wastes at the new landfill facility or training local communities on composting techniques. This may be incorporated into an urbanisation plan for the area.
- Consider involving local communities in waste recycling initiatives if these are considered practical within the context of the project.

Significance Statement:

The development of knowledge and appreciation of the need for sound waste management amongst employees, and subsequent informal dissemination of this knowledge into local communities may ultimately, together with the provision of waste management infrastructure such as formal temporary storage areas or a landfill (perhaps through an urbanisation plan), result in an improved management of waste streams within the local communities. As one of the positive impacts would be an enhanced local knowledge, the impact may be considered permanent. Without mitigation the impact would possibly be considered to be *slightly beneficial* and of LOW significance. However, with mitigation, the impact could be considered *beneficial* and of MODERATE positive significance.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	District	Slightly Beneficial	Definite	**LOW**
With Mitigation	Permanent	District	Beneficial	Definite	**MODERATE**

Impact 1.2: Change to waste profiles in the local communities

Cause and Comment:

The proposed development, together with others in the region, will elevate the economic profile of the local communities and will result in a change in the profile of community waste streams, both in terms of quantity and the nature of the wastes. If existing waste management practices are not adapted, this could result in potential visual impacts as well as health, safety and environmental impacts around the communities.

Mitigation Measures:

- The mine could assist in the facilitation the development of an urbanisation plan for the local communities;
- Consider options to facilitate improved management of solid waste in local communities. This may include allowing local communities to dispose of their solid wastes at the new landfill facility, training local communities on composting techniques or investigating and, if considered feasible, supporting recycling initiatives.

Significance Statement:

The impact would probably be of MODERATE negative significance without mitigation and LOW negative with mitigation.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Permanent	District	Slightly Beneficial	Definite	**MODERATE**
With Mitigation	Permanent	District	Moderate	Slight	**LOW**

8.6.2 Impacts related to traffic and transport

Impact 1: Cumulative traffic impacts

Cause and Comment:

CMC Africa Austral Lda is currently upgrading the 135 km stretch of road from the border of Niassa and Cabo Delgado Province, the crossing of the Ruaça River, to the southwest part of Montepuez town. This is part of the route that will be utilised by the mine. With the improved road, it is expected that traffic volumes on the road will increase as access becomes easier. This may facilitate economic development of the region. Although the development of the mine is unrelated to the road upgrade, it is a possibility that the improved road will increase non-mine related traffic, which would result in risks associated with the mine's operations i.e. potential accidents involving mine vehicles and other road users, which wouldn't have been using the road if it was not in good condition.

Mitigation Measures:

Mitigation measures applicable to construction and operation phase impacts will also be applicable here.

Significance Statement:

This impact will be long term (the mine life). It will impact the roads and villages between Balama and Montepuez. It will be moderately severe but with mitigation measures applied, only slight.

Impact	**Effect**			**Risk or Likelihood**	**Overall Significance**
	Temporal Scale	**Spatial Scale**	**Severity of Impact**		
Without Mitigation	Long term	Regional	Moderate	May occur	**MODERATE**
With Mitigation	Long term	Regional	Slight	Unlikely	**LOW**

8.6.3 Impacts related to noise

The proposed Balama Graphite Mine will significantly contribute to the existing ambient noise levels at the surrounding villages due to the expected cumulative noise contribution from the haul roads, east and west pit as well as the processing plant. Impacts and associated mitigation measures are assessed under the construction and operation phase.

8.6.4 Impacts related to air quality

The project will add to air pollution already being generated by farming activities on site. However there are no projects of a similar nature in the area so cumulative impacts are not applicable.

8.6.5 Geochemistry related impacts

As there are no other mines in the area (or planned for the near future), there will be no cumulative geochemical impacts.

8.6.6 Radiation related impacts

The severity of radiation impacts is determined not only by the radioactivity of the source minerals, but also by exposure to these minerals (in terms of both time and proximity). For this reason, impacts are generally site specific and cumulative impacts are irrelevant.

9. EFFECTS OF THE PROJECT ON GLOBAL CLIMATE CHANGE

9.1 Introduction

This chapter deals with climate change as it relates to the Balama Graphite Mine Project. Climate generally induces change to physical and biological systems and the adverse change in the global and regional climate scenarios can exert considerable stress on a country and region's vulnerable sector, specifically those who rely heavily on ecological resources. This chapter will describe the climate change scenario in Mozambique and assess the potential contribution of the project to climate change.

9.2 Climate Change: Cause and Effect

Climate and weather are very closely intertwined. While weather refers to short term variations of the state of the atmosphere (include changes in air temperature, cloudiness, precipitation and wind), according to Battan (1974), climate is the long term manifestations of the weather. In general the climate of a region will be described in terms of the average temperature, precipitation, atmospheric humidity and wind velocity over periods of approximately 30 years. Climatologists are confident that over the past century, the global average surface temperature has increased by about half a degree Celsius (IPCC, 1995a). This warming is thought to be at least partly the result of human activities, such as the burning of fossil fuels and the clearing of forests for agriculture.

According to the Intergovernmental Panel on Climate Change (IPCC), climate change refers to any change in climate over time, whether due to natural variability or as a result of anthropogenic activity. Climate change is thus a long-term change in the statistical distribution of weather patterns over long periods of time. Fluctuations in the weather patterns in periods shorter than a few decades, such as El Niño, do not represent climate change. This definition differs slightly from that in the UN Framework Convention on Climate Change (UNFCCC) where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods (IPCC Summary for Policymakers, 2007).

The change in climate is generally attributed to the change in the atmospheric gaseous composition and this could be enhanced by anthropogenic sources of greenhouse gas (GHG). The increased concentrations of GHG (including water vapour, carbon dioxide, methane, nitrous oxide, and ozone) produce global warming that affects long-term climate, with potential impacts, both negative and positive, on humanity in the foreseeable future (IPCC Summary for Policymakers, 2007).

Climate change is one of the most important environmental issues facing humankind. Concern over the anthropogenic factors relates to the increase in atmospheric CO_2 and its equivalents due to emissions mainly from fossil fuel combustion and the removal of vegetation due to land use change. Understanding the potential impacts of climate change on natural ecosystems is essential in order to manage the environment to minimize the negative consequences of climate change and maximize the opportunities that it may offer. According to the IPCC (1995a) report the global average temperature is expected to continue increasing by an additional 1.0 to 3.5^{o}C by the year 2100 while the IPCC (2013) report shows the global mean surface temperature change for the period 2016–2035 relative to 1986–2005 will likely be in the range of 0.3°C to 0.7°C. Global emissions of greenhouse gases have risen to unprecedented levels despite a growing number of policies to reduce climate change and emissions have increased more rapidly between 2000 and 2010 than in each of the three previous decades. The report concludes that there will be more frequent hot and fewer cold temperature extremes over most land areas on daily and seasonal timescales as global mean temperatures increase. It is very likely that heat waves will occur with a higher frequency and duration, with occasional cold winter extremes (IPCC, 2013).

Climate change may affect natural ecosystems in a variety of ways. In the short term, it can alter the mixture of plant species in land ecosystems such as grasslands while over the long term, climate change has the potential to dramatically alter the geographic distribution of major vegetation types. Climate change can also potentially alter global ecosystem processes, including the cycling of carbon, nitrogen, phosphorus, and sulfur. All of the climate change-induced alterations of natural ecosystems affect the services that these ecosystems provide to humans. However, not all impacts related to climate change are negative and adverse. While droughts, floods and sea level rise can be frequent and significant in some places, other areas such as the sub-arctic, may experience and increase in crop yields due to the fertilising effects of CO_2 and longer growing seasons. This may however have a negative effect on natural resources, ultimately resulting in infrastructure damage and extinction of indigenous life forms with slow adaptation rates.

Globally, the implementation of a low-carbon economy is proposed as a means to avoid catastrophic climate change. This will involve stabilizing greenhouse gas concentrations in the atmosphere by reducing emissions of GHGs from energy production and use, transport, buildings, industry, land use, and human settlements. Furthermore, it will be necessary to find ways to decouple greenhouse gas emissions from the growth of economies and population (IPCC, 2013).

9.3 Mozambique and the Cabo Delgado Province

9.3.1 Geographical Context

Mozambique is located on the Southern half of South Africa bordering the Mozambique Channel, between South Africa and Tanzania. This country covers a total area of approximately 800km^2 and is characterized mainly by flat Coastal Plains along the Indian Ocean and high plateaus and mountains more inland towards the Western and Northern borders of the country. The lowest elevation point is the Indian Ocean (0m), while the highest elevation point is Monte Binga at 2,436 masl. A number of important rivers occupy this country such as the Zambezi and the Limpopo Rivers. Climate in Mozambique varies from tropical to sub- tropical with climate of the coastal region being largely determined by the offshore warm waters of the Agulhas current and the close proximity of tropical cyclones which pass mostly from the north to the south of the country (INGC, 2009).

Cabo Delgado Province has a tropical climate with two distinct seasons. The wet season occurs from November to March and the dry season from April to November. Specific weather data for the project area is not available. Climate data for Montepuez, the nearest town to the project site (93km away), was therefore used. Montepuez has a tropical climate and is also a summer rainfall region. The average annual rainfall is approximately 942.3 mm. The driest month is August/September with 0 mm - 2 mm. Most precipitation falls in January, with an average of approximately 246.4 mm (http://www.weatherbase.com).

The average annual temperature in Montepuez is 24.2 °C. The warmest month of the year is November with an average temperature of 26.7 °C. In July, the average temperature is 21.1 °C making it the coolest month in the year. The average temperatures vary during the year by 5.6 °C. The highest recoded temperature was a maximum of 50 °C, recorded in November, while the lowest recoded temperature was a minimum of 5 °C, recorded in May (http://www.weatherbase.com).

The Balama Graphite Project is situated 140km west of Solwezi within the Northern region of Cabo Delgado Province and in the District of Balama. The Mehucua River flows through the southern section of the project site in a South-west to North-east direction. A few small wetlands occur in the project area, the most notable being a swampland located approximately 2 km south west of the proposed site and a wetland located approximately 7 km east south-east. The largest water body in the area, but outside of the project area, is the Chipembe Dam which is located 13 km northwest of the site.

Soils are low to moderately fertile, with inland land being stonier with moderate to strong erosion. Land use in the area is primarily for subsistence agriculture. Main crops are groundnut, cassava, maize, rice, sorghum and cotton (INGC, 2009). Crops are grown on the flat areas which are cleared using slash and burn techniques. Some small livestock is reared in the area although these animals were only noted near the villages and are not abundant in the project site. Almost all households within the project area and immediate surrounds are heavily reliant on the natural resources for their livelihoods. Natural resources are used for construction, medicinal use, consumption and to supplement their food. Charcoal production was also evident in the project site. Produce that is not consumed is traded informally, the verges of the main road to Montepuez providing the primary market place.

The proposed project's area of influence encompasses four villages (Ntete, Nquide, Maputo and Pirira) and approximately 11,048 people. No basic services exist, with water for domestic use pumped by hand from at least one well per village while self-constructed pit latrines are utilised in most households. In general, skill levels are low with high levels of unemployment.

Two boreholes currently supply the site and are capable of delivering 10 000ℓ and 3 000ℓ every 24 hours. Two additional 3000 ℓ boreholes have been provided to surrounding villages. Operational requirements have been estimated to peak at 2 million m^3 per annum and it is anticipated that this water will be supplied from the Chipembe Dam via a 13 km pipeline.

9.3.2 Projected Climate Fluctuations

In order to understand the likely biophysical and socio-economic impacts of climate change, it is necessary to first examine the likely climate change scenarios of the areas of interest. Tandross (2009) examined Global Circulation Models (GCM) and Mozambican climatic data for the period 1960-2005 in order to identify trends in climate patterns. This research revealed the following with respect to climate change in Mozambique:

- There has been an increase in the number of hot days and hot nights;
- There will be a general increase in temperature of up to 3^oC in certain areas;
- There are indications of a later start to the wet season and an increase in dry day persistence and dry spell length in the north of the country, including Cabo Delgado;
- The dry season is expected to become drier across the whole country as the rate of evaporation is likely to be greater than the increase in rainfall during winter and early summer;
- There is expected to be a delay in the end of the dry season;
- The winter season will become drier across the whole country; and
- There will be increased variability in rainfall for June, July and August.

One of the key conclusions of this study was that "*cropping / farming systems are already close to critical thresholds of either water availability or seasonal duration (for growing specific crops). Increase in temperature alone (with no significant change in rainfall) could make cultivation of particular crops unviable.*" This is of concern in an area where livelihoods are reliant on rainfed agriculture. The specific manifestations of climate change within the context of Mozambique are discussed in more detail below.

9.4 Climatic Hazards

Historically, Mozambique has been exposed to droughts and floods but recent decades have seen the frequency and severity of these climatic hazards increase together with a change in climate trends (INGC, 2009). The shifts in climatic patterns ranges from increased or decreased average precipitation; shifts in rainfall patterns; and increasing average and maximum temperatures. Due to these shifts in climate, the frequency and severity of extreme natural disasters have also increased, including tropical cyclones, floods, droughts (MICOA, 2007). The La Niña and El Niño phenomena have also contributed to climate-related challenges (INGC, 2009). Mozambique has experienced a frequence of floods between 1977 and 2005. The country has regularly suffered from drought events, resulting in extreme negative impacts, which have halted efforts towards sustainable development.

The government of Mozambique recognizes that the country is vulnerable to catastrophes and that the hazards resulting from climate change are some of the factors that aggravate the situation of absolute poverty in Mozambique. The Governments Five Year Plan (2005-2009) was developed with those challenges in mind, and includes the following priority objectives to:

- Reduce the number of human victims and the loss of properties;
- Promote a culture of prevention; and
- Provide the country with the means for prevention and mitigation.

Arndt *et al* (2010) used an integrated modelling framework to translate a set of climate predictions into biophysical and economic impacts for the Mozambican context. In general, their predictions in terms of climate change matched that of Tandross (2009), specifically increased temperatures, variability and uncertainty. The specific impacts that they considered covered four key sectors:

- Infrastructure (such as damage to roads)
- Hydropower production
- Agriculture
- Coastal zones and sea level rise

The results of the analysis suggested that Mozambique would continue to generate surplus hydropower and while climate change posed a significant threat to the coastal zone, this is of limited relevance to the proposed inland development. Infrastructure such as roads and bridges are expected to be vulnerable to the effects of climate change, not only as a consequence of flood-related damage but also more rapid deterioration under warmer conditions. In addition to the general short-term disruption of economic activities associated with temporary severe damage to transport routes, there are likely to be longer-lasting economic implications related to increased maintenance efforts. More specifically, funds that are used for the repair and maintenance of roads will not be available for other development and support initiatives.

Of particular relevance to the proposed project is the expected impact of climate change on agricultural productivity. The crop model employed by Arndt *et al* (2010) indicated that crop yields would be worst under the local dry scenario but that certain crops would actually benefit under other possible climate scenarios. There is therefore expected to be variability in terms of the response of crop yields. For example, under certain scenarios, cassava yields are expected to decline while that of maize will increase.

Sacramento *et al*. (no date) investigated climate-related hazards and impacts on small scale farmers and livelihood systems in the Chicualacuala District of Mozambique. This study included the identification of adaptation options and/or coping strategies currently being employed. The findings revealed that the main climate hazard that affecting all interviewed communities is drought, although extreme heat, desertification and strong winds (for tree communities) were also mentioned. Coping strategies employed by local communities to mitigate the impacts of these climate-related hazards are listed in Table 9-1.

Table 9-1: Current Strategies to Cope with the Main Hazards (Sacramento *et al*., N.D).

HAZARD	COPING STRATEGIES
DROUGHT	Consumption of wild tubers and fruits Selling of firewood and charcoal Selling of wild fruits and vegetables Sale of livestock Small business Digging deeper wells and walking long distances to fetch water Travelling long distances in search of pasture and water for livestock Purchasing water for animals and humans Practice of agriculture using irrigation systems Selling traditional alcoholic drink from the forest Open borehole for livestock
EXTREME HEAT	Designating new grazing areas Digging deeper wells Opening new fields Grazing livestock in the morning and evening Planting shed trees Working early in the mornings Move the livestock to places with shadow trees Feed the animals close to the river and/or lagoon Sensitize and awareness the community to reduce firewood Firebreak Health post
DESERTIFICATION	Use of animal manure to improve soil fertility Migrating to towns for employment Digging deeper wells Cultivating along the river Selling of fire wood and charcoal
STRONG WINDS	Building strong structures Rebuilding the structures damaged Planting wind breaks Protective measures

It is important to note that not all current local strategies to cope with hazards are efficient or appropriate for long term adaptation. Some strategies, based on short-term considerations, survival needs, lack of information or imperfect foresight, can worsen environmental degradation and thereby diminish future adaptive capacity and livelihood options. The sustainability of different coping strategies also depends on the intensity, duration and frequency of the hazard. The major threat to most of the coping strategies is their lack of sustainability in the face of current and projected climate change impacts which will lead to ecosystem degradation and loss of goods and services from the natural resources on which this community depends on (Sacramento *et al*., N.D).

Arndt *et al* (2010) also stressed the importance of addressing the challenges associated with climate change and advocated agricultural intensification through technical advancement combined with enhanced education to facilitate rapid economic development.

9.5 Climate change-related impacts of the proposed project

The purpose of this section is to comment on the extent to which the proposed project will potentially contribute to climate change and, more importantly, to examine the extent to which the project activities could exacerbate expected climate change-related impacts.

9.5.1 Contribution to climate change

The proposed project may contribute directly to climate change through consumption of non-renewable energy sources and associated CO_2 emissions and indirectly through reduction of local carbon stock.

Issue 1: Loss of Carbon Stock

In addition to its direct importance for the maintenance of ecological systems and provision of food, material for housing, medicine and energy, vegetation can act as an important carbon sink. If cleared vegetation is either burned or allowed to decompose, the carbon stored within the plant material will be released as carbon dioxide, thereby eliminating any future carbon storage potential of these plants while at the same time, releasing additional carbon dioxide to the atmosphere.

The primary actions required to mitigate for the disruption of the natural habitat have been described in detail in Chapter 6 of this report. Regarding the loss of carbon stock and offset of CO_2 emissions, the developer will implement best practice training programmes. These programmes will be designed to teach farmers how to farm more efficiently and thus reduce reliance on the slash and burn farming technique practiced in the project area as well as the ability to live off smaller pieces of land. The techniques to be improvised will adopt carbon capture and storage techniques as part of the soil conservation practice and soil improvement programmes. This is in line with the suggestion of Arndt *et al* (2010).

In addition, the following mitigation measures will be implemented by the Balama Graphite Mine Project to mitigate against the climate change impacts of the loss of habitat:

- As far as possible, minimise clearing of woodlands which are in a mature or climax state;
- As an offset, consider facilitating alternatives to the charcoal industry in the local economy to reduce reliance on harvesting of woodlands for energy;
- Where feasible, implement carbon emissions offsets elsewhere. This may include long-term preservation of mature forest and other vegetation types with high carbon stock;
- Educate employees about conservation of vegetation resources (in the hope that unsustainable harvesting is decreased);
- Maintain vegetation in drainage lines to reduce loss of soil by erosion in the event of increased rainfall;

- Prepare a detailed rehabilitation strategy that takes into consideration the likely impacts of climate change. This could include selection of more drought-tolerant species.

Issue 2: Energy Consumption

In addition to the potential climate change-related impacts associated with the clearing of vegetation, the consumption of fossil fuels, whether directly as fuel or indirectly through the use of electricity from non-renewable sources, may also contribute to climate change.

According to the IFC's Performance Standard 3 (2012), the production of more than 25 000 tonnes of CO_2-equivalents annually by a development should be regarded as significant. Based on an estimated diesel consumption of 14 million liters/annum (11 796 L/day) during the operational phase and an emissions factor of 2.63 kg CO_2 e/L diesel, CO_2-equivalents per annum from fuel consumption will be ~11 323 tons. This alone will not exceed the IFC threshold. Please note that these calculations are based on 100% diesel power generation and thus represents the worst case scenario. In addition to the above, considering that ~90% of electricity generated in Mozambique is via renewable hydropower, it is unlikely that direct power and fuel consumption of the proposed project will be regarded as significant in terms of CO_2 emissions. However, this calculation does not include direct loss of carbon as a consequence of land use change. According to the IFC's Performance Standard 3 (IFC 2012), "*project-induced changes in soil carbon content or above ground biomass, and project –induced decay of organic matter may contribute to direct emissions sources and shall be included in this emissions quantification where such emissions are expected to be significant.*" Consequently, a comprehensive carbon footprint will be established for the facility within the first year of operation. This will take into consideration the loss of vegetation. If this confirms that annual CO2 emissions are likely to exceed the abovementioned threshold , the proponent will develop a greenhouse gas management plan for the operation with the specific intention of reducing GHG emissions as far as practicable.

Potential mitigation measures include:

- Quantify GHG emissions annually in accordance with internationally recognized methodologies and good practice;
- Commit to efficient use of energy through the environmental policy;
- Size motors and pumps to the applied load and use adjustable speed drives in applications with highly variable load requirements;
- Consider and, where practical, implementing measures to reduce energy consumption of the development. This may include the installation of solar water heaters;
- Ensure that all machinery, including vehicles, are well maintained;
- Design and implement an operating procedure for carbon management, that includes key performance targets. This will include the management of re-vegetated areas (as carbon sink) for carbon offsetting measures;
- Develop and implement of an Energy Management Plan for the facility; and
- Consider carbon sequestration potential when developing the rehabilitation strategy for the facility.

9.5.2 Exacerbation of climate change impacts

Issue 1: Reduced availability of water

The findings of the climate change predictions are that Mozambique will experience longer drier periods and that there may be a delay in the start of the wet season. It is therefore possible that local communities, in particular those that rely on natural water resources for their water supply may experience challenges with access to water during dry periods. Mining activities could affect both the quantity and quality of local water resources which could pose significant challenges to local communities during periods of water stress. For example, mining activities could affect local groundwater flow due to minor groundwater abstraction activities which could lower the water table, and make it more difficult for local communities to access drinking water from groundwater wells, particularly during the dry season. However, competition between the proposed mine and communities for water is not expected to be a significant risk as water for the project will be obtained from the Chipembe Dam which is located 13 km northwest of the site. The Mozambique Water Authority is responsible for the management of Chipembe Dam and has confirmed that there is suitable available capacity and allocation for Syrah to obtain over 2 000 000m^3 annually for use in the processing of graphite (EBS, 2012).

There is, however, a risk of contamination of water resources in the vicinity of the mine and this would be a significant issue for communities, particularly during dry periods.

Measures aimed at minimising impacts to the quality and quantity of local water resources have been addressed in Chapter 6 of this report.

Issue 2: Loss of ecosystem goods and services

Change in climate may result in the change of vegetation types and abundance of fauna and flora. The biophysical environment, of which various vegetation types are a key component, has been shown to be of great importance to local human and animal communities, particularly in rural areas where these resources provide a measure of insurance in times of hardship. For example, in times of drought and associated failure of crops, communities may become highly reliant on local ecosystems for food. The loss of vegetation as well as ecosystem services currently provided within the 350 ha project area is likely to further increase use and pressure on the natural resources of the surrounding area to sustain local communities.

Measures aimed at minimising impacts to the availability of ecological goods and services have been addressed in Chapter 6 and Chapter 7 of this report.

Issue 3: Reduced food security

The predicted change in rainfall, temperature and length of dry periods is expected to impact negatively on food security of the area. These factors may also contribute to greater erosion of top soil with subsequent reduction in availability of arable land. The vulnerability of water supplies to climate change translates to the vulnerability of growing crops and the production of food in those areas without access to formalised irrigation schemes. The yield and survival of food crops may also be reduced. The proposed development may exacerbate this risk of food insecurity through:

- Competition for limited water resources;
- Conversion of existing agricultural land for mining; and
- Loss of natural habitat for wild food plants and game.

Mitigation measures aimed at reduction of soil erosion, loss of vegetation and food security have been addressed elsewhere in this report. In line with recommendations by Arndt *et al* (2010), the developer will investigate opportunities to enable local communities to intensify agricultural production using technical advancements. This may include assistance with the development of irrigation or training or soil management.

__Issue 4: Health Impacts__

It has been predicted that climate change will influence the prevalence of certain diseases and susceptibility of local communities to disease may be increased as a result of reduced food availability and subsequent reduction in immunity as well as a loss of access to medicinal plants. Certain vectors may be able to extend their ranges and changes to climate may influence vector populations. Change to rainfall patterns (such as shorter periods of more intense rainfall) may provide additional breeding areas (such as temporary puddles / ponds) for vectors such as mosquitos (which transmit malaria). In the event of climate change impacting on rainfall patterns, the proponent will take measures to assist with food security and access to medical plants, and ensure that the project does not further contribute to the increase in numbers of disease vectors.

Potential mitigation measures could include:

- Take steps to improve awareness of vector-borne health risks amongst employees and local communities;
- Develop an integrated pest management plan for the facility that includes vectors for disease;
- Consider engaging with and assisting relevant authorities to develop and implement malaria reduction programmes in local communities;
- Implement necessary procedures to minimise the presence of stagnant water on the site;
- Through consultation with local communities, establish an inventory of key ethnobotanical resources in the area of the mine and, as far as practical, develop a nursery for cultivation of these species (such as medicinal plants); and
- Take reasonable efforts to rescue key ethnobotanical species from the mine path.

9.6 Conclusions

Based on various studies on the likely climate change scenarios for Mozambique and the associated biophysical and socio-economic impacts, it is likely that the area will become hotter and that rainfall will become more variable. Although the direct contribution of the proposed mining operation to global climate change is expected to be limited, it will have the potential to exacerbate impacts of climate change. The impacts on local communities that rely on natural resources, particularly in times of drought, may be particularly vulnerable. The developer will implement various mitigation measures aimed at reducing this vulnerability, including provision of assistance to improve agricultural yields and the reliability of water supply.

10. ALTERNATIVES

10.1 Introduction

One of the objectives of an EIA is to investigate alternatives to the proposed project. There are two types of alternatives - Fundamental Alternatives and Incremental (or development) Alternatives.

10.1.1 Fundamental Alternatives

Fundamental alternatives are developments that are totally different from the proposed project and usually involve a different type of development on the proposed site, or a different location for the proposed development. Since the core business of the project developer is mining, the fundamental alternative of a development other than the proposed mine and associated infrastructure is therefore technically not feasible in this instance. For this reason no fundamental alternative to mining has been considered in this ESHIA. Furthermore, since mining is a “locality bound” industry (it has to take place where the resources are) no alternative locations for the mine can be assessed. However, alternative locations for infrastructural components of the project that are not locality bound are considered in section 10.3, except for the location of the pit. This is because the pit is locality bound, as its location is entirely dependent on the resource being mined.

10.1.2 Incremental Alternatives

These are alternative designs, plans, technologies, operational options and layouts for which options are available, and which were investigated in this ESHIA. They are considered further in Section 10.3.

10.2 No Development Alternative

The removal of vegetation during the mining process and construction of associated infrastructure will cause the loss of important vegetation communities as well as habitat fragmentation. These are dynamic ecosystems that provide the habitats to support all forms of life, which will be lost during construction and operation of the mine. Based on the sensitivity analysis undertaken during the vegetation assessment, the majority of the area is considered to be of low sensitivity (refer to Figure 10.1 below). This is due to the fact that extensive areas have been cleared for agricultural fields through mainly slash and burn practises. Under the “no-go” scenario the current disturbance caused by the locals will remain, and may even expand, resulting in more undisturbed areas becoming fragmented. Thus, compared to the current land use which is presently having a large impact on the vegetation both within the proposed mining area as well as within the wider region, the impacts associated with the mine site and associated infrastructure are comparatively low when viewed at a broader scale.

In addition to the above, no socio-economic benefits would accrue to the nearby communities and the government. If the proposed project is not implemented benefits such as the opportunity to increase revenue capacity at local and regional levels, as well as the creation of employment will be lost, resulting in unimproved living conditions of the population in the project area. Furthermore, there will be a loss in the general upliftment of the area that may result from the implementation of social programmes (as part of social corporate responsibility) and the secondary impacts that stem from higher income earnings (such as support for local businesses).

Due to the fact that the majority of the area to be developed is of low sensitivity and that existing practises by local communities may result in further degradation of the area, the social benefits of the proposed project outweighs the potential negative ecological impacts and thus the "no-go" option in this case is not considered feasible.

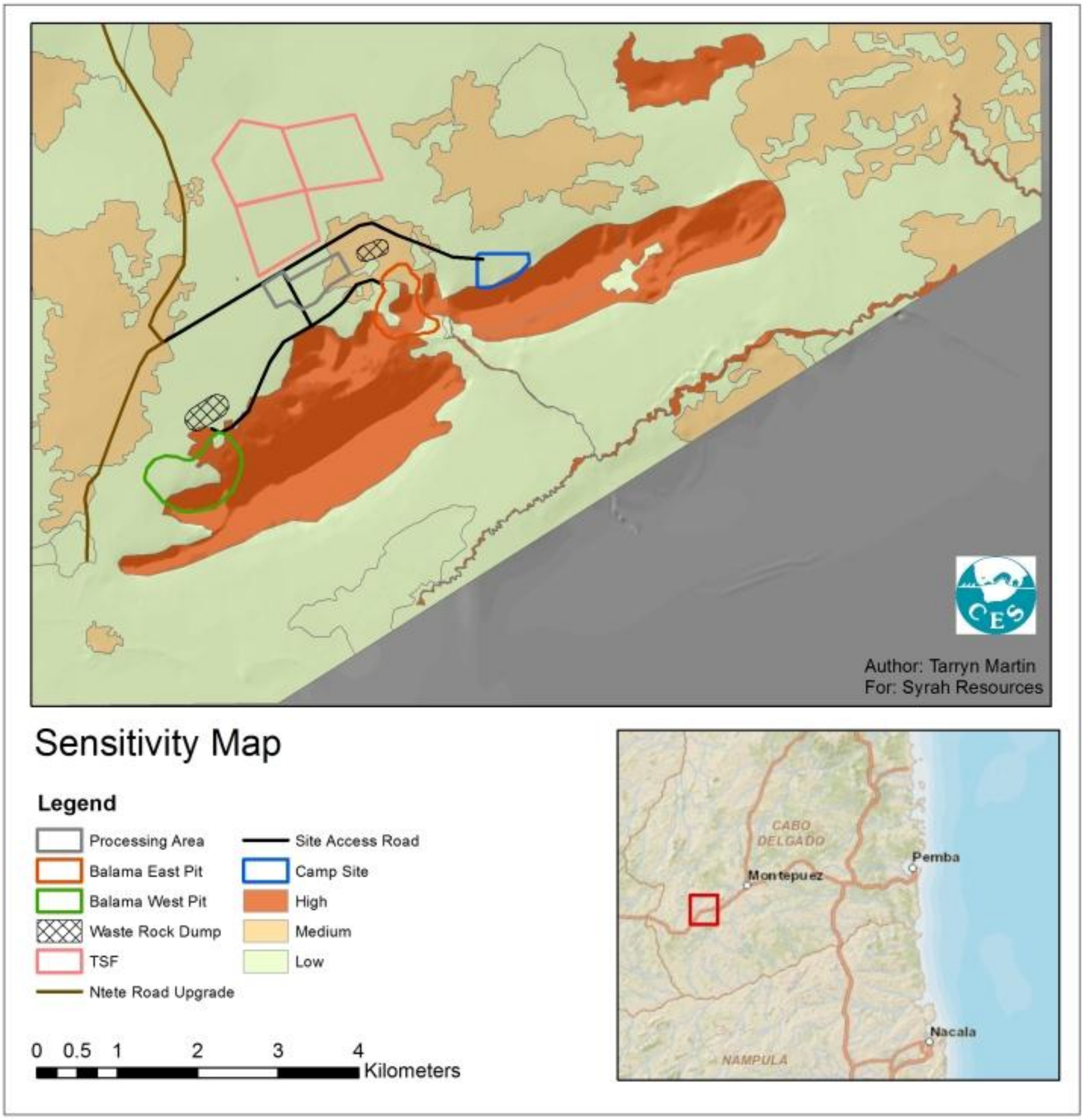


Figure 10.1: Sensitivity of the project area

10.3 Design and Layout Alternatives

10.3.1 Location of the haul road

Road Option 1 would connect to the Pirira-Ntete Road, which runs in a north-south direction. From there the haul trucks would turn left onto the Pemba-Lichinga Road which runs in a west-east direction to Pemba, from where product will be exported. This route would result in road-trains travelling through the villages of Pirira and Maputo. There is little that can be done to mitigate this impact, as the graphite that is produced needs to be delivered to the port for export. The busiest section of the route is the last 3 kilometers of the double lane

EN106, before it reaches the Avenida Eduardo Mondlane. This intersection is shown in Plate 10.1 below. The best that can be suggested is that trucks attempt to turn left off the EN106 before this stretch of the road, drive south and then turn right on the Rua No. III, a relatively quiet road which will take the trucks to the port. Whichever route within Pemba is decided upon, it will be necessary to consult with local traffic authorities. Deliveries to the Port should also be scheduled to avoid typical peak traffic times of 7 – 8:30 am and 5 – 6 pm. All drivers must observe all traffic regulations in terms of speed limits and should be trained in defensive driving techniques. If these mitigation measures are adhered to the impact on this road is considered to be of moderate significance (please refer to Traffic and Transport Assessment in Part V of this document).

Ecologically road Option 1 and road Option 3 is preferable to Option 2 for the following reasons:

- Road Option 2 is positioned close to the head of a stream which is ecologically sensitive. Impacts on this could have further impacts downstream.
- Option 2 also passes close to a small grove of *Sterculia appendiculata* which are listed as Vulnerable on the Mozambique Red Data List and transects an area of high sensitivity, which has been identified in the vegetation assessment as an area that should be set aside for conservation purposes.
- A portion of Option 2 - where it goes around the western end of the Mount Coronge - is relatively steep, which increases the cost of construction, but my also result in increased erosion and sedimentation of the stream and the Mehucua River downstream.

For the reasons listed above, Options 1 and 3 are the preferred options from an ecological point of view. Both these options pass through an area of medium sensitivity, however this is along the outskirts of these sections, which are already fragmented by agricultural activities and thus further fragmentation is not anticipated. Road Option 3, however, passes through the proposed corridor identified in the vegetation assessment, which is intended to provide a link between Mount Coronge and the patch of intact woodland to the east of Nquide village. However, this corridor passes through areas that are fairly degraded. Although not ideal, a haul road crossing through this corridor will not contribute to further fragmentation, but it is preferable that no further infrastructure is located within the corridor.

Based on this, road Option 1 is preferred from an ecological point of view and road Option 3 from a social perspective. However, the transport of construction material during the construction phase requires immediate access to the site, and this can only be obtained from the exiting Pirira-Ntete Road. It is therefore recommended that a combination of Option 1 and Option 3 be utilised for the project. Option 1 is utilised for the construction and initial operational phase of the project, and once production has been ramped up Option 3 is implemented and utilised for the remainder of the project. This will result in a reduction of the temporal scale and the impact on the villages along this road will thus be short term. Impacts associated with 45 vehicles passing per day through these rural villages are considered very significant.

Plate 10.1: The intersection of the Avenida 25 de Septembro and the Avenida 16 de Junho

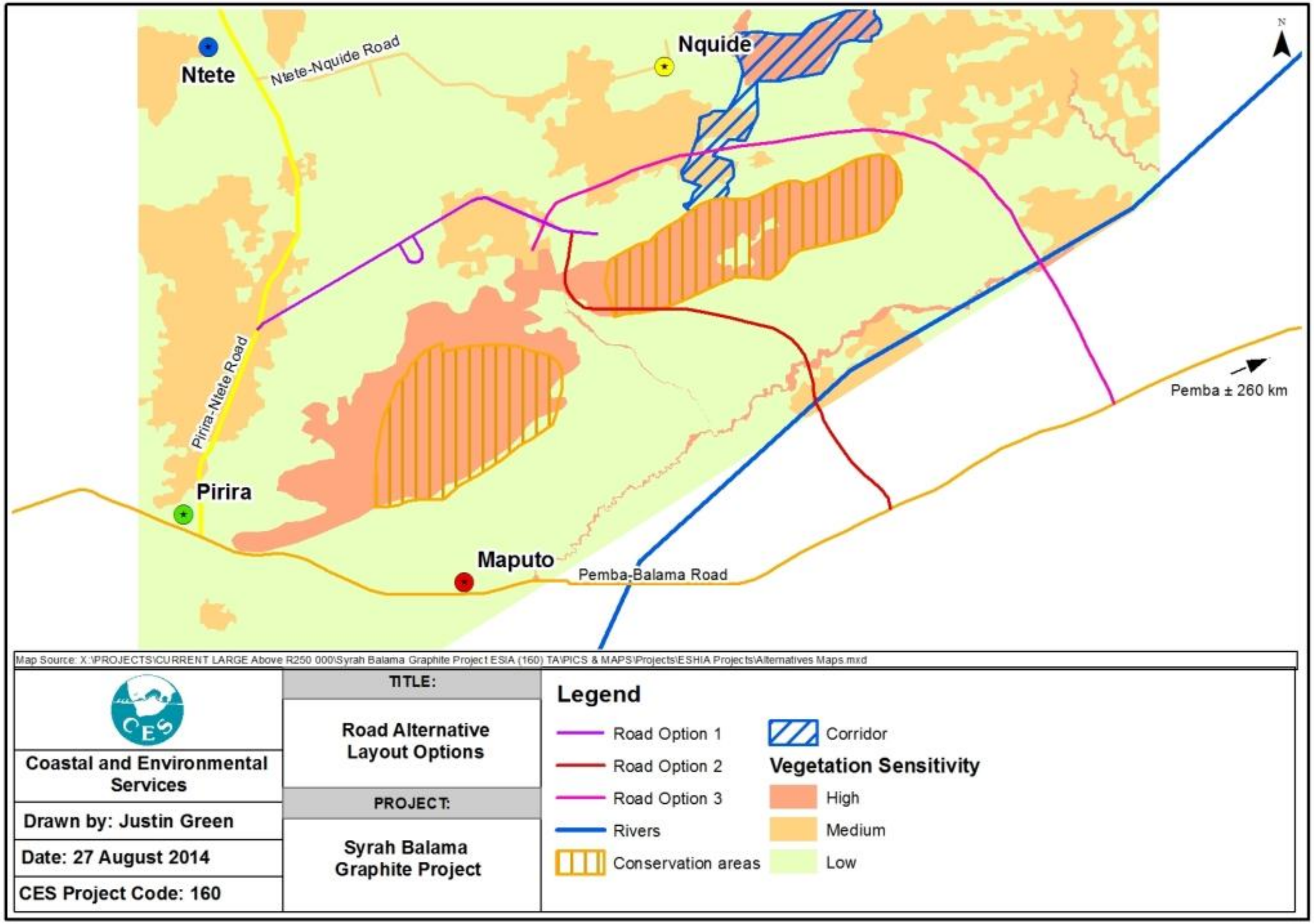


Figure 10.2: Haul road options

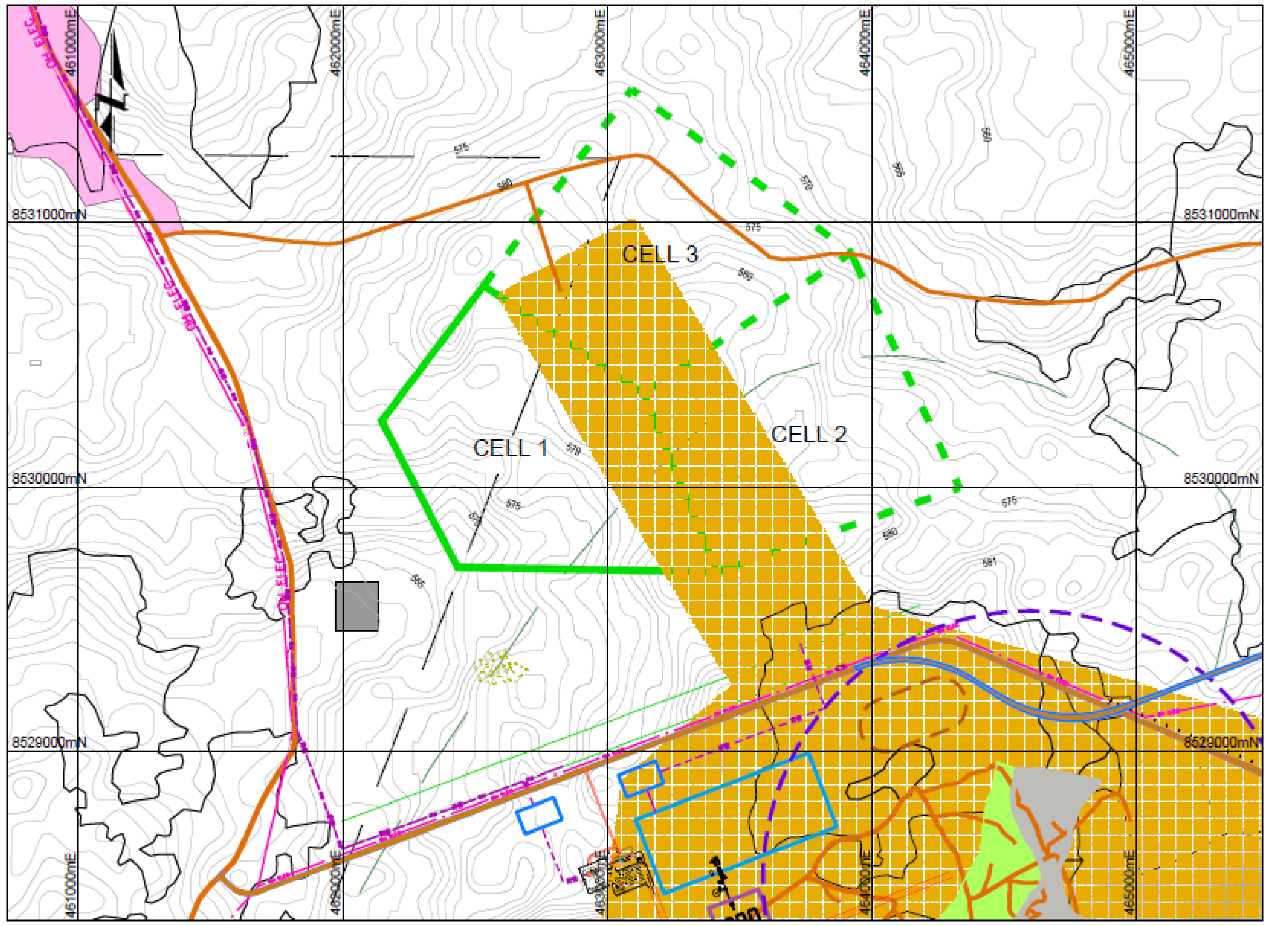
10.3.2 Location of the tailings storage facility

Four options were considered for the position of the tailings storage facility (refer to Figure 10.2). These options were assessed on financial and technical aspects by Knight Piesold Consulting, which concluded that either Option 3 (lowest cost prior to start-up) or Option 1 (lowest cost up to end of Year 1), would be preferred.

From an ecological perspective, it is important to note that both Option 1 and Option 3 are located within areas classified as low ecological sensitivity (refer to Figure 10.3). These areas are covered in Miombo Plains that are highly degraded. A small section of intact Miombo Plains occurs within TSF Option 3 crossing the southern border. This intact section of Miombo Plains is classified as having medium sensitivity as it still has a relatively high species richness and forms an important ecological process area for small mammals and birds. Areas of medium sensitivity can withstand a limited loss of, or disturbance to, natural areas. No protected areas or areas of high sensitivity will be directly affected by either of these two options. So, from an ecological perspective Option 1 is preferred, followed by Option 3 as a close second.

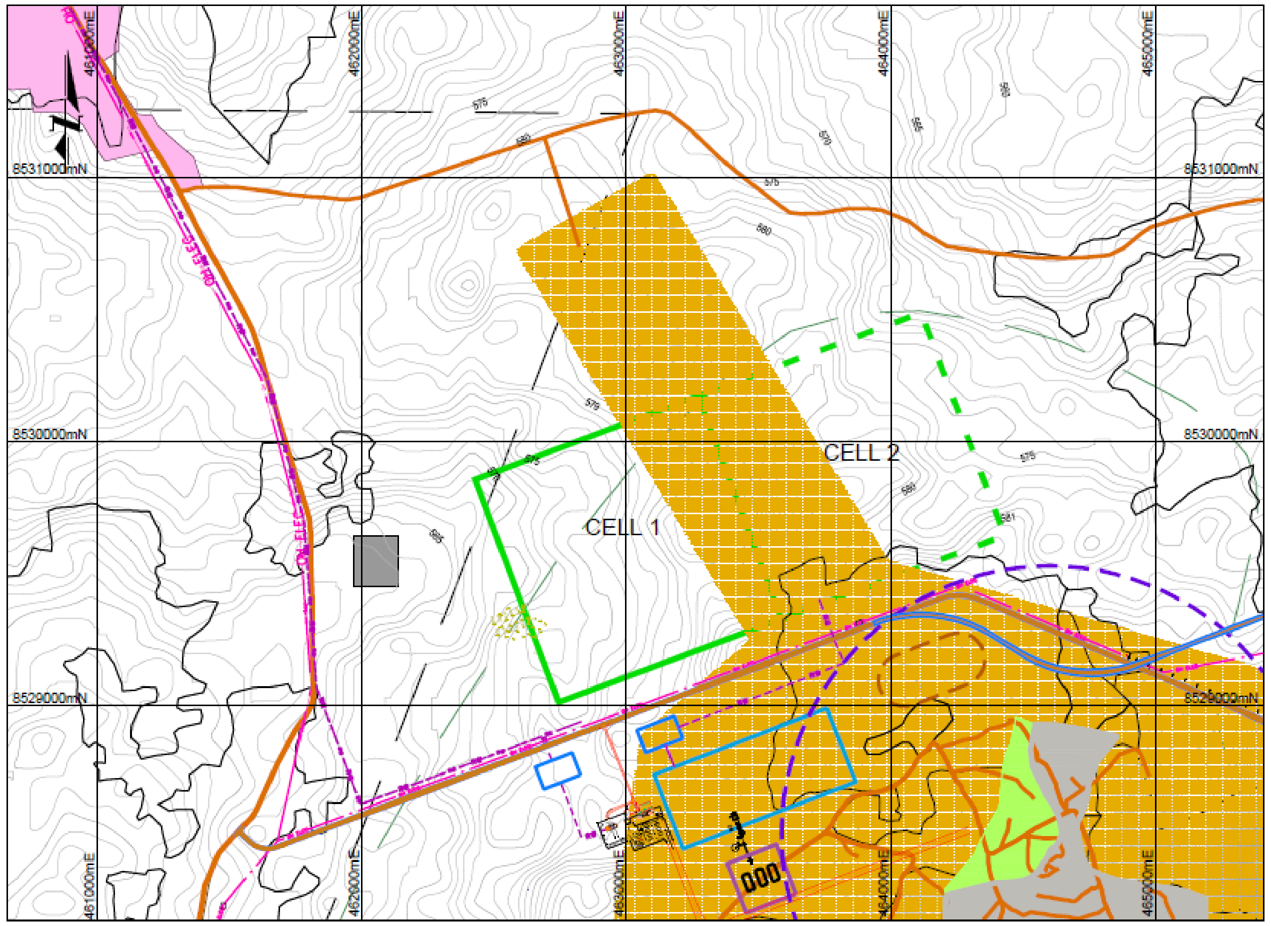
From a social perspective, Option 3 would be the preferred option as this option will allow for the expansion of Ntete Village beyond its current borders, noting that the village already seems to be expanding in a southern direction. In addition to this, Option 3 also provides for a reasonable buffer area between the TSF and Nquide Village. A number of *machambas* and new village infrastructure could possibly be affected should the TSF be positioned closer to Ntete Village. Option 1 was initially not preferred as it will definitely affect the current economic displacement process and possibly elevate it into a full-scale resettlement project, as dwellings are situated on the border of Ntete Village, which is rapidly expanding southwards, resulting in possible physical displacement in close proximity to Ntete Village. However, this Option has been revised (refer to Figure 10.4) and has been located further south, below the Ntete / Nquide Road, thus eliminating the social impact associated with this option.

In summary, from a social perspective Option 3 / Option 1 is preferred, and from an ecological perspective Option 1 is preferred. Thus, it is concluded that modified ***Option 1 is the preferred option for the TSF*** (Figure 10.4).



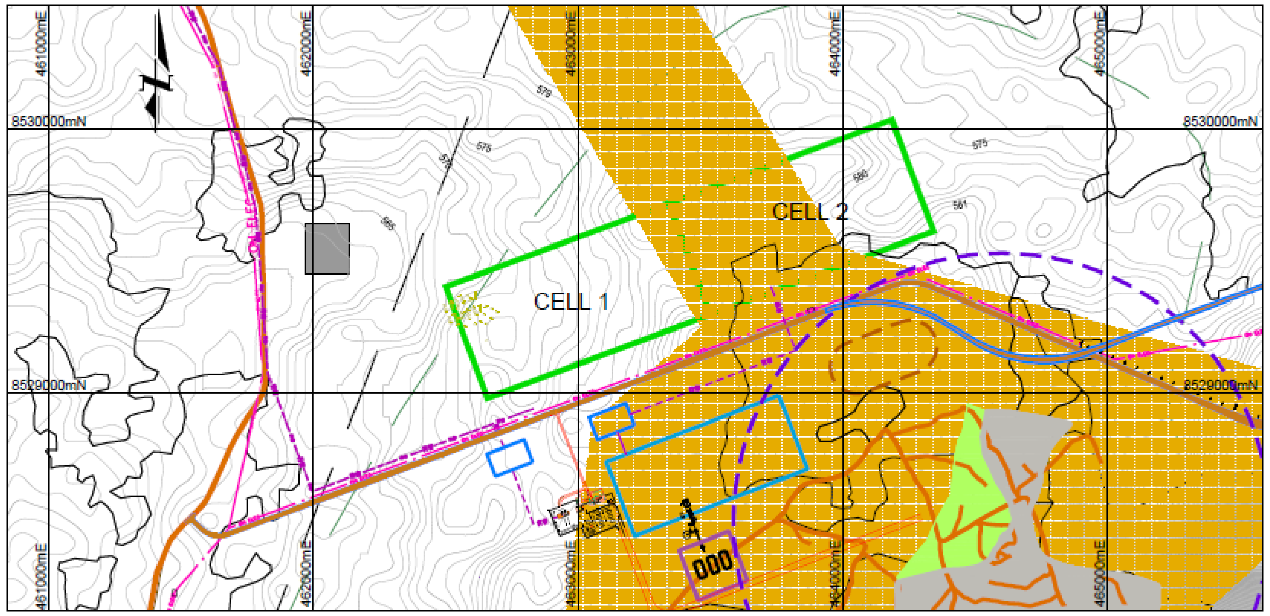
TAILINGS STORAGE FACILITY - OPTION 1

SCALE 1:25,000



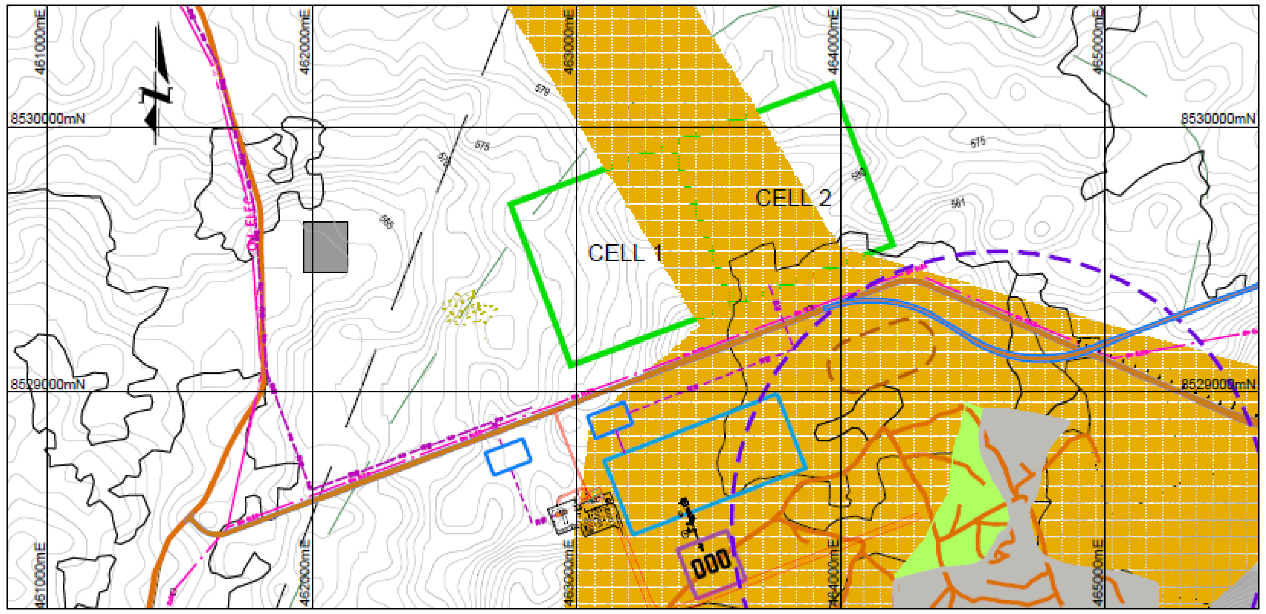
TAILINGS STORAGE FACILITY - OPTION 2

SCALE 1:25,000



TAILINGS STORAGE FACILITY - OPTION 3

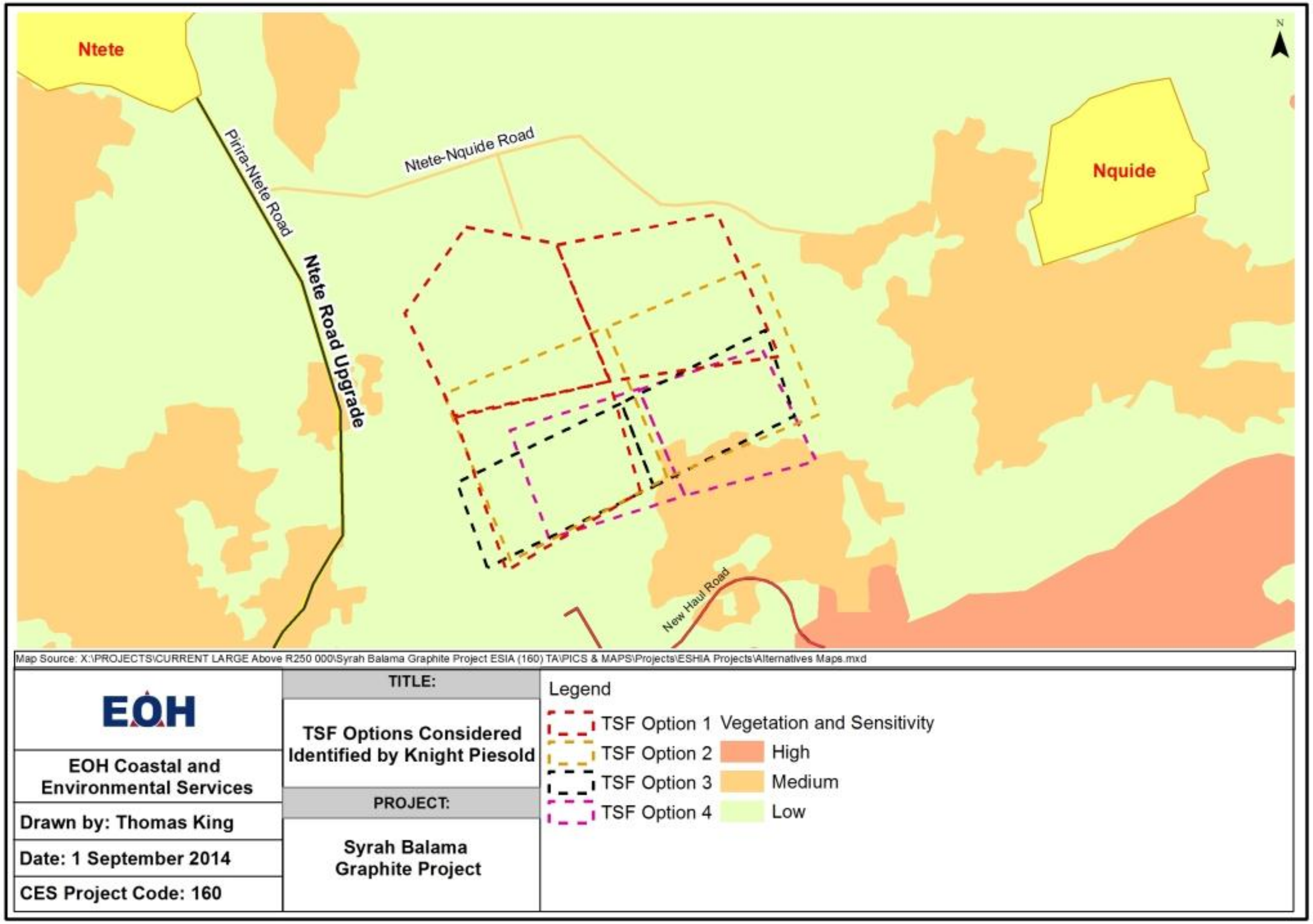
SCALE 1:25,000



TAILINGS STORAGE FACILITY - OPTION 4

SCALE 1:25,000

Figure 10.3: Options for the tailings storage facility
Source: Knight Piesold Consulting



Map Source: X:\PROJECTS\CURRENT LARGE Above R250 000\Syrah Balama Graphite Project ESIA (160) TA\PICS & MAPS\Projects\ESHIA Projects\Alternatives Maps.mxd

Figure 10.4: Comparison of the four TSF alternatives

10.3.3 Location of the mine camp

Two alternatives were considered for the location of the mine camp (construction and operation accommodation). These are depicted in Figure 10.5. The majority of Option 1 is situated in a vegetation type identified as Miombo woodland: Granite. This vegetation type was identified as an area of high sensitivity due to the fact that these areas are all relatively intact and have high species diversity. They also contain species of special concern such as *Sterculia appendiculata* (listed as Vulnerable on the Mozambique red Data Lists). A number of these species were noted to occur on the slopes of the Granite Inselberg (Mount Coronge). According to the vegetation assessment the impact on this vegetation type were considered to be high negative and it was recommended that this area should be left intact and non-essential infrastructure, such as the mine camp, be moved to a less sensitive area.

Option 2 is situated in an area that has been transformed from its natural state to agricultural land. This has resulted in a reduction of the overall impact on Miombo woodland: Granite to that of moderate significance, since no infrastructure or project activities (other than the pit) will impact this vegetation type. With mitigation measures in place, this impact could be reduced to that of low significance.

Thus, based on the above, **Option 2 is the preferred site for the mine camp**.

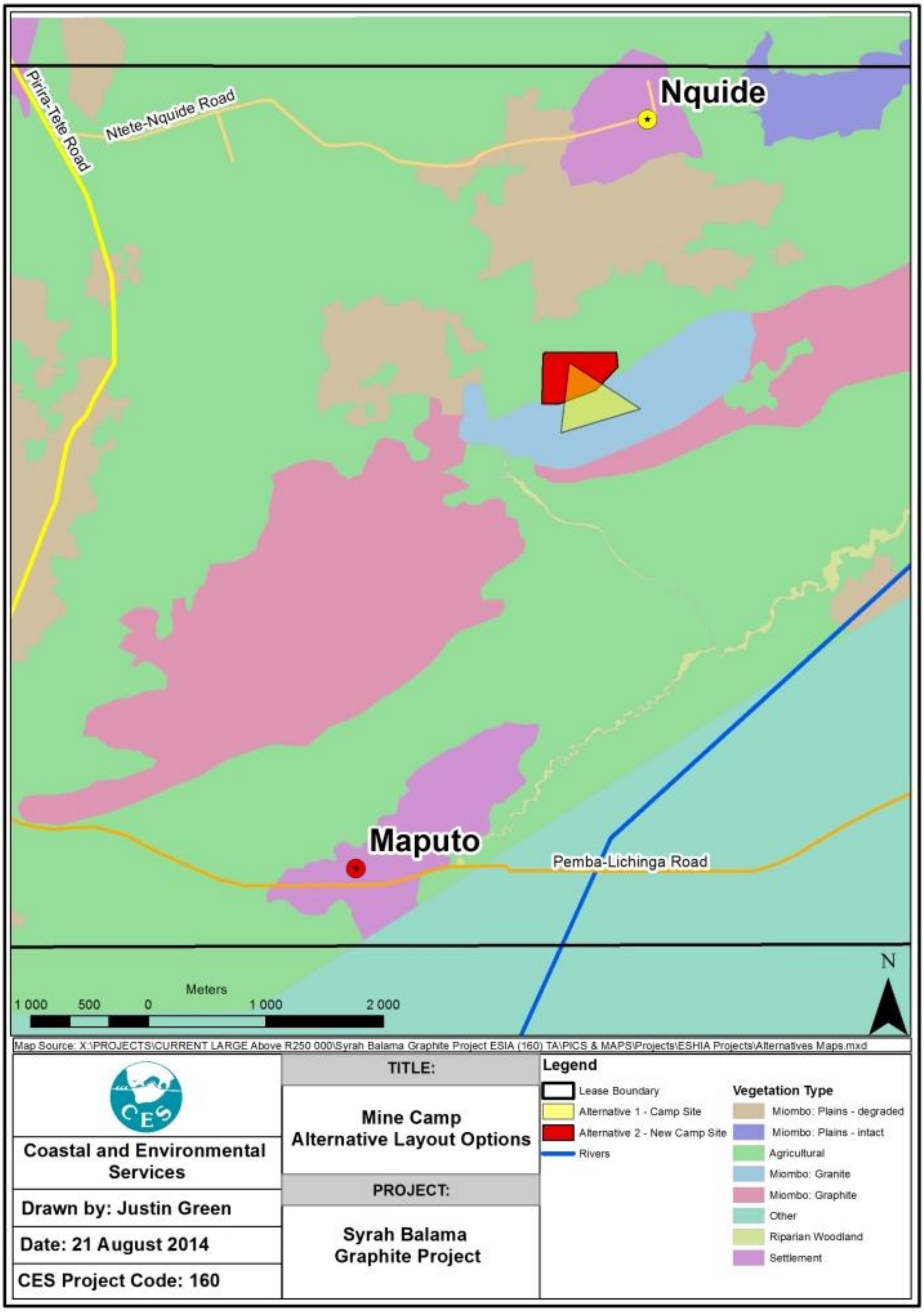


Figure 10.5: Alternative locations for the mine camp

11. DECOMISSIONING AND CLOSURE PLAN

11.1 Introduction

11.1.1 Background

In accordance with the Mozambican legislation (Environmental Framework Act (Law No. 20/97, 1 October 1997)) as well as in compliance with the International Finance Corporation (IFC) Environmental, Health and Safety Guidelines for Mining, a Mine Closure and Rehabilitation Plan is required for the Syrah Balama Graphite project. The activities associated with mine closure and rehabilitation are designed to prevent or minimise adverse long-term environmental impacts, and to create a self-sustaining natural ecosystem or alternative land use based on an agreed set of objectives associated with mine closure and rehabilitation. This plan must support the operation in achieving a post closure status that leaves behind a positive legacy in the community. Health, safety, social, environmental, legal, governance and human resource aspects will need to be considered and addressed.

The long term nature of the proposed operations (25 years) places limitations on the amount of detail that can be included into this current draft closure plan and it should therefore be regarded as being ‘conceptual’. This current version of the closure plan would therefore need to be reviewed regularly to keep in line with legislation, environmental, technological and socio-economic changes over the operational period.

11.1.2 Development of a preliminary mine closure plan

Mine rehabilitation is an on-going programme designed to restore the physical, chemical and biological quality or potential of air, land and water regimes disturbed by mining to a state acceptable to the regulators and to post-mining land users. Rehabilitation can take place throughout the life of mine, whereas mine closure by definition refers to those activities that take place after production has ceased.

The developed world (especially Australia and United Kingdom) have been among the leading countries on mine closure and rehabilitation, with the International Council on Minerals and Metals (ICMM) Planning for Integrated Mine Closure: Toolkit produced in London, being amongst the most widely used international guideline documents for mine closure. The recommendations included in this report will need to comply with ICMM Guidelines which is explained in more detail below (Figure 11.1).

As mentioned above, the closure plan should be viewed as a process which begins during the planning phase of a mine’s development and continues throughout the operation phases. Central to the closure plan is the development of a progressive rehabilitation plan (prior to mining). This approach encourages planning for closure becoming part of the design of a mine operation in order to facilitate closure. The Mine Closure and Rehabilitation plan will be initiated at this early stage as a Conceptual Closure Plan. The comprehensive information that is required for the detailed closure and rehabilitation plan will be developed during the mine operational phase which will assist in compiling a detailed closure and rehabilitation plan. This rehabilitation plan will ensure:

- That the post-mined landscape is safe and stable from a physical, geochemical and ecological perspective;
- The quality of the surrounding water resources is protected;

- The agreed sustainable post-mining land use is established and clearly defined to the satisfaction of the community and government; and
- Success criteria are agreed with relevant stakeholders, monitored, and reported to stakeholders.

The Mine Closure and Rehabilitation plan will be reviewed and updated annually in preparation for potential events such as material changes in operating parameters. Ultimately, closure must ensure that the site is stable and safe in the long-term.

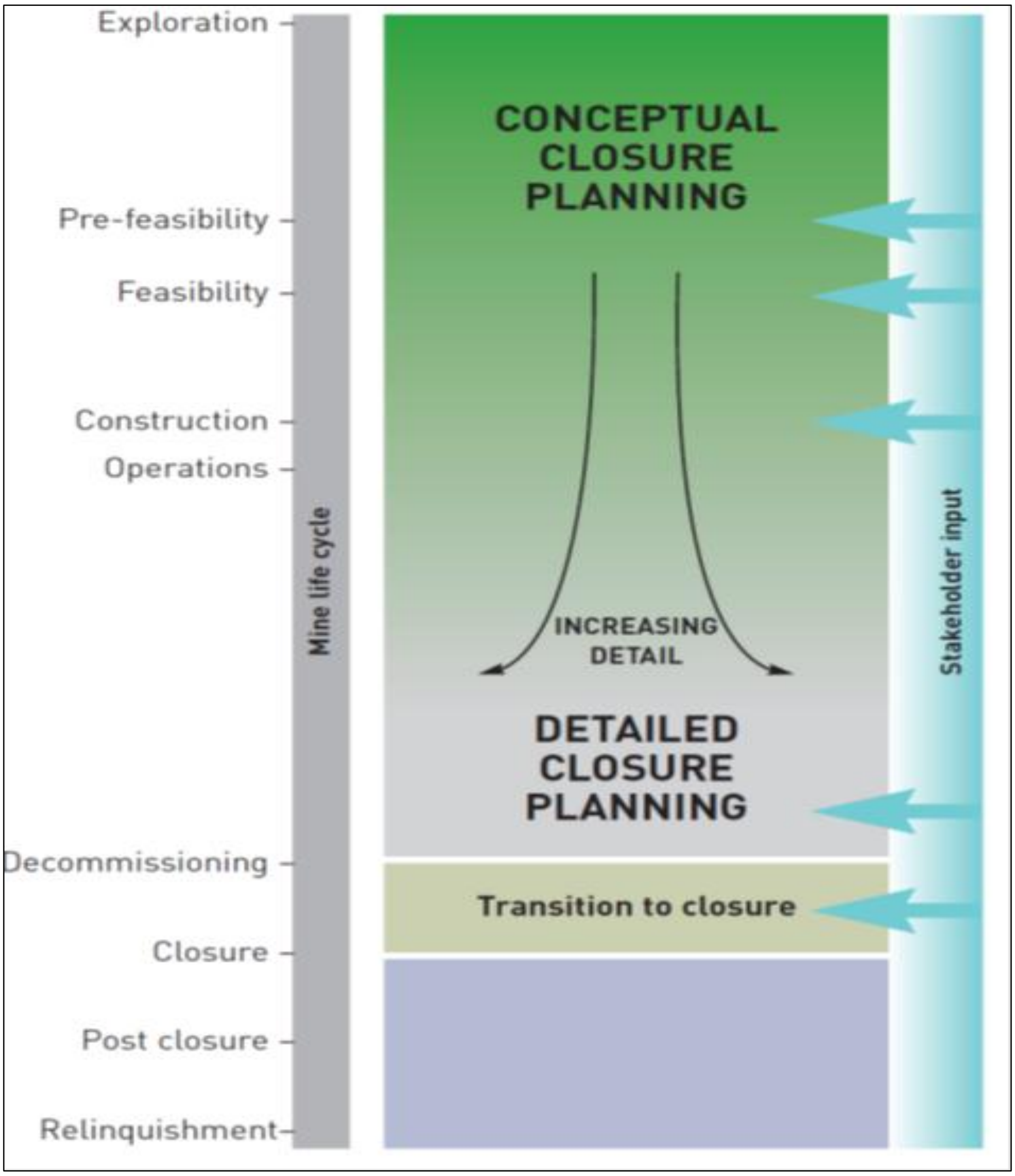


Figure 11.1: The integrated mine closure planning approach as recommended by the ICMM (2008)

11.1.3 Applicable legislation and international standards

This Preliminary closure report has been compiled in fulfilment of the relevant Mozambican legislation. The overarching item of environmental legislation is the Environmental Framework Act (Law No. 20/97, 1 October 1997) which governs the use and correct management of the environment and its components, and to ensure sustainable development. It is the foundation for the legal instruments for the preservation of the environment. According to the Environment Act, the mining operation is liable for the costs of rehabilitating the degraded environment or restoration thereof.

In addition to compliance with Mozambican Legislation, the development is expected to adhere to the following:

- Equator Principles (2013);
- International Finance Corporation's Standards on Environmental and Social Sustainability (IFC, 2012);
- International Finance Corporation's Environmental, Health and Safety General Guidelines (IFC, 2007); and
- International Finance Corporation's Environmental, Health and Safety (EHS) Guidelines for Mining (IFC, 2007).

According to the requirements of these international standards, the mining operation should plan for the following:

- A Mine Reclamation and Closure Plan in draft form prior to the start of production, clearly identifying allocated and sustainable funding sources to implement the plan;
- The incorporation of both physical rehabilitation and socio-economic considerations in the mine closure plan;
- The duration of post-closure monitoring should be defined on a risk basis taking site conditions into account. Monitoring is typically required for a period of five years or longer; and
- The financial feasibility of mine closure and post-closure activities, including post-closure care should be included in the business feasibility analysis during planning and design stages.

In terms of the IFC requirements for closure and the Equator Principle guidelines, pollution prevention is the main driving factor. The IFC guidelines specify that a mine closure plan should incorporate both physical rehabilitation and socio-economic considerations as an integral part of the project life cycle and that a mine be designed so that:

- Future public health and safety are not compromised;
- The after-use of the site is beneficial and sustainable to the affected communities in the long term;
- Adverse socio-economic impacts are minimized and socioeconomic benefits are maximized.

Furthermore, it is specified that the objectives for closure need to be considered as early in the life cycle of the mine and that a draft closure plan should be compiled prior to the start of production or operation. This plan needs to indicate funding requirements (anticipated closure costs) and to achieve this, a Mine Works Program would be required and be updated on an on-going basis. For short life of mines a fully detailed plan is required and the longer the life of mine the more conceptual the plan can be. However, it will need to be updated regularly. The timing and finalisation of a final plan is site specific, however all mines need to demonstrate some form of progressive rehabilitation as necessary during the operational and construction phase. Lastly, during the last five years of forecasted operations, a final closure plan needs to be developed with the objective of leaving the mine area in a ecological functioning condition (to the extent possible).

In summary, if the life of mine is longer than five years then a draft / conceptual plan is acceptable but it will still need to contain an estimate of the cost for rehabilitation.

Importantly, the IFC guidelines require that funds are available, through “*appropriate financial instruments, to cover the cost of closure at any stage of the mine life, including provision for early, or temporary closure*”.

11.1.4 Social components of closure

Post closure the mine should ensure that the communities impacted and dependent on the mine are suitably catered for. Social risks must be identified, and goals need to be defined and set for, inter alia, the following: Poverty alleviation, education, health care, employment and employability, reducing child mortality, improving social infrastructure.

Engagement with affected communities throughout the life of the project is essential and to this end, the company will be guided by the approach recommended by the ICMM. It is recognized that to achieve effective closure that is beneficial to the operating company and the community that hosts it, the views, concerns, aspirations, efforts and knowledge of various internal and external stakeholders must be brought together. For the Balama mine this will involve:

- Incorporating closure planning into the early stages of project development and operations;
- Collating the goals and views of various stakeholders (project owner, local community, government, and non-governmental organizations (NGOs)) at the early feasibility (ESIA) stage of project development to inform closure and post closure goals;
- Acting to meet the goals by working with the relevant stakeholders within and outside Syrah Resources;
- Using the concepts of risk and opportunity to both minimize liability and maximize benefits to all relevant parties; and
- Using multidisciplinary expertise and multi-stakeholder processes to ensure that mitigation of risk in one area does not increase risks in another.
- Ensuring that the social closure phase ties in with the infrastructural and environmental closure phases.

Thus, engagement with internal and external stakeholders will be undertaken throughout the life cycle of the project, and to achieve lasting benefits at a local and regional level, Syrah Resources appreciates that the views of external stakeholders must be understood. To ensure that these benefits are delivered, Syrah Resources will identify key external stakeholders and engage with them to foster a two-way understanding of mutually beneficial outcomes. These outcomes will be explained and presented in the Comprehensive Closure Plan and disclosed to stakeholders in a manner consistent with the requirements of the applicable standards referred to above.

11.2 Decommissioning, rehabilitation and closure of specific components

A number of closure requirements have been identified for this specific mine, relating to an opencast operation, with associated waste rock dump, overburden, topsoil, wash plant, discard and tailings facilities. In terms of rehabilitation it is important to note the following:

- The “roll over” method of progressive rehabilitation will not be suitable given the structure of the resource mined;
- The cost associated with the treatment of decant water for a period of 20 year post closure have yet to be determined and have been excluded from the cost estimate in this chapter;
- Monitoring and reporting for a period of 10 years post-closure is required;

- Post closure land use will be grazing and subsistence agriculture, with the general area being returned to a savannah woodland area, dominated by various slow growing Brachystegia (Miombo) and other local species.

11.2.1 Overview of closure activities

The activities that will be carried out for rehabilitation and closure of the proposed project operation include the following aspects:

- Comprehensive characterisation and classification of soils, overburden and mineral processing wastes to determine their capacity to support plant growth and their potential to have adverse impacts on water quality
- Implementing rehabilitation measures during the construction and operational phases of the mine (wherever possible). As areas become available in their final closure form, they will be rehabilitated during the operational phase, rather than the decommissioning phase;
- Ensuring that rehabilitated areas are left free draining and well vegetated (whether through re-vegetating or natural plant colonization) and the plant cover is self-sustaining;
- Ensuring that the Pits, TSF and WRD slopes are designed with topographies to minimise future potential for erosion;
- To ensure that the Pits, TSF and WRD are rehabilitated in such a way as to prevent erosion and to minimise any potential contamination emanating from them post-closure;
- Maintenance of all disturbed areas and re-vegetated areas until such areas have developed a sustainable and erosion-free cover; and
- Monitoring of key environmental variables such as soils, erosion, vegetation, groundwater, surface water and air quality; in order to demonstrate stability and sustainability of rehabilitated areas.

Further details on each of the above are contained in the full preliminary original closure report (DWE, 2014).

The mine closure and rehabilitation plan will be reviewed and updated annually in response to material changes in operating parameters. Wherever possible and practical, closure planning and closure risk assessments will continue to involve relevant internal and external stakeholders.

11.2.2 Mine void / Pits

Approximately 30ha of land will be disturbed during the first 5 years of the mining operations for the proposed Balama East and Balama West pits. It has been assumed that these pits will not be backfilled with overburden but instead left to fill with water in order to become in-pit lakes. The objective of opencast rehabilitation is to ensure that the site is left in a state that poses minimal risk to the health and safety of humans and animals and the health of the environment.

Final pit slopes will be designed for long-term stability. This is normally achieved by sloping the perimeter walls of the open pit at slopes no steeper than 34º to the pit floor or to the stable groundwater level that could establish within a reasonable period. This pit wall sloping renders the pit safe for humans and domestic animals. Where concerns exist regarding the risk that the pit water poses to humans and animals, it will be necessary to implement measures to reduce access to the pit. As fences would be stolen, this may be achieved by the construction of a sizable berm around the entire perimeter of the open pit to keep domestic animals out and restrict human access. A further option is to plant an impenetrable vegetation barrier around the pit, using a spiny, fast growing but non-invasive species such as sisal. Prior to making a choice about a suitable species, a risk assessment to determine the potential for the species to become invasive will be undertaken.

Signs will be erected around the open pit and on all approach roads warning the public of the potential dangers of falling or drowning. These signs will be in English, local languages and symbols for illiterate people. Access ramps to the open pit will be closed off to prevent vehicle access. In addition, as part of the closure process, local communities will be informed directly of the potential hazards and precautionary measures to be observed around the pit.

The mine closure plan and, in particular, the costing, will need to be updated to include these measures if they are considered necessary.

11.2.3 Waste Rock Dump

The Waste Rock Dump (WRD) will be established between Balama East and Balama West. The WRD will consist of all overburden and waste material generated during mining. To significantly reduce the costs of rehabilitation, the slope angle of the WRD will not exceed 1:5 and topsoil and vegetation will also be added to these areas. This angle will also be maintained for WRD areas that have reached final profiling. Upon closure the WRD sides and tops will be covered with soil, and vegetated with indigenous species during the wet season.

In addition to the above mentioned objectives, the shaping of the WRD slopes will be undertaken during the operational phase of the mine and that if acid generating waste rock has been identified, that this be separated from non-acid generating waste rock. Acid generating waste rock can be encapsulated within non-acid generating waste rock in order to prevent/minimise the risk of acid mine drainage formation.

11.2.4 Tailings storage facility (TSF)

The TSF will be located north of the proposed plant location. The TSF is expected to cover a total footprint area of approximately 94 ha over the 25 year Life of Mine (LoM).

Post closure, the TSF may be a potential source of sulphide minerals (pyrite and chalcopyrite, sphalerite and pyrrhotite). Should acid rock drainage from tailings impoundments occur, it is likely to reduce groundwater quality. However, the TSF will be clay lined and the potential for ARD generation is therefore unlikely. Furthermore the effects of the sulphides can be effectively mitigated through lime injection and or floatation of the sulphides from the tailings before depositing in the tailings dam. The other minerals present will most probably be inert and although they are not expected to contribute significantly to groundwater pollution, they may contribute to elevated metal and trace element concentrations in the groundwater.

To minimise the potential negative environmental impacts (both chemical and physical) of the TSF at closure and post-closure, the following is proposed for the TSF:

- During the construction phase the upper dandy silt layer classified as topsoil must be stripped (depth ranges from 100mm to 600mm – Knight Piesold Consulting, Internal

Memo, October 2014.) before the TSF is constructed. These materials will be used to cover the WRD and TSF post closure;
- Construct a permanent spillway to ensure physical stability of the facility during storm events. This will be done during the construction phase of the dam;
- Fill the tailings pond area to eliminate water ponding on the surface of the TSF post closure. This will be done during the final stages of the mine's operation;
- Cover the TSF with the sandy silt topsoil layer (contoured to ensure free drainage of surface runoff post-closure) , and then establish vegetation; and
- Monitoring of groundwater and surface water qualities around and downstream of the TSF area.

The rehabilitation of the TSF mentioned above is the procedure that will be done to rehabilitate the tailings during the LoM (include the first 5 years). It is estimated that only 30ha will be covered with tailings during the first 5 years.

11.2.5 Roads

The proposed access roads around the site will be ripped, except those needed to access the facilities for inspection after closure. Roads that can and will be used by other users post closure will, however, be left, provided this is agreed upon by all parties concerned.

11.2.6 Ore processing plant and other infrastructure

It is assumed that some of these buildings and infrastructure will remain to support post closure use. Once closure is complete, a decision to either demolish remaining facilities or hand them over to Government for conversion into social infrastructure (e.g. schools, clinic) will need to be made using a consultative process.

All other infrastructure will be decommissioned as follows:

- Any surface buildings and infrastructure which are no longer required will be demolished, unless specific directives to the contrary are received from the authorities. Such directives may result from communities' requests. This will need to be confirmed through a stakeholder engagement process undertaken as part of the closure plan goal refinement exercise.
- Foundations will either be removed or will be covered with a layer of soil, or soil forming material, the depth to be determined following trials to be undertaken.
- Non-re-useable materials including rubble and waste will be disposed of at suitable sites in accordance with the waste management and disposal plan that will be developed. It may be acceptable to dispose of certain bulky inert items in the mine void but this will need to be confirmed as the closure plan is refined.
- Following the removal of the infrastructure a soil contamination assessment will be undertaken by an independent specialist and remediation and re-vegetation activities implemented where necessary.
- Support infrastructure buried underground such as tanks and their pipes, other pipes and service tunnels will, depending on the proposed future use of the site, either be kept as is or be unearthed and removed from the site. If they are to be left in-situ, the integrity of all underground pipes and tanks will be assessed by an independent expert. If the integrity of sub-surface infrastructure is compromised, it will be removed.
- Remaining openings and access ways of support infrastructure will be blanked.

- A detailed plan indicating the location of any remaining infrastructure will form part of the closure plan.
- Any roads which will no longer be required will be rehabilitated. The details of such rehabilitation will be outlined in the Ecological and Rehabilitation EMPs, but in general the following will be undertaken:
    - Bridges, culverts and ducts will be removed where they are no longer required.
    - The natural water flow will be restored and any disturbed section of the watercourse will be stabilised and revegetated.
    - The road surface, shoulders and embankments will be graded to a slope suitable to prevent erosion. Cuttings will be assessed and where necessary measures to improve safety and erosion stability will be implemented.
- Electrical equipment and infrastructure such as transmission towers, electric cables and transformers which are no longer required will be demolished and removed from the site. The soils in the vicinity of transformers will be assessed for contamination and appropriate decontamination measures will be implemented, in accordance with Zambian regulatory requirements.
- All disused mining plant and equipment such as winches, pumps and conveyors, concentrator equipment such as thickeners, and heavy machinery will be removed from the site. It is not anticipated that any of this machinery or equipment will be contaminated. However, the mine will confirm this before any machinery or equipment is removed from the site. If any of the machinery or equipment is found to be contaminated it will be appropriately decontaminated before being removed.
- During the mitigation and rehabilitation works, particular attention will be paid to the places where equipment will be parked. The mine will assess these sites and if the soils are contaminated appropriate remedial measures will be taken in compliance with Mozambican regulatory requirements.
- The closure plan for the mine will include details for the closure of the landfill and will ensure that the closure of these specific facilities meets the requirements of Mozambican legislation and international best practice. Post-closure monitoring of these facilities may be required.

11.2.7 General Surface Rehabilitation

General surface rehabilitation will ensure the surface topography emulates the surrounding area, is free draining, has a “neat” appearance and is re-vegetated. Special attention will be given to shaping and removal of heaps of excess material, scrap and waste. The entire area is to be ripped, covered with topsoil and vegetated. The details of the revegetation will be documented in a comprehensive rehabilitation plan.

11.3 Post closure mine site inspection, environmental monitoring and reporting

The purpose of monitoring is to ensure that the objectives of the rehabilitation programme are met and that the progressive rehabilitation process is followed as planned during the life of the mine. More specifically, the post closure environmental inspection and monitoring will enable Syrah Resources to assess the success of mine reclamation and verify that the various components of the closed mine are not adversely impacting water resources and do not pose a potential health risk and/or danger to the public.

Detailed tracking of the progress of progressive rehabilitation will also permit the annual review of the closure plan to reflect this progress, thus reducing or increasing the quantum required for final closure costs. The physical aspects of rehabilitation should be carefully monitored during the operational phase as well as during the progress of establishment of desired final ecosystems, so that deviations from expectation can be catered for in subsequent versions of the mine closure plan and costing.

The following items should be monitored continuously:

- Alignment of actual final topography to agreed planned landform;
- Depth of topsoil stripped and placed;
- Chemical, physical and biological status of replaced soil;
- Erosion status, including the waste rock dump upper surface and sidewalls;
- Surface drainage systems and surface water quality;
- Groundwater quality and quantity at agreed locations;
- Vegetation basal cover;
- Vegetation species diversity;
- Faunal re-colonisation;
- Proportion of mined land that has been fully rehabilitated;
- Pit wall stability;
- Condition of site access roads, culverts and bridges;
- Community health and safety;
- Radiation levels; and
- Socio-economic status of affected communities.

Consultations will be held with local community leaders to listen to and record any issues of concern pertaining to the closed mine site.

An external consultant will produce an annual post-closure environmental monitoring report. These post closure environmental reports will be submitted to the MICOA and made available to all stakeholders. The reports will present the findings of the mine site inspections/walkovers and the results of the environmental monitoring programmes. Where reclamation activities have not obtained the desired result, the consultant will make recommendations on what additional reclamation work is required to achieve full reclamation. Any areas of concern will be highlighted. The reports will include a post closure photographic record of mine reclamation.

Further details of the post-closure monitoring are presented in the ESMP and monitoring programme.

11.4 Closure cost estimates

The costs reported in this section are an estimate based with an assumption that progressive rehabilitation will occur during the mine operation. The cost estimate is also only valid for the first five years of operation, assuming that the mine would be closed after then. The costs will therefore be reviewed at least every five years.

Assumptions

The following assumptions were used for the closure cost calculations:

1 Costs have been calculated for the first 5 years (Table 11.1) of mining and 25 years of mining (Table 11.2);
2 It is assumed that the total disturbed (during the first 5 years of mining) area for both Balama East and Balama West pit is 30 ha and this will need to be rehabilitated. The

cost does not include shaping that may be required and it is assumed that this will be done as an operational cost during the life of mine;

3 The WRD (slope) will be maintained at 1:5 slope during the LoM hence, there will be no need to cost for shaping the side of the WRD at closure. The covering of the WRD with topsoil, vegetation and monitoring of groundwater and surface water has been costed;

4 The rehabilitation procedure for the TSF will be done on the areas deposited with tailings (30ha) within the first 5 years;

5 Costs associated with bringing in topsoil (transportation) have been excluded thus far, until the distance for the transportation of topsoil from outside of the mining area is determined. The costs provided are based on placement of topsoil. The cost assumes that enough topsoil is available within the current mining footprint, thus placement of topsoil on rehabilitated areas is costed for. Should additional topsoil be required, this will result in additional costs which will need to be included during the operational phase to ensure that the financial provision is adequate for the decommissioning phase;

6 All roads associated with the mine are assumed to be gravel roads and 8 m wide;

7 Eight groundwater monitoring points were assumed adequate to monitor groundwater quarterly (i.e. 4 times a year) for 10 years after the mine has closed. The groundwater monitoring boreholes will be drilled during the operation of the mine, hence drilling costs have not been included in the groundwater monitoring costs;

8 Calculations do not account for any value recovered from the sale of plant or other material;

9 The actual placing of saprolite and topsoil cover might start a few years after deposition on tailings has ceased and the feasibility of placing the cover on the TSF should take advantage of the dry season in the project area; and

10 A contingency of 15% has been included to cover areas that may have been overlooked, or costs that have been underestimated. A 12% allowance has been included for project management fees. These fees account for the costs required to manage the closure and rehabilitation phase.

The estimated total cost for the closure of the Balama Graphite Mine operation is $6 237 915.61 for the first five years of mining and $10 309 154.40 after 25 years of mining. Table 11.1 and 11.2 provide a summary of the costs; refer to the full preliminary closure plan for a detailed cost breakdown.

Table 11.1: Summary of Closure costs for the first five years of mining

Summary - Balama Graphite Project	
Balama East and Balama West Pit	**Total**
Topsoil spread	$ 319 396.17
Vegetation Establishment	$ 104 475.38
	$ 423 871.56
Waste Rock Dump (WRD)	**Total**
Topsoil spread	$ 803 813.70
Vegetation Establishment	$ 262 929.72
	$ 1 066 743.42
Tailings Dam	**Total**
Tailings deposited area- Saprolite spread	$ 319 396.17
Tailings deposited area- Topsoil spread	$ 319 396.17
Vegetate	$ 104 475.38
	$ 743 267.73
Linear Infrastructure	**Total**
Rip Road	$ 315 217.16
Vegetation Establishment	$ 110 326.01
	$ 425 543.16
Plant Area	**Total**
Rip Plant area	$ 439 194.61
Vegetation Establishment	$ 153 718.11
	$ 592 912.73
Total	**$ 3 252 338.60**
Monitoring Ground & Surface water	**$ 1 422 080.00**
Monitoring Aquatics	**$ 24 296.00**
Monitoring Rehabilitated Areas	**$ 40 318.40**
Maintenance of Rehabilitated Areas	**$ 620 751.18**
Project Management (12%)	**$ 390 280.63**
Contingency (15%)	**$ 487 850.79**
GRAND TOTAL	**$ 6 237 915.61**

Table 11.2: Summary of Closure costs after twenty five years of mining

Summary - Balama Graphite Project	
Pits	**Total**
Balama West	
Topsoil spread	$ 654 549.23
Vegetation Establishment	$ 214 104.89
Balama East	
Topsoil spread	$ 612 176.00
Vegetation Establishment	$ 200 244.49
	$ 1 681 074.60
Waste Rock Dump (WRD)	**Total**
Topsoil spread	$ 803 813.70
Vegetation Establishment	$ 262 929.72
	$ 1 066 743.42
Tailings Dam	**Total**
Tailings deposited area- Saprolite spread	$ 998 645.37
Tailings deposited area- Topsoil spread	$ 998 645.37
Vegetate	$ 326 659.70
	$ 2 323 950.44
Linear Infrastructure	**Total**
Rip Road	$ 315 217.16
Vegetation Establishment	$ 110 326.01
	$ 425 543.16
Plant Area	**Total**
Rip Plant area	$ 439 194.61
Vegetation Establishment	$ 153 718.11
	$ 592 912.73
Total	**$ 6 090 224.35**
Monitoring Ground & Surface water	**$ 1 422 080.00**
Monitoring Aquatics	**$ 24 296.00**
Monitoring Rehabilitated Areas	**$ 58 652.00**
Maintenance Rehabilitated Areas	**$ 1 069 541.47**
Project Management (12%)	**$ 730 826.92**
Contingency (15%)	**$ 913 533.65**
GRAND TOTAL	**$ 10 309 154.40**

11.5 Conclusions

The following actions will be taken prior to the update of the annual Closure and Rehabilitation Plan:

- As the knowledge base develops, a more detailed closure risk assessment will be built up (in the annual reviews) with input from representatives of the design team, operational personnel and environmental specialists. This will enable the development of solutions to key issues that are both acceptable to the technical specialists concerned while at the same time being practically implementable;
- Continue with detailed modelling of the impact from various TSF cover configurations on the rate of generation of pollution plumes, together with modelling of the long-term impact of those plumes on downstream water users and modelling a feasible way to place the saprolite and topsoil covers on the TSF, post-closure;
- Implement the measures as outlined in the specialist studies to minimise the risk to surface water contamination from the operations during rehabilitation and closure;
- Research trial work during the operational phase to determine other rehabilitation options that could be considered for the closure and rehabilitation of the TSF;
- Additional research (by field testing) to identify the average depth of topsoil available, and the potential for use of topsoil covers of less than 300mm for sustainable rehabilitation. Although conventional wisdom is that 300mm is the minimum, it is possible that insufficient topsoil will be available on site. Investigations to determine if a lesser quantum may be satisfactory for the plant species naturally occurring under the Mozambican environment is therefore required. Options of mulching and composting could also be explored;
- Refine the cost model by verifying the various cost rates for the Mozambican environment;
- Actively consult with key stakeholders, including affected communities, throughout the life of the mine;
- When the closure and rehabilitation plan is updated ensure that community related issues are fully covered in the plan; and
- Ensure that the Environmental Management Plan is aligned to the Closure and rehabilitation plan

12. FINAL CONCLUSIONS AND RECOMMENDATIONS

This chapter discusses the key issues which have been identified by the various specialist assessments and the proposed key mitigation and management actions which will be required in order to reduce all risks associated with the project to an acceptable level. In addition to this, this chapter also summarizes the residual impacts that may occur as a result of the construction, operation and decommissioning phases of the proposed development.

12.1 Key findings of specialist assessments:

12.1.1 Vegetation Assessment

Impacts were identified and assessed for each phase of the mine. The largest number of HIGH impacts were noted to occur during the construction phase. This phase will have the highest impact on the vegetation communities and floral biodiversity followed by the operational phase. It is imperative that mitigation measures suggested for each identified impact are implemented to reduce the effects of the mine. These include (but are not limited to) the following:

i. Reduce the number of crossings through the riparian woodland;
ii. Use bridge designs that afford the lowest impact on riparian vegetation;
iii. Locate bridges and river crossings at existing crossings and in areas that are already impacted;
iv. Rehabilitate all vegetation types that are impacted on during the construction phase but that are no longer required during the operation phase;
v. In areas of high sensitivity, demarcate restricted go areas and ecological corridors to facilitate their continued functioning;
vi. Avoid locating unnecessary infrastructure in areas of high sensitivity or areas demarcated as no-go areas;
vii. Set aside key representative portions of each vegetation type as conservation areas within the mining concession area;
viii. Prevent employees from harvesting plants for personal use, firewood or charcoal;
ix. Avoid locating infrastructure such as the TSF and mine camp in areas with high concentrations of species of special concern;
x. Where feasible relocate samplings of species of special concern;
xi. Use existing roads where feasible;
xii. Align roads and pipelines along a single corridor and keep this as narrow as possible;
xiii. Avoid locating linear infrastructure (such as roads and pipelines) through areas of high and moderate sensitivity;
xiv. Move infrastructure out of areas of high sensitivity;
xv. Wetlands and rivers are important ecological process areas, with a high sensitivity, that form corridors for plant and animal dispersal. Therefore, a 50 meter “Restricted-Go” buffer on either side of all water bodies (rivers, streams, wetlands and tributaries) should be implemented. In addition, drainage lines should be rehabilitated and re-vegetated. Where feasible, infrastructure occurring in these areas should be moved to less sensitive zones.
xvi. Habitat fragmentation creates breaks in previously continuous vegetation, causing a reduction in the gene pool and a decrease in species richness and diversity for both flora and fauna. Ecological corridors, designated as “RestrictedGo”, areas should therefore be set aside within the project site to facilitate the movement of faunal species, seed dispersal and the expansion of existing vegetation types.

xvii. It is recommended that areas of Mount Nassilala unaffected by mining are left intact so that it may continue to function as a “stepping stone” for the dispersal of animal and plant species. Management intervention by the mine will be required to avoid community exploitation of the resources by local communities, and a community based natural resource management strategy should be developed.

xviii. It is recommended that an **Ecological Management and Monitoring** Plan is designed and implemented.

xix. Proposed corridors have been recommended in the vegetation assessment.

xx. Rehabilitation of the project site should include restoration of the inselberg where feasible. The conservation of these areas will be dependent on the co-operation “buy-in” of the local communities. Educating communities on the sustainable use of natural resources in these areas is imperative as well as why poaching shouldn’t occur in these areas. Additionally, improved agricultural practices that are more intensive as well as alternative sources of construction materials through the creation of woodlots will aid in conserving these areas.

xxi. Unlike the graphite resources, which are located in an ecologically sensitive area and cannot be relocated, the mine camp need not be located in an ecologically sensitive area. It is therefore recommended that it be moved 400 metres north into less sensitive disturbed Miombo woodland (this has been done and the mine camp has been relocated, please refer to Chapter 10).

xxii. It is recommended that a botanist/ecologist be on site to determine if any of the species of special concern or protected species occur where the mine and associated infrastructure are positioned. Plants can be removed and placed in a nursery for use for rehabilitation purposes where appropriate. If a species is identified for relocation, individuals will need to carefully uprooted and removed by a skilled horticulturist. Prior to removal, however, suitable relocation host areas need to be identified, either within the site or in other disturbed areas on the property, preferably in the ecological corridor and conservation areas. Individual plants that cannot be relocated at the time of removal should be moved to the nursery, although this is less preferable due to associated costs and low survival rates. It is recommended that the Ecological and Management and Monitoring Plan include details on ***Plant Search and Rescue***.

xxiii. It should be noted that many critical species of special concern are plants that will not be able to be successfully uprooted and replanted at all, or at best may have a low survival rate. In all cases the species will require very careful treatment to give them the best chances of survival, and specialist horticultural knowledge will be needed.

xxiv. It is recommended that an Environmental Control Officer (ECO) is employed to ensure that construction and operation activities are undertaken in accordance with the recommendations contained in the vegetation assessment and the Environmental and Social Management Plan, and to monitor that no unauthorised activities are occurring.

xxv. Not only is rehabilitation considered “good practice” but it is important in the prevention of soil erosion and alien species invasion; and it returns the land to a functional state that can be used by future land owners. A ***Rehabilitation Management Plan*** for the mining site must therefore be created and implemented. This should include a rehabilitation plan for any extra land that was needed for the construction phase of the development but will not be used during the operation phase of the development, as well as suggestions on how best to rehabilitate the waste rock dump, and other strategies to make the pits safe.

xxvi. Any form of disturbance to the natural vegetation provides a gateway for alien species to invade the site of disturbance. In this regard, it is recommended that a strict ***Alien Management and Monitoring Plan*** is implemented to prevent the spread of any alien species and to remove alien species already present at the site.

xxvii. The spread of the existing bamboo should be monitored and mitigation measures implemented where necessary.

12.1.2 Faunal Assessment

The following conclusions were reached with regards to fauna in and round the project area:

i. The Faunal Assessment identified and listed all species of terrestrial vertebrates occurring in the mining area; identified SSC using reference to the IUCN Red Data List and CITES; defined and mapped faunal habitats that are sensitive and require conservation; described current impacts on faunal groups and identified any impacts that mining will have on the different faunal groups and specific species that would be significantly affected by the mining proposal.
ii. The area is predominantly covered by various forms of Miombo woodland, much of which has either been removed or degraded due to human land use impacts. The proposed mine site lies in the Chipembe River catchment, but without extensive riparian vegetation or wetlands.
iii. Faunal diversity was historically high, but certain groups (large mammals and birds), have been depleted or locally extirpated. Thirty nine amphibian species may occur in Cabo Delgado Province, of which 20 were observed during the faunal surveys. No amphibian SSC or endemic species, or specimens of problematic taxonomic status, were recorded, and the amphibian fauna is not obviously impoverished from that expected to have historically occurred in the region.
iv. During the faunal surveys only 22 reptiles were observed, and another seven were reported to occur in the region. This number is relatively low compared with the +60 species that can be expected for the region. No reptile SSC or endemic species or specimens of problematic taxonomic status were recorded in the region, although a number of species do occur on CITES appendices, and their international trade is either banned or subject to strict control. It is probable that the low number of reptiles recorded during the survey reflects the shortness of the survey period and reduced reptile activity at the time. Due to persecution, the density of the larger, more conspicuous reptiles (e.g. pythons, cobras, mambas) may be impoverished from numbers expected to have historically occurred in the region. It is likely that the overall reptile diversity remains relatively intact.
v. Although the incidence of snakebites in the region is reported to be low, at least 12 venomous snakes occur in the region, bites from the majority of which have caused fatalities. In addition, three fatal attacks from crocodiles in Chipembe Dam were reported in 2012.
vi. One hundred and thirty six (136) bird species were observed during the faunal surveys. Although the number of birds recorded is low relative to the possible 430+ bird species that may occur in the study area, it is a good reflection of the common bird fauna of Miombo woodlands. This number can be expected to increase with long-term observations, especially as many intra-African and Palaearctic migrant birds had already migrated northwards during the time of the field surveys.
vii. No bird IUCN threatened bird species were recorded on site. However, several (11) CITES listed species were recorded. The recorded SSC include mainly the Falconiformes species (e.g. eagles, buzzards, goshawks, sparrowhawks etc.), and Strigiformes species (owls). Of the Tauraco species that also fall under CITES, the purple-crested turaco was the only species observed on site.
viii. Of the possible 145 mammal species which may occur in Cabo Delgado Province; only 14 were recorded during the wet season survey. A further 20 mammal species are reported to occur in the area, while a further 96 could possibly also occur in the area. Most of these are small mammals, such as rodents, bats and shrews. Eighteen large to medium-sized herbivores and carnivores that historically occurred in the area are now either locally extinct or very rare vagrants.
ix. Eight mammal SSC were identified for the study area: three of these occurred in the area during historical times but are highly unlikely to still occur; two mammal SSC

(elephant and hippo) are still reported by local villagers to occur, at least seasonally, in the area.

x. The most sensitive habitats utilized by the surviving fauna include: 1) the Riparian zone and wetlands; 2) Steep slopes and rocky ridges. None of these habitats are specific to the project area and are well represented in the Balama Province. The Chipembe River and its associated drainage lines represent particularly sensitive habitats, especially from an amphibian and bird perspective. Similarly, the rocky ridges of Mts Nassilala and Coronge represent a sensitive habitat for the maintenance of reptile, bird and mammal diversity.

The following recommendations were made by the specialist, incorporated in the ESMP and are endorsed by Syrah Resources:

i. River drainage and small associated wetland areas should be avoided if possible as these are sensitive areas for amphibians and associated reptiles and birds.

ii. Ecological corridors need to be maintained between all identified areas of high sensitivity. For birds and some reptiles and small mammals the primary target habitat is Mature (Intact) Miombo woodland. Complete severance of this currently largely intact habitat by means of transport links, tailings and waste sites, and the mine pits, will further exacerbate existing impacts. Thus an ecological corridor between the major fragments on the mine site needs to be developed and protected. The riparian zone draining south from the East Pit, and between the two major rock areas of the mine site, also forms an important corridor for natural faunal movement. Due to its proximity to the mining activities it has increased susceptibility to hydrological impacts, and its condition needs careful monitoring to maintain its functionality.

iii. The recommended conservation areas serve as small local refugia from existing land use impacts, and also those that will occur from the construction and operation of the proposed mine. In a regional context they are small, and their greater efficacy depends upon their incorporation into regional planning for conservation and ecosystem services. These currently have low priority as the country and province recover from past conflict. However, with burgeoning provincial growth local developments such as the proposed mine must be integrated into regional environmental planning.

iv. An Environmental Management Plan (EMP) is essential. A qualified ecologist, familiar in both vegetation and fauna, should be on site during the construction phase, and to monitor environmental impacts during the operational phase. For faunal SSC (threatened, endemic or cultural important species), the EMP should include guidelines for the safe capture and relocation of SSC to suitable, safe habits. During all phases of significant habitat loss trained observers should be present to identify, capture and relocate SSC.

v. Any form of disturbance to the natural habitats provides an opportunity for the invasion and colonization of alien species. The EMP should contain a strict monitoring plan that can be implemented to prevent the spread of alien species, and to identify and remove alien species when encountered.

12.1.3 Aquatic Assessment

Based on the survey of aquatic ecosystems the following conclusions were reached with regard to the present state of rivers and ecosystems within and around the project area::

i. *In situ and ex situ* water quality indicated that in general the water quality was good when compared to the various relevant water quality guidelines.

ii. The moderate / high percentage contribution (25 - 30%) of Ephemeroptera, Trichoptera and Plecoptera (EPT taxa) to the overall invertebrate assemblage in the general area indicates that biotic integrity remains high despite the impacts of riparian zone clearance and sediment load increases due to local farming practices.

iii. The main existing negative impacts on the aquatic habitats are associated with clearing of riparian vegetation to cultivate crops and the construction of roads and river crossings. These activities have resulted in localised river bank instability, soil erosion and elevated sediment input, the filling in of deeper refuge pools and also higher than normal turbidity in the rivers after rainfall events.

iv. Field observations indicated that the aquatic habitat integrity in the project area has been moderately modified. Here a loss and modification of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged. These river reaches, which would fall into a Habitat Integrity of Category C after Kleynhans (1996) and Kemper (1999), are representative of most of the mine project area.

v. However, in the upper tributaries of the Mehucua River, where human population densities are low, environmental impacts on aquatic habitat quality, diversity, size and variability are present at a relatively low number of sites and are also limited in severity. In terms of significance, the modifications to habitat integrity in these upper catchment streams are considered small to moderate and would fall into a Category B after Kleynhans (1996) and Kemper (1999). In this category the habitat integrity is described as largely natural with few modifications and a small change in natural habitat and biota may have taken place, but the ecosystem functions are essentially unchanged.

vi. In addition to the direct environmental impacts due to the construction and operation of the proposed mine, the indirect impacts associated with the inevitable increase in the local population due to the influx of job-seekers and families to the study area should also be considered. The increased population will place more pressure on natural resources, resulting in increased environmental degradation of the catchment and the associated aquatic habitats. These negative impacts on biodiversity in the vicinity of the mine project area, including aquatic biodiversity in local rivers, will be difficult to adequately mitigate.

Recommendations

It is essential to prevent sediment-laden run-off from all cleared areas, or areas associated with the mining activities (open pits, WRD and TSF sites, etc.) from entering drainage lines and adjacent rivers. The following actions are recommended:

- The TSF and WRD sites should be located in suitable areas away from drainage lines or rivers and best industrial practices put in place in terms of design and operation.
- Mine-water and surface run-off from the mining areas should be detained in sedimentation ponds before the clear surface water (if uncontaminated) is allowed to flow into the adjacent drainage lines or streams.
- Contaminated water from the process plant should be stored in the tailings storage facility (TSF) and the supernatant or decant water from the TSF will be fed back to the process water reticulation.
- Details of mitigation measures for full containment and treatment (if feasible) of contaminated waters should be clearly stipulated in the EMP document.
- Strict management of hazardous chemicals.
- Prevention of hydrocarbon spills from machinery and vehicles.
- Domestic effluent from the mine camps should be treated in an on-site waste water treatment works and final effluent should be of high quality and used for irrigation or mining purposes.
- Containment and treatment of all contaminated water from mine and associated infrastructure.

- Strict control of workers movements and behaviour
- All water contaminated by sulphide bearing ores from the mining operations and WRD sites should be retained and pumped to the TSF.
- All low pH water should be treated appropriately.
- All effluent from the mine should be subjected to regular chemical analyses, including for vanadium and uranium concentrations.
- Industry best practice to prevent pollution from the TSFs and WRDs should be strictly implemented to ensure full containment and treatment of contaminated run-off, as well as anti-pollution management practices during mining operations, as well as during decommissioning/closure – as set out in EMP.
- surface run-off within the project areas is kept as natural as possible and natural drainage lines remain functional.
- Road and causeway construction should incorporate specific impact assessment studies to ensure eco-friendly designs incorporating bank stabilization structures, as well as the development and implementation of very strict construction environmental management plans (CEMPs).
- Riparian buffer zones (no-development areas) of 30 to 50m on both banks should be demarcated on all watercourses within the project area (and adjacent areas if feasible).
- Ensure the provision of suitably designed bridges across rivers in the Study Area that allow free movement of fish and other aquatic biota.
- Incorporate suitably designed fishways on any in-stream dams or weirs, as required.
- A series of practical, common sense rules and restrictions to regulate fishing activities could be developed in consultation with the local Chief, village elders and local fishermen. If these rules are in place before the population increases, it will go a long way to help manage the fisheries resources in a sustainable way.
- The fisheries potential of Chipembe Dam should be investigated and possibly enhanced and developed. This could create work opportunities and catches from Chipembe Dam could provide a more sustainable all-year round source of fish for the local villages.

12.1.4 Hydrogeology Assessment

The following conclusions were reached:

i. A total of ten boreholes were surveyed during the hydrocensus:
    - There are two water supply boreholes at the Balama camp; Camp BH1 and Camp BH2;
    - Boreholes BM-DD-001, BM-DD-005, BMRC 003 and BMRC 005 are old exploration boreholes
    - Boreholes Pirira BH1, Pirira BH3, and Maulia BH1, are equipped with hand pumps. The Maulia BH1 hand pump is no longer in use. Pirira BH1 and Pirira BH3 are used by the locals for domestic water supply; and
    - Pirira BH2 is a recently drilled borehole. It will be used to augment water supply.

ii. The Balama hills form part of the Mt Nassilala range of hills which are headwaters of local river systems in the project area. Groundwater discharge from the hillside supports perennial base flows in streams originating from the range. The Mualipue River drains the study area to the west and joins the northwest flowing Naconha River in the south.

iii. Groundwater occurrence in the project area is associated with weathered and fractured graphitic schist, granites and pegmatites. The aquifer associated with the weathered bedrock varies in thickness throughout the area, but it can extend to depths of about 40 mbgl. Fifty one per cent of the fractures in the study area occur in the upper 60 m of the geological succession. Up to 27 % of the fractures occur between 140 and 180 mbgl. However a majority of the deeper fractures are unweathered. The fractures in the upper 60 m are mostly moderate to highly weathered. Therefore fracturing is relatively common in the upper 20 m of the fractured aquifer and groundwater flow is well interconnected. At greater depth groundwater flows may be associated with individual disconnected water bearing fractures.

iv. All major water strikes intercepted during drilling were between 40 and 60 mbgl. The major water strikes had yields between 0.78 and 9 L/s. Besides the fault gouge at Balama East, all major water strikes were associated with fractured intrusive areas at contact zones. Groundwater levels in the project area range between 2 mbgl at Pirrira BH3 (Balama west) to 33 mbgl in BH8 (Balama east).

v. Analysis of hydraulic head and aquifer tests show the Mualipue River recharges the fractured aquifer system. The weathered aquifer system is recharged directly from rainfall. A transmissivity value (T-value) of 7.7 m3/d is estimated for the fractured aquifer system in borehole BBH3. The relatively high yielding fractured granites at Maulia have a T-value between 5 and 6 m^3/d as analysed from BBH6.

vi. Groundwater from water supply boreholes Pirira BH2 and Pirira BH3 are not fresh due to elevated TDS values above 1000 mg/L.

vii. Acid mine drainage (AMD) processes have taken place due to oxidation of exposed pyrrhotite in the dug trenches. As such BMRC 005, BBH2, BBH3 and BBH7 have AMD signatures due to their proximity to the trenches.

viii. The only common heavy metals that have been significantly mobilised are iron, manganese, nickel and zinc.

ix. Although all major and minor ions in BBH1 are within guideline values, its alkalinity has been depleted. The pH of BBH1 will further decrease due to seepage of AMD water from the nearby trenches.

x. BBH6, BBH8, Camp BH1, Pirira BH1 and Pirira BH3 are relatively unpolluted water with calcium-magnesium-bicarbonate signatures.

xi. The chloride enrichment in Pirira BH2 is associated with seepage from the sewage disposal at Pirira village.

The following recommendations were made by the specialist, have been incorporated in the ESMP and are endorsed by Syrah Resources.:

i. It is recommended that the mine should supply an equal/better amount of water to affected communities that rely on groundwater in the receiving environment, if proven that there is impact on specific users. The baseline water quality of private boreholes in and around Balama has been analysed and is discussed in Section 3.6 of the Hydrogeology Assessment. These results could be used for future comparisons to evaluate if the proposed mine has impacted the groundwater.

ii. Diesel and other chemicals must be handled properly and not spilled. If a considerable amount of fluid is accidentally spilled, the contaminated soil should be scraped off and disposed of at an acceptable dumping facility.

iii. Storm water and runoff management through diversion channels and sedimentation ponds, required to be built around and downstream of the waste stock pile and TSF is recommended.

iv. Seepage interception boreholes downstream of the TSF should be drilled to intercept and capture any seepage that may enter the groundwater system. Any captured contaminated water should be pumped back onto the TSF.

v. Monitoring of groundwater quality and water levels is recommended up gradient and down gradient of the TSF, waste rock dump and particularly down gradient of the mine site with continuous refining and updating of the monitoring network based on the results obtained.

vi. The conceptual and numerical models should be refined every six months in the first four years and thereafter every five years based on groundwater monitoring results.

vii. Annual audits of monitoring and management systems should be conducted by independent environmental consultants

viii. No decant mitigation is required, since no decanting is expected to occur. Should decanting occur, passive or active treatment plans should be considered for treatment before the decant joins the streams.

ix. Since significant sulphide oxidation in the post closure environment at Balama is unavoidable, the most cost effective control of oxidation would be to reduce oxygen availability of the waste rock dump and the TSF. A low oxygen permeability (diffusion) clay cover would be ideal for the encapsulation of the waste rock dump and TSF to inhibit water and oxygen ingress thus reducing both oxidation rate and product transport.

x. The establishment of a permanent wetland on the TSF may be used to cover the reactive materials in the post closure environment. Once the available oxygen in the water is consumed, the rate of reaction is reduced and the rate of oxygen replacement will be relatively slow. The resultant diminished availability of oxygen is the single most effective inhibitor to sulphide oxidation.

xi. Backfilling the pits with reactive materials may be the best available option to manage sulphide oxidation in the post closure environment. The backfilled pits should be completely flooded with water to at least 15 m depth. The resulting pit lake will render the reactive materials chemically inert by diminishing the available oxygen

12.1.5 Geochemistry

The following conclusions were reached:

i. The mineralogy of the Balama deposit is dominated by metamorphic minerals with high clay mineral, amphibole and garnet content within a silicate matrix;

ii. The enriched formations are high in Au, Ag, As, Ba, Fe, Cu, Cr, Zn, U, Co, Cs, Mo, Ni, V, W, Y and Pb with these elements well above the crustal averages observed around the world. This is however no indication of whether they do pose an environmental risk with the bio-availability determined through the leachate tests;

iii. ABA and NAG results show that the Balama waste rock and mineralised material is acid generating and a potential for AMD and high metal contaminant seepage exists; and

iv. Parameters with concentrations above the recommended domestic water limits are aluminium (Al), cadmium (Cd), iron (Fe), copper (Cu), nickel (Ni), vanadium (V) and uranium (U) and these concentrations will increase if AMD formation does occur. These concentrations will however be diluted to much lower concentrations once mixing and reacting with the receiving groundwater and surface water volumes.

The following recommendations were proposed:

i. Due to the waste rock and ore material being heterogeneous in mineralogy with enriched formations along with a possibility of acid formation it is recommended that an intensive sampling campaign is done allowing the ABA evaluation of at least 50 samples to have a statistical distribution of the acid producing potential of the Balama geology;

ii. It is also recommended that 3 hanging wall samples, 3 footwall samples and 3 mineralised zone samples are submitted for long term kinetic tests (22 week Column leach or humidity cell tests) to evaluate the long term behaviour of the system and to see whether some of the elements of concern will not precipitate out once equilibrium is reached;

iii. Radio activity evaluations and tests should be done on the waste and ore material to evaluate the sources of possible contaminants (these tests are underway);

iv. Lining of the TSF and WRD as currently planned with clay material; and
v. A monitoring program should be designed and implemented to monitor both surface water and groundwater in and around the area where mining activities such as WRD, TSF and open pit mining will occur.

12.1.6 Radiation

To manage naturally occurring radioactive material (NORM) it is recommended that Syrah adopt the NORM guidelines as published by the Government of Western Australia, Department of Mines and Petroleum. As stated in the guideline NORM 1 the purpose of this set of guidelines is to summarise the system of radiation protection as recommended by the International Commission on Radiological Protection (ICRP), International Atomic Energy Agency (IAEA) and the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). The guidelines illustrate how the system of radiation protection may be practically applied in the mining and mineral processing industry and in particular:

- implementing best practicable technology to reduce exposure and contamination levels. For example, ensuring suitable engineering controls are used to the extent feasible;
- classifying employees, work conditions and workplaces on the basis of measured or predicted radiation levels. For example the classification of designated employees, restricted areas, controlled areas and supervised areas; and
- the establishment of contamination levels that trigger radiation protection responses. For example, defining special exposures and setting investigation and reporting levels.

Measurements taken (sampling points shown in Figure 4.8 and Figure 4.9), indicated the levels of radioactivity naturally occurring in radioactive materials . The readings were in the order of 3 to 10 times the background level, and generally across the field locations where measurements were taken. One test at location number 35 exhibited a value about 30 times background. Measurements on core samples at the core shed also followed the same trend, although one specific piece of core from drill hole BMDD0123 at a depth of 18m exhibited a value about 30 times background.

Calculations based on the field measurements indicate the dosage level encountered by personnel working in these areas will be less than 5mSv per year. The NORM guidelines provide classifications of work conditions and at dosage levels less than 5mSv the work area would be classified as a supervised area. The ARPANSA definition of a supervised area is "an area in which working conditions are kept under review but in which special procedures to control exposure to radiation are not normally necessary". As the project progresses to production, on-going monitoring will be conducted and any actions and mitigation measures required will be determined by the NORM guidelines.

12.1.7 Socio-Economic Assessment

The proposed mining operation is being developed in an area that is poor and faced with limited economic opportunities at present. Living a predominantly subsistence agricultural lifestyle, most villagers are self-employed farm workers, supporting large and extended families. The largest industry in the area is Plexus, a cotton producer which supports many farmers in the area with cotton production. In addition to large-scale maize productions, some farmers do receive agricultural support either from companies such as Plexus, but also the government through seed provision and support.

i. Land is under the traditional jurisdiction of the Macua Tribe, and the area and its people are male-dominated and very patriarchal. In consequence, any development in the area has the potential to reinforce this system, which disempowers and marginalises vulnerable groups such as women, the elders and the youth. Coupled with the extended civil war, it is fair to argue that these villagers are vulnerable to development, especially since they are so heavily dependent on their land and agricultural harvests.

ii. The SIA identified several impacts which need to be mitigated. Most of these issues revolve around a central theme of ***land and food security***. The mining operation will affect a large area which is currently extensively utilised by almost all the households for agricultural production. Nearly all the households have large farms or *machambas*, many of which will either be affected or lost during the mine development.

iii. The extent of economic displacement is significant (more than 200 *machambas* will be lost), for which purposes the most important mitigation measure is the development and implementation of a resettlement action plan (RAP) and the development of associated procedures to guide compensation (which has already been drafted).

iv. The most significant issue that needs to be addressed through this RAP is future food security, especially since the mine is not permanent. Affected villagers should be empowered and provided with the capacity to continue with their preferred livelihoods after a mine has closed, which should not leave them being worse off. Large areas to be mined are also used by most villagers for natural resource harvesting, whilst small areas used for cultural and religion practices will also be lost or affected by the development.

v. The SIA concludes that the development is needed in the area, especially since the villagers suffer from food insecurity and severe poverty. It is difficult to believe that the villagers' socio-economic status would improve or sustain itself without an external economic intervention. Preserving the environment for cultural reasons will not alleviate any resident from his or her poverty and food insecurity, whilst employment will. Local employment opportunities will be created, and the impact of even providing one household member with employment cannot be overemphasized. The income dependency is very high, which means that even one regular income stream in one household might sustain a series of households in these villages. The development could create an economic opportunity which can, in the long-term, boost and empower the villagers with education, skills, training and agricultural productions.

vi. The RAP report will be referred to and implemented which details the entitlement frameworks for the possible disturbance of graves/cemeteries, such as exhumation and reburial procedures);

vii. The established Grievance Mechanism will be used for members to lodge any complains with regard to the disturbance of graves/cemeteries to mine management. Corrective action will be taken, as described in the mechanism (refer to Chapter 7 of the RAP); and

viii. A Cultural Heritage Management Plan will be drafted and implemented (as explained).

12.1.8 Land, Natural Resource Use and Agriculture Assessment

The Land, Natural Resource Use and Agriculture Assessment concluded that the impacts of all the aspects of the proposed Balama Graphite Mine were considered and deemed to be acceptable, provided that the mitigation measures presented below are implemented:

i. All topsoil should be stockpiled and replaced as a final graded layer over the subsoil.

ii. An Environmental Control Officer (ECO) should monitor all excavations to ensure backfilling with subsoil first and then topsoil afterwards takes place.

iii. In accordance with the IFC PS 5, a RAP needs to include a detailed agricultural valuation of all the affected farmlands and owners' possessions in order to develop appropriate compensation strategies and entitlement matrixes; and

iv. Livelihood restoration strategies need to be considered, aimed at assisting households with re-establishing and improving their livelihoods. As the villagers are primarily involved in subsistence agriculture, it makes sense to provide agricultural support and/or training as a livelihood restoration strategy. Options include supporting the cotton and maize production capacity of the area by investing in market access, seed provision and agricultural training programmes. A key focus of such programmes needs to be the empowerment of vulnerable children and youth, as well as women (especially female-headed households).

v. The new haul road contouring should assist in dispersing water run-off instead of concentrating it and increasing the risk of erosion.

vi. Disturbed areas should be rehabilitated as soon as construction has been completed. Rehabilitation should be undertaken progressively.

vii. The amount of runoff crossing exposed areas must be controlled by using berms or temporary or permanent drainage ditches to divert water flow around the cleared areas.

viii. The access road should be designed no wider than necessary to accommodate the immediate anticipated use.

ix. Rivers should be kept in a natural state as far as possible.

x. Minimise the alteration to topography.

xi. Minimise the area of impervious surfaces.

xii. Grade impervious surfaces to drain into vegetated areas.

xiii. Ensure fine materials being transported are covered with tarps or equivalent material.

xiv. A Hydrocarbon Management Operating Procedure should be designed and implemented. Copies of this document should be made available at designated facilities where hydrocarbons are used or stored. The purpose of this procedure is to provide for the proper storage and handling of hydrocarbons, including waste hydrocarbons, on site and hence prevent any form of contamination.

xv. It is recommended that soil contaminated with hydrocarbon should be immediately removed and disposed of at a soil bioremediation facility on site.

xvi. All staff must be trained on the correct management of bunded facilities, including the discharge of collected liquids.

xvii. Spill kits must be readily available at strategic points throughout the site and staff must be trained on the correct use of these kits.

xviii. Spillage and seepage of contaminants should be prevented at all times through the implementation of good housekeeping and management procedures.

xix. A monitoring program must be defined in the EMP.

xx. In the case of accidents immediate remedial measures should be implemented.

xxi. Storage facilities should be adequately bunded and inspected on a regular basis.

xxii. The tailings storage facility must be designed and operated to prevent infiltration of toxic leach into groundwater through the provision of appropriate liners and sub-drainage systems to collect or recycle water.

xxiii. Leak detection equipment should be installed with an appropriate Leak Response Plan.

xxiv. A conservation agriculture approach is recommended. This can be achieved through basic training to ensure the affected communities become self-sufficient in generating high protein foods as well as cash liquidity. The traditional slash and burn practices that depletes soil nutrition can be cancelled while less land could be used more efficiently. Agriculture could then, with correct rotations and cropping programmes ensure more stable employment conditions for the local farmers.

xxv. The following crops are recommended (All these crops can be grown through multi-cropping with more traditional crops like cassava and maize):

- Peanuts - high protein and a legume crop.
- Beans & peas (Sugar beans, Pigeon Pea and Cow Peas) - high protein and a legume crop.
- Sesame - cash crop that is drought resistant and grows well in most soil types.

12.1.9 Health Assessment

Table 12.1 below summarises the key findings and recommendations provided in the Health Assessment. These have been incorporated in the ESMP and are endorsed by Syrah Resources.

Table 12.1: Key findings and recommendations

KEY FINDINGS	RISK FACTORS	RECOMMENDATIONS
EHA 1 – Communicable diseases linked to housing design and overcrowding		
• Most households are large, with several polygamous families. There is enough housing and adequate access in five out of the six villages – overcrowding was reported in only one of the villages. • Tuberculosis is widespread in Mozambique. There is poor case detection in the district. • Acute respiratory infections are a major cause of morbidity especially in children under five years of age. • Poverty, poor environmental health conditions and poor nutrition play a role in community susceptibility to infectious diseases.	• The overall development may trigger in-migration to the project area and the risk of overcrowding and housing inflation exists, which may in turn increase the risk of transmission of communicable diseases. • Increased traffic load may lead to exposure from dust and air pollution which has the potential to negatively impact acute and chronic respiratory tract diseases. • This is likely to be minimal in the operational phases if appropriate exclusion zones are maintained and dust management principles followed.	• Support TB knowledge campaigns related to awareness and health seeking behaviour. • Influx management and advice with regards to town planning to prevent overcrowding. • Health service planning and strengthening to ensure adequate health service capacity for TB diagnosis and management in the project area. These should always be performed in partnership with the local authorities and focussed on prevention and early recognition.
EHA 2 – Vector-related diseases		
• Malaria is a major public health challenge in the project area and is regarded as the biggest concern related to burden of disease. It accounts for a significant portion of consultations at the local level. • Community knowledge on transmission and prevention of malaria is good. • Ownership of insecticide-treated nets is good, although it is difficult to assess proper utilisation. • There are a number of interventions in the area to reduce the burden of disease from malaria but monitoring and evaluation activities are limited.	• The project may influence malaria through changes to the environment and demographics in the area linked to influx. • There is stakeholder concern that vector breeding and thus densities will increase with the project and may create focal high risk areas for malaria transmission. • The health of the workforce also needs to be considered, especially as some of them might be from the local community.	• Support malaria awareness campaigns in the communities. This can be done in collaboration with the local health authorities. • Health systems strengthening with regards to malaria reporting to obtain accurate longitudinal data on malaria incidence.
EHA 3 – Sexually transmitted infections, including HIV/AIDS		

KEY FINDINGS	RISK FACTORS	RECOMMENDATIONS

• HIV/AIDS remains an increasing public health challenge in the area. HIV prevalence is about 6-8% in the general population.
• Although commercial sex work is not common in the area, there is a potential for this to increase.
• Knowledge and awareness related to HIV appeared good. However, this does not translate into behaviour change and high risk practices are reported. Stigma was still high within the communities.
• Comprehensive knowledge of HIV prevention and transmission is low due to the belief of some misconceptions within the community.
• There are frequent HIV campaigns in the area. However, the limited functionality of the community health worker units may affect the delivery of services.
	• The project development has potential to further raise the risk of HIV/AIDS and STI transmission in the local population as a result of a number of factors. These are often as an indirect effect of the project, but may also be associated with more direct influences such as:
	  • Money: Increased disposal income;
	  • Men who may be away from the family unit with income;
	  • Mobility: access to rural communities. Transport workers are a high risk group; and
	  • Mixing: in-migration and as a result of improved access. Different viral strains can also be transmitted.
		• Support information & education campaigns as well as peer educator programs in both the workforce and in the community.
		• Develop a HIV/AIDS strategy at workplace and community level.
		• Support health systems strengthening in the area to enhance the work performed by the local health authorities and their partners. This can have a specific focus on the community health worker units.
		• Support projects that can serve as indicators for HIV and other STI prevalence.
		• The VCT and antenatal clinics that function in the area should be supported and used as a source of data to monitor HIV prevalence.

EHA 4 – Soil-, water- and waste-related diseases		
• Generally poor access to drinking water sources. Water is generally available during wet and dry seasons.Improved water sources, such as water pumps are common in some communities while others rely on non-improved water sources. • Very few improved sanitation facilities within the communities. • The vast majority of households throughout the villages do not have access to their own improved sanitation facility. Diarrhoeal diseases are common. Intestinal parasites and urogenital schistosomiasis are also common.	• There is a heavy reliance on non-protected sources of water in the area. Moreover, water microbial quality has not yet been assessed. • The presence of the Chipembe Dam in the project area will potentially influence the risk of water borne diseases, particularly schistosomiasis.	• Support the provision of safe and clean water in the communities. • Establishm institutional arrangements and mechanisms to ensure the sustainability of community-managed rural water supplies. • Assess the quality of available drinking water at source and end user to ensure that the project does not have any detrimental effects on community water sources. • Support information and education campaigns that promote community water use, hygiene and general sanitation. • Immediate prioritization of sanitation through the adoption at scale of total sanitation and sanitation marketing approaches for rural areas, and the strengthening of private and public sector capacities to participate successfully in

KEY FINDINGS	RISK FACTORS	RECOMMENDATIONS
		these approaches.
EHA 5 – Food- and nutrition-related issues		
• Malnutrition and micronutrient deficiencies are challenges in the project area. These are generally linked to food shortages and poor feeding practices. • However, active surveillance of nutritional indicators is limited, due to the fact that some of the health facilities do not have height and weight scales. • Anaemia is a major concern in the area although the true burden is not known. It is mainly linked to malnutrition, intestinal parasites and malaria.	• The poor socio-economic status of some families living in the wider project area is a significant risk factor for malnutrition. • Food security in Mozambique is currently a national challenge. Moreover, most women are poorly educated on proper feeding practices. • Food inflation will also need to be considered, itself consequent upon in-migration and changes to supply and demand.	• Support nutritional and anaemia programs in the area to enable the collection of indicators that can be used to monitor the nutritional situation in the area. • Equip local health facilities with height and weight scales and provide training for the implementation of a basic nutritional program, which targets children under the age of five years. This will not only serve as a community intervention per se but will support accurate longitudinal data surveillance on the nutritional status of children. This can be performed in association with existing local programs. • Support agricultural programs that teach the community members proper farming practices. This will help increase their food yields.
EHA 6 – Accidents and injuries		
• Road traffic accidents (RTA) are the most common form of non-accidental injury in the area. • Gender-based violence and crime related injuries such as assault are less common.	• The Project may lead to increased traffic loads in the local area and has the potential to increase the number of traffic accidents. This is particularly relevant for small children and domestic animals. • Alcohol plays a significant role in most forms of accidents and social influences may increase local alcohol abuse.	• Develop a clear policy for the management of emergencies or accidents in the community as a direct result of the project. These should consider awareness and education programs, and schools can be a good target. • Mitigation measures should be developed as part of a traffic and vehicle management plan.
EHA 7 – Exposure to potentially hazardous materials, noise and malodours		
• Communities residing in the Project area live in close contact to their environment and are thus vulnerable to any changes in water and air quality, as well as to noise pollution. • There have been no cases of heavy metal pollution or toxicity in the project areas.	• The project has the potential to create environmental health concerns if such areas are not well managed. Concerns relate mainly to noise, water and air quality. • There is a general lack of knowledge and understanding related to mining. This may pose a risk related to perceptions once the project moves into operations as factors and rumours that have no human	• As per air and noise quality specialist reports. • Develop clear and proactive communication strategies for potential environmental health risks that can possibly impact on human health.

KEY FINDINGS	RISK FACTORS	RECOMMENDATIONS
	health risks may flourish and create reputational risks. The company may then spend an extraordinary amount of time allaying these fears and misconceptions.	
EHA 8 – Social determinants of health		
• Very good health-seeking behaviour in the project area. • Very few people consult traditional healers. However, most communities do not have easy access to a health facility. • Affordability is an issue as not all health services are free. Transportation to health care facilities is a major determinant in evaluating affordability. • Education is an existing need.	• Various social-determinants may be impacted by its development. • Although few people admitted to seeking treatment from a traditional healer, the importance of traditional medicine must not be discounted. • The resettlement process may also influence general well-being and sense of place. • Migration may influence social determinants especially in centres where unplanned growth may occur without the provision of commensurate services.	• Understand the drivers for health seeking behaviour so that these can be used to support specific health interventions which require mitigation. For example HIV education programs will not be effective if the way the community forms opinions or behaves towards the disease is not understood. In addition, develop good programs to support good health seeking behaviour. • Programs and interventions should support vulnerable groups as required, both in terms of impact mitigation and community development. Most other elements will be addressed in the social management plan. • Information and education programs on substance abuse to prevent the problem manifesting at local level.
EHA 10 – Health systems issues		

<table>
<tr><th>KEY FINDINGS</th><th>RISK FACTORS</th><th>RECOMMENDATIONS</th></tr>
<tr><td>• The capacity and quality of health care services is limited in the project area. There are only two health facilities in the immediate project area. Not all communities have immediate access to a health facility, with accessibility and affordability the main issues.
• The Mozambican health system has a good structure and the ability to partner for health systems strengthening appears receptive.
• There is a functioning health information management system in place in the district but it has a few limitations:
  • Data is recorded manually from local health facilities with the risk that there is an error in capturing;
  • The information is maintained on a spreadsheet but no proactive trends are drawn; and
  • Limited diagnostics and human resource skills at the health centre level reduced the fidelity of data around the PACs.</td><td>• The project has the potential to increase the burden on the already limited health care infrastructure in the area. This is especially a risk in the rural communities where influx to an area may mean that the available services are rapidly outstripped by an increased population.
• The health information management system has considerable gaps especially at the local health facility level which limits the longitudinal monitoring of health data and these impacts.</td><td>• Develop a plan to support the health infrastructure in the project area. This strategic investment should consider the existing health needs of the community.
• Initiate health service planning with local authorities so that health services can manage any influx into area.
• Improve and support health information management systems to generate longitudinal data sources and thus support the monitoring of management/mitigation plans.</td></tr>
<tr><td colspan="3">EHA 11 – Non-communicable diseases</td></tr>
<tr><td>• Non-communicable diseases are not well documented in the area due to limited capacity in the local health facilities.</td><td>• With improved economic status and organised settlement a degree of urbanism may result with associated changes in lifestyles and related diseases such as obesity, diabetes, hypertension and dental caries.
• The health care facilities in the rural areas do not have a focus on the management of these diseases, nor do they have the diagnostic capabilities to appropriately recognise and manage these conditions.</td><td>• Support health education programs as part of a community health program. These should focus on lifestyle risk factors like diet, exercise, smoking and alcohol consumption.
• Develop wellness programs in the workforce, with the aim that these are extended to the family unit.
• Consider health systems strengthening to support improvement of local diagnostics for non-communicable diseases.</td></tr>
</table>

12.1.10 Air Quality Assessment

The conclusions reached with regards to the various pollutants modelled are reported below:

Dust Deposition:

i. The predicted dust deposition rate was below the recommended NEMAQA-NDCR, 2013 standard. The highest deposition rates predicted of 272 mg/m^2/day are confined to within the mine boundary. The predicted dust deposition rates at the different sensitive receptor sites in the vicinity of the proposed Balama Graphite Mine are below the standard for residential areas (600 mg/m^2/day) without mitigation.

Particulate Matter:

i. ***The highest predicted particulate matter PM$_{10}$ daily concentrations*** value of ~71 µg/m^3 occurred within the mine concession area (north of the waste rock dump). Although this value exceeds the WHO 24-hour guideline of 50 µg/m^3, bust is not in violation of the WHO Interim target-3 value of 75 µg/m^3 for developing countries. It occurred within the mine project area. Residential settlements will be exposed to concentration of ~10 µg/m^3, below acceptabed thresholds. .
ii. ***The predicted particulate matter PM$_{10}$ annual concentrations*** indicated that the highest value of ~11 µg/m^3 also occurs within the mine concession area. This value is not in violation of WHO 24-annual guideline of 20 µg/m^3 and is well within the WHO Interim target-3 value 30 µg/m^3 for developing countries. Residential settlements are exposed to concentrations below ~1 µg/m^3.
iii. ***For PM$_{2.5}$, the predicted daily highest concentrations*** was 15 µg/m^3, and occurred within the mine concession area (north of the waste rock dump). This value is within WHO 24-hour guideline of 25 µg/m^3, and is also not in violation of the WHO Interim target-3 value 37.5 µg/m3 for developing countries. Residential settlements will be exposed to concentrations around ~5 µg/m^3. s.
iv. ***Annual PM$_{2.5}$ predicted concentrations*** reached a maximum of 2.3 µg/m^3. This value is not in violation of WHO 24-annual guideline of 10 µg/m^3 and is well within the WHO Interim target-3 value 15 µg/m^3 for developing countries. Sensitive receptors in the vicinity of the proposed operation are exposed to concentrations below ~0.5 µg/m^3.

Gaseous Emissions:

i. The isopleth plot of the ***highest hourly value for predicted NO$_2$*** ground level concentrations reached 588 µg/m^3. This maximum value is confined to the project area, with levels at the surrounding villages all within the recommended WHO guideline of 200 µg/m^3. Thus, there is no violation of the recommended guideline in the area. However, it is recommended that ambient monitoring be conducted to establish actual measurements to which future perturbation can be compared.
ii. The predicted ***CO ground level concentrations***, both hourly and 8-hourly, were all within the SANS 1929:2012 limit. Values were several orders of magnitude lower than the limit values. Thus, CO concentrations predicted for the area are not in violation of the recommended standards.

The AERMOD pollutant concentrations generated in the Air Quality Assessment are without mitigation. If mitigation measures are implemented once mining commences, there will be marked reduction in the values reported on above, and the impacts are thus considered to be mainly of low significance for the duration of the project.

Based on these results , the recommendations to be taken into consideration are as follows:

i. ***Dust generation -*** Wind erosion from exposed areas has the potential to generate dust. Dust deposition results from September sampling window (34 days) recorded dust deposition rates at two sites (Nquide and Piriri) of 1,061 mg/m^2/day and 850 mg/m^2/day, respectively. Interestingly, both locations are downwind. These values are in violation of the residential threshold as stipulated by SANS (1929:2005). Although the sampling was not compliant with the 30±2 day window, the elevated level of dust observed during the dry season might not be far from the ambient dust deposition rates currently in the area. Background levels reaching values above residential thresholdsis an indication that specific management practices, operational controls and mitigation measures should be implemented when the mine starts operating.
ii. The current dust deposition measurement should be continued and aligned to the SANS (SANS 1137:2012) sampling window. This will provide long term continuous monitoring historical data to which future levels can be compared.
iii. Dust impacts during the operational phase can be controlled by adopting practical mitigation measures. The use of water to reduce dust generated from areas such as stockpiles, haul roads and exposed soil is recommended. Crushers, screens and conveyor belt must be housed, and if required the use of chemical dust suppressants, wind breaks and rapid re-vegetation of exposed areas.
iv. Good housekeeping practices to minimise the accumulation of loose dust piles.
v. It is recommended that ambient air quality monitoring for criteria pollutants, such as NO_2, SO_2, CO, CO_2, TSP, PM_{10}, and $PM_{2.5}$ be conducted in the proposed project area prior to the commencement of operations.
vi. Establish an on-site meteorological station that measures hourly values for wind speed and direction, ambient temperature, relative humidity, barometric pressure, solar radiation and precipitation.

12.1.11 Noise Assessment

i. In terms of the baseline conditions, existing ambient day and night time noise levels in the surrounding villages are mostly below the IFC EHS noise rating limit for residential districts.
ii. The findings have indicated by means of dispersion modeling that the noise levels from the proposed construction phase, especially the haul road development, will measure above the existing ambient noise levels at the village of Piriri. During the operational phase the proposed mining activities are expected to measure between 10dBA and 20dBA above the current ambient levels at Nquide and Maputo during the day and night time, but only during the night time at Piriri.
iii. The overall pre-mitigation significance of the noise impact from the proposed Balama Graphite Mine is moderate to high during the construction and operational phase and drops to a low significance during the decommissioning phase.
iv. The noise contributions can be reduced through the implementation of the recommended mitigation measures, especially the construction of the earth berms around the pits, which will help with the noise attenuating towards the villages. Depending on the general construct of the earth berms, an effective noise contribution decrease of between 5dBA and 10dBA can be achieved. The post-mitigation significance of the noise impact is considered to be moderate to low.

12.1.12 Waste Assessment

A total of 15 impacts were identified and of these, with mitigation, 11 were considered to be of LOW negative significance and three of MODERATE negative significance.One impact was considered beneficial and of moderate significance with mitigation. However, due to the potential long-term nature of waste-related impacts, it is essential that the developer adhere to national legislative requirements and international best practice with regards the management of all waste streams.

It is recommended that:

i. All waste streams should be managed according to the waste management hierarchy and according to Decree 13/2006, of 15 July: Regulation of Waste Management. This specifies that wherever possible, production of wastes should be prevented or minimised at source.
ii. Where prevention or further minimization is not possible, wastes should be re-used, recycled and then disposed of responsibly so as to minimise impacts to the environment. Further guidance on the management of waste streams is provided in the IFC General EHS Guidelines (2007) and the IFC EHS Guidelines for Mining (2007).
iii. In the event that there are no national standards available, the proponent must comply with internationally recognised standards developed by international organisations such as the IFC. In the case where there are several standards available for use, the proponent must provide justification for the choice of use, other than the use of the most stringent.
iv. Due to the remote location of the project site and relevant legislation, it is recommended that the proponent establish a non-hazardous waste disposal facility on the site.
v. Practical options will need to be considered for the management and disposal of hazardous wastes. These would be to either develop a dedicated and specially-designed hazardous waste cell within the new on-site landfill or, alternatively, to construct a bunded and secure facility for temporary storage of hazardous waste on site until such time as it can be transported off-site for safe disposal.

12.1.13 Traffic and Transport Assessment

i. The most significant contribution to traffic during the operational phase will be from the transport of graphite concentrate from the mine site to the Port of Pemba. Assuming the base case of 2,000,000 metric tons of RoM ore being processed annually, it will take 45 trucks per day to deliver the product to the port in payloads of 20 and 26.7 metric tons. Delivery will take place 360 days per year.
ii. From the mine site to Pemba or Nacala, trucks will need to pass through a number of settlements, some of which have markets along the roadside. Pedestrians and shoppers frequently cross the road, or the sheer number of people present spill into the road. Additional hazards are caused by taxis, vehicles and bicycles pulling off and pulling onto the road. Drivers of trucks will need to be vigilant in these areas and will need to exercise caution.
iii. There are also bridges along the route which need to be structurally assessed by a competent professional prior to having trucks pass over them. This may not be required for the bridges on the paved and good quality road from Montepuez to Pemba, but for the road from Balama to Montepuez this will be necessary. The second bridge along this route is in very poor condition, with the underside beginning to fall away.
iv. The passing of traffic along the unpaved road will generate large amounts of dust if the road is left untreated. The dust will affect local residents who have their houses and stalls built immediately on the road side. Their houses and merchandise will be coated with dust. Measures have been suggested to reduce dust emissions.
v. Operational phase traffic will also be due to transport of skilled employees to and from the site and the airport in Pemba, buses transporting locally sourced labour from surrounding villages to the mine site, and the delivery of supplies and consumables to the mine site.

vi. In the absence of a detailed Bill of Quantities for the construction phase, it has not been possible to calculate traffic quantities during this phase, however many of the expected impacts have been identified and discussed. Many of the plant components will be manufactured outside of Mozambique, and be delivered to the ports of either Nacala or Pemba. Some of these will be abnormally sized, and will need special transport arrangements that will need to be made in consultation with local traffic authorities.
vii. To reduce transport and logistics costs, the EPCM contractor is likely to attempt to source as much construction material locally as possible. The area is very rural and all traffic, regardless of its source, will concentrate on the EN242 from Montepuez to site. Construction will take approximately a year to complete. Delivery of the bulk of construction materials is likely to take place within the first few months, with deliveries tapering off as construction activities are completed.
viii. The most pressing issue, from a traffic and transport perspective, is the storage and distribution arrangement within Pemba town. The layout of the town is such that traffic to the port has relatively few options available to it, and is restricted to roads which lead through a busy town centre. Calculations have shown that if a constant daily delivery schedule to the Port is followed, a truck will be passing through the busy town centre every 8 minutes. As suggested in the Snowden Draft Scoping Report it might be worth considering the purchase or rental of warehousing on the edge of Pemba, and the transport of graphite to the Port as the need arises. This will avoid high port fees but will take an even and constant traffic flow and concentrate it on days immediately prior to export. More thought and planning is required in this respect. These concerns become irrelevant if Nacala is selected as the preferred port option, which is currently the case.
ix. Impacts that have been identified and assessed relate to: safety of other road users, the generation of dust, and the transport of abnormal loads. Mitigation measures have been suggested which will significantly relieve the seriousness of these impacts. Many of the impacts identified will no longer be applicable if the upgrade of the EN242 is completed prior to the initiation of construction. Unfortunately, construction activity appears to be minimal, with partial upgrades completed and little evidence that work is on-going.

12.1.14 Mine Closure Report

The Mine Closure Report forms part of Part V (Specialist Volume). In addition to this, a summary of this report is available in Chapter 12 above.

It is recommended that the following actions are taken prior to the update of the annual Closure and Rehabilitation Plan:

i. As the knowledge base develops, a more detailed closure risk assessment should be built up (in the annual reviews) with input from representatives of the design team, operational personnel and environmental specialists. This will enable the development of solutions to key issues that are both acceptable to the technical specialists concerned while at the same time being practically implementable.
ii. Continue with detailed modeling of the impacts from various TSF cover configurations on the rate of generation of pollution plumes, together with modeling of the long-term impacts of those plumes on downstream water users and modeling a feasible way to place the saprolite and topsoil covers on the TSF, post-closure.
iii. Implement the measures as outlined in the specialist studies to minimise the risk to surface water contamination from the operations during rehabilitation and closure.
iv. Research trial work during the operational phase to determine other rehabilitation options that could be considered for the closure and rehabilitation of the TSF.
v. Additional research (by field testing) to identify the average depth of topsoil available,

and the potential for use of topsoil covers of less than 300mm for sustainable rehabilitation. Although conventional wisdom is that 300mm is the minimum, it is possible that insufficient topsoil will be available on site. Investigations to determine if a lesser quantum may be satisfactory for the plant species naturally occurring under the Mozambican environment is therefore required. Options of mulching and composting could also be explored.

vi. Refine the cost model by verifying the various cost rates for the Mozambican environment.

vii. When the closure and rehabilitation plan is updated ensure that community related issues are fully covered in the plan.

viii. Ensure that the Environmental Management Plan is aligned to the Closure and Rehabilitation Plan

12.2 Residual Impacts

Table 12.2: Residual impacts as a result of the construction phase

			Without Mitigation		With Mitigation	
Impact	**Temporal scale**	**Spatial scale**	**Severity**	**Significance**	**Severity**	**Significance**
BIOPHYSICAL IMPACTS						
Impacts on topography and geology	Long Term	Localised	Slight	**LOW -**	N/A	**N/A**
Removal of topsoil and soil erosion	Short Term	Study Area	Severe	**MODERATE -**	Moderate	**LOW -**
Soil contamination	Short Term	Study Area	Severe	**MODERATE -**	Slight	**LOW -**
Disturbance to existing soil profile will result in a decrease in agricultural capability	Permanent	Study Area	Severe	**HIGH -**	Slight	**MODERATE -**
Loss of agricultural land due to establishment of mining infrastructure	Permanent	Study Area	Very Severe	**VERY HIGH -**	Moderate	**MODERATE -**
Loss of subsistence crops due to establishment of mining infrastructure	Permanent	Study Area	Very Severe	**VERY HIGH -**	Moderate	**LOW -**
Sedimentation and elevated turbidity levels	Medium Term	Study Area	Severe	**HIGH -**	Moderate	**MODERATE -**
Contamination of non-ore pollutants	Medium Term	Study Area	Severe	**MODERATE -**	Moderate	**LOW -**
Aquatic habitat modification	Permanent	Study Area	Severe	**HIGH -**	Moderate	**MODERATE -**
Loss of aquatic species of special concern	Long Term	Study Area	Severe	**HIGH -**	Moderate	**MODERATE -**
In-stream structures blocking migrations (bridges, causeways)	Long Term	Study Area/ Regional	Severe	**HIGH -**	Low	**LOW -**
Over-utilization of fish resources	Long Term	Study Area/ Regional	Severe	**MODERATE -**	Low	**LOW -**
Loss of riparian woodland	Permanent	Study Area	Moderate	**MODERATE -**	Slight	**MODERATE -**
Loss of Miombo woodland: graphite	Permanent	Study Area	Severe	**HIGH -**	Severe	**HIGH -**
Loss of Miombo woodland: granite	Short Term	Study Area	Moderate	**MODERATE -**	Moderate	**LOW -**
Loss of intact Miombo woodland: plains	Permanent	Study Area	Severe	**MODERATE -**	Slight	**LOW -**
Loss of degraded Miombo woodland: plains	Permanent	Study Area	Moderate	**MODERATE -**	Moderate	**MODERATE -**

			Without Mitigation		With Mitigation	
Impact	**Temporal scale**	**Spatial scale**	**Severity**	**Significance**	**Severity**	**Significance**
Loss of biodiversity (general)	Permanent	Study Area	Severe	**HIGH -**	Moderate	**MODERATE -**
Loss of floral species of special concern	Long Term	Study Area	Moderate	**MODERATE -**	Moderate	**MODERATE -**
Fragmentation of vegetation and edge effects	Permanent	Study Area	Severe	**HIGH -**	Moderate	**MODERATE -**
Disruption of ecological systems and functions	Short Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Loss of amphibian diversity	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Loss of reptile diversity	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Loss of bird diversity	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Loss of mammal diversity	Medium Term	Study Area	Severe	**MODERATE -**	Moderate	**MODERATE -**
Loss of faunal species of conservation concern	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Faunal impact of habitat fragmentation and loss	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Ecological impacts from dust	Short Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Disruption to fauna from increased noise levels	Short Term	Study Area	Moderate	**MODERATE -**	Slight	**MODERATE -**
Chemical pollution	Short Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
SOCIO-ECONOMIC IMPACTS						
Reduced access to productive land and economic displacement	Long Term	Study Area	Very Severe	**VERY HIGH -**	Severe	**MODERATE**
Increased Food Insecurity	Permanent	Regional	Very Severe	**HIGH -**	Moderate Beneficial	**LOW +**
Reduced access to Natural Resources	Short Term	Study Area	Severe	**HIGH -**	Moderate	**MODERATE -**
Loss Sacred and culturally significant sites	Permanent	Study Area	Severe	**HIGH -**	Slight	**LOW -**
Loss of graveyards/sites	Permanent	Study Area	Very Severe	**VERY HIGH -**	Moderate	**LOW -**
Community safety risk	Short Term	Study Area	Severe	**MODERATE -**	N/A	**N/A**
Employment, Skills training and Scholarshops	Short term	Study area	Moderate Beneficial	**MODERATE +**	Very Beneficial	**HIGH +**
In-migration in search of job opportunities	Short term	Study area	Very Severe	**HIGH -**	Slight	**LOW-**
Stakeholder and community engagement	Short Term	Localised	Severe	**MODERATE -**	Beneficial	**MODERATE +**
Road traffic accidents and other accidental injuries	Long Term	Localised	Severe	**MODERATE -**	Moderate Beneficial	**MODERATE +**
Air pollution, noise and mal-odours	Long Term	Localised	Moderate	**MODERATE -**	Moderate Beneficial	**LOW +**
Chemicals, pesticides and heavy metals	Long Term	Localised	Severe	**MODERATE -**	Slight	**LOW -**
Gender-based violence, alcohol and drugs	Long Term	Localised	Very Severe	**HIGH -**	Very Beneficial	**MODERATE +**
Social cohesion and well being	Long Term	Localised	Very Severe	**HIGH -**	Very Beneficial	**MODERATE +**
Health system strengthening	Long Term	Study Area	Severe	**HIGH -**	Very Beneficial	**HIGH +**
Non-communicable diseases	Long Term	Study Area	Moderate Severe	**MODERATE -**	Moderate Beneficial	**MODERATE +**

			Without Mitigation		With Mitigation	
Impact	**Temporal scale**	**Spatial scale**	**Severity**	**Significance**	**Severity**	**Significance**
Permanent loss of fruit trees, wood sources and other natural resources	Long Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Increasing demand for natural resources	Long Term	Study Area	Severe	**HIGH -**	Moderate	**MODERATE -**
IMAPCTS ASSOCIATED WITH WASTE INFRASTRUCTURE AND PROCESS RELATED ISSUES						
Pollution of land and water (general waste)	Long Term	Study area	Moderate Severe	**MODERATE -**	Slight	**LOW -**
Pollution of land and water (hazardous waste)	Permanent	District	Very Severe	**VERY HIGH -**	Moderate	**MODERATE -**
Nuisance impact (production of odours, visual impact and attraction of pests and vermin) from solid waste	Long Term	District	Moderate Severe	**MODERATE -**	Slight	**LOW -**
Pollution of soil and water from domestic wastewater and sewage sludge	Long Term	Study Area	Moderate Severe	**MODERATE -**	Slight	**LOW -**
Health impacts to employees and communities	Long Term	District	Severe	**MODERATE -**	Slight	**LOW -**
Nuisance impact (odour and flies) from domestic wastewater and sewage sludge	Short Term	Study Area	Moderate Severe	**MODERATE -**	Slight	**LOW -**
Pollution of land and water from disposal of run-off / storm water	Long Term	Study Area	Moderate Severe	**MODERATE -**	Slight	**LOW -**
Increase in traffic frequency through villages	Short Term	Regional	Severe	**MODERATE -**	Severe	**MODERATE -**
Transport of abnormal loads	Short Term	Regional	Slight	**LOW -**	Slight	**LOW -**
Dust generated from traffic	Short Term	Regional	Severe	**MODERATE -**	Slight	**LOW -**
Impact of traffic noise on surrounding noise sensitive receptors in terms of annoyance during the construction phase	Short Term	Study Area	Severe	**MODERATE -**	Moderate	**LOW -**
Impact on air quality as a result of site clearing (removal of topsoil and vegetation and stockpiling of overburden topsoil)	Short Term	Local	Slight	**MODERATE -**	Slight	**LOW -**
Impact on air quality as a result of the construction of any surface infrastructure	Short Term	Local	Moderate	**MODERATE -**	Slight	**LOW -**
Impact on air quality as a result of the transportation of materials and workers on site	Short Term	Local	Slight	**MODERATE -**	Slight	**LOW -**
Impact on air quality as a result of temporary storage of hazardous products	Short Term	Local	Slight	**MODERATE -**	Slight	**LOW -**

Table 12.3: Residual impacts as a result of the operational phase

			Without Mitigation		With Mitigation	
Impact	**Temporal scale**	**Spatial scale**	**Severity**	**Significance**	**Severity**	**Significance**
BIOPHYSICAL IMPACTS						
Impacts on topography and geology	Permanent	Localised	Moderate	**MODERATE -**	N/A	**N/A**
Soil contamination	Long Term	Regional	Moderate to Severe	**HIGH -**	Slight	**LOW -**
Possible contamination of groundwater through leaching of toxic materials from tailings storage facility	Permanent	Regional	Very Severe	**VERY HIGH -**	Moderate	**LOW -**
Sedimentation and elevated turbidity in rivers	Permanent	Regional	Very Severe	**HIGH -**	Moderate	**MODERATE -**
Contamination from non-ore pollutants	Permanent	Regional	Very Severe	**MODERATE -**	Moderate	**LOW -**
Ore contamination	Permanent	Regional	Very Severe	**MODERATE -**	Moderate	**LOW -**
Alteration of river flow-dynamics	Permanent	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Mine dewatering	Long Term	Localised	Severe	**MODERATE -**	Moderate	**LOW -**
Mine water contamination	Long Term	Localised	Severe	**MODERATE -**	Moderate	**LOW -**
Hydrocarbon spillage	Long Term	Localised	Moderate	**MODERATE -**	Slight	**LOW -**
Aquatic habitat modification	Permanent	Study Area	Severe	**HIGH -**	Moderate	**MODERATE -**
Loss of aquatic species of special concern	Long Term	Study Area	Severe	**HIGH -**	Moderate	**MODERATE -**
In-stream structures blocking migrations	Long Term	Study Area/ Regional	Severe	**HIGH -**	Slight	**LOW -**
Over-utilization of fish resources	Long Term	Study Area/ Regional	Severe	**HIGH -**	Slight	**LOW -**
Invasion of floral alien species	Permanent	Regional	Severe	**HIGH -**	Moderate	**LOW -**
Loss of ecosystem services provided by the plant communities identified in the project area	Permanent	Study Area	Severe	**HIGH -**	Moderate	**MODERATE -**
Disruption of ecological systems and functions	Long Term	Study Area	Severe	**HIGH -**	Slight	LOW -
Loss of faunal biodiversity	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Loss of faunal species of conservation concern	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**MODERATE -**
Introduction of alien fauna	Medium Term	Study Area	Slight	**LOW -**	Slight	**LOW -**
Faunal impact of habitat fragmentation and loss	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Impact of increased dust levels on fauna	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**MODERATE -**
Impact of noise pollution on fauna	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**MODERATE -**
Impact of chemical pollution on fauna	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Threats to animal movements	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**MODERATE -**
SOCIO-ECONOMIC IMPACTS						
Temporary or permanent in-migration in search of job opportunities	Long Term	Regional	Very Severe	**HIGH -**	Severe	**MODERATE -**

			Without Mitigation		With Mitigation	
Impact	**Temporal scale**	**Spatial scale**	**Severity**	**Significance**	**Severity**	**Significance**
Reduced access to the inselberg's forest cover and small wildlife	Permanent	Study Area	Very Severe	**HIGH -**	Moderate	**MODERATE -**
Personnel safety risk	Long Term	Study Area	Severe	**MODERATE -**	N/A	**N/A**
Health services and water provision	Long Term	Study Area	Moderate	**MODERATE -**	Moderate	**MODERATE +**
Employment opportunities and the stimulation of economic growth in the region	Long-term	Regional	Moderate Beneficial	**MODERATE +**	Beneficial	**HIGH +**
Stakeholder and community engagement	Long Term	Regional	Moderate	**MODERATE -**	Beneficial	**HIGH +**
Transmission of communicable diseases due to overcrowding	Long Term	Study Area	Severe	**HIGH -**	Moderate Beneficial	**MODERATE +**
Malaria burden	Long Term	Study Area	Severe	**HIGH -**	Very Beneficial	**HIGH +**
Transmission of STIs and HIV/AIDS	Permanent	Regional	Very Severe	**VERY HIGH -**	Moderate Beneficial	**MODERATE +**
Soil, water and waste related issues	Long Term	Localised	Severe	**HIGH -**	Very Beneficial	**HIGH +**
Malnutrition	Long Term	Localised	Moderate	**MODERATE -**	Moderate Beneficial	**MODERATE +**
Road traffic accidents and other accidental injuries	Long Term	Localised	Severe	**MODERATE -**	Moderate Beneficial	**MODERATE +**
Air pollution, noise and mal-odours	Long Term	Localised	Moderate	**MODERATE -**	Moderate Beneficial	**LOW +**
Chemicals, pesticides and heavy metals	Long Term	Localised	Severe	**MODERATE -**	Slight	**LOW -**
Gender-based violence, alcohol and drugs	Long Term	Localised	Very Severe	**HIGH -**	Very Beneficial	**MODERATE +**
Social cohesion and well being	Long Term	Localised	Very Severe	**HIGH -**	Very Beneficial	**MODERATE +**
Health system strengthening	Long Term	Study Area	Severe	**HIGH -**	Very Beneficial	**HIGH +**
Non-communicable diseases	Long Term	Study Area	Moderate Severe	**MODERATE -**	Moderate Beneficial	**MODERATE +**
Increasing demand for natural resources	Long term	Study Area	Severe	**HIGH -**	Moderate	**MODERATE -**
IMAPCTS ASSOCIATED WITH WASTE INFRASTRUCTURE AND PROCESS RELATED ISSUES						
Health and safety of employees and local communities	Long Term	Localized	High	**HIGH -**	Slight	**LOW -**
Disruption of ecological function	Long Term	Localized	Moderate	**MODERATE -**	Slight	**LOW -**
Pollution of soil and water resources as a result of the storage of effluent in the process water pond	Medium Term	Localized	Very Severe	**MODERATE -**	Severe	**LOW -**
Risk to health and safety of employees due to storage of effluent in the process water pond	Medium Term	Localized	Severe	**HIGH -**	Slight	**LOW -**
Risk to health and safety of employees due to disposal of potentially hazardous process chemicals	Long Term	Localized	Severe	**VERY HIGH -**	Slight	**MODERATE -**

			Without Mitigation		With Mitigation	
Impact	**Temporal scale**	**Spatial scale**	**Severity**	**Significance**	**Severity**	**Significance**
Pollution of water resources and soil due to disposal of potentially hazardous process chemicals	Long Term	Localized	Severe	**VERY HIGH -**	Slight	**MODERATE -**
Increase in traffic frequency through villages and Pemba	Long Term	Regional	Moderate	**HIGH -**	Moderate	**HIGH -**
Dust generation as a result of traffic	Long Term	Regional	Moderate	**MODERATE -**	Slight	**MODERATE -**
Impact of noise on surrounding noise sensitive receptors in terms of annoyance during the operational phase	Long term	Regional	Severe	**HIGH -**	Moderate	**MODERATE -**
Impact on air quality as a result of removal of ore material (opencast mining process) and ROM Stockpile	Permanent	Local	Severe	**MODERATE -**	Moderate	**LOW -**
Impact on air quality as a result of operation of infrastructure	Permanent	Local	Moderate	**MODERATE -**	Slight	**LOW -**
Impact on air quality as a result of the storage, handling and treatment of hazardous products	Permanent	Local	Severe	**MODERATE -**	Severe	**LOW -**
Moderate potential for acid mine drainage (AMD) formation from waste rock dumps (WRD) and tailings storage facility (TSF)	Permanent	Local	Very Severe	**MODERATE -**	Moderate	**LOW -**
Potential trace element contamination from the WRD seepage into the receiving environment with high concentrations of Mn, Fe, Ni and U	Permanent	Local	Very Severe	**MODERATE -**	Moderate	**LOW -**
High potential for AMD formation	Permanent	Study Area	Severe	**HIGH -**	Moderate Severe	**MODERATE -**
Trace element contamination from stock piles and exposed ore zones with a high potential of metal contamination with concentrations of Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, V, Zn and U entering the receiving environment	Permanent	Study Area	Severe	**HIGH -**	Moderate Severe	**MODERATE -**
Radiation (public exposure)	Long Term	Local	Moderate	**MODERATE -**	Slight	**LOW -**
Radiation (worker exposure)	Long Term	Local	Moderate	**MODERATE -**	Slight	**LOW -**

Table 12.4: Residual impacts as a result of the decommissioning phase

			Without Mitigation		With Mitigation	
Impact	**Temporal scale**	**Spatial scale**	**Severity**	**Significance**	**Severity**	**Significance**
BIOPHYSICAL IMPACTS						
Sedimentation and elevated turbidity in rivers	Permanent	Regional	Severe	**HIGH -**	Moderate	**MODERATE -**
Contamination from non-ore pollutants	Permanent	Regional	Severe	**MODERATE -**	Moderate	**LOW -**
Ore contamination	Permanent	Regional	Severe	**MODERATE -**	Moderate	**LOW -**
Alteration of river flow-dynamics	Short Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Mine water contamination	Long Term	Localised	Severe	**MODERATE -**	Moderate	**LOW -**
Mine decant	Permanent	Localised	Severe	**MODERATE -**	Moderate	**LOW -**
Aquatic habitat modification	Long Term	Study Area	Severe	**HIGH -**	Moderate	**LOW -**
Loss of aquatic species of special concern	Long Term	Study Area	Moderate	**MODERATE -**	Moderate	**LOW -**
Over-utilization of fish resources	Long Term	Study Area/ Regional	Severe	**MODERATE -**	Slight	**LOW -**
Impact of increased dust levels on fauna	Medium Term	Study Area	Definite	**MODERATE -**	Slight	**LOW -**
Impact of chemical pollution on fauna	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**
Impact of noise pollution on fauna	Medium Term	Study Area	Moderate	**MODERATE -**	Slight	**LOW -**

12.3 Conclusion

It is the opinion of the authors of this ESHIA that the Balama Graphite Mine will result in environmental, social and health impacts that can be managed to levels of significance that would be regarded as acceptable to society and the natural environment, provided the recommendations presented in this report are implemented as part of the social and environmental management programme developed as part of the EIA process (available as Part III of this document).

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APPENDIX 1: MICOA APPROVAL FOR SCOPING REPORT

Based on the above letter please find the requested information included below:

1. **The observance of the Regulation on the Procedure of Environmental Impact Assessment approved by Decree 45/2004, of 29 September, the General Directive for the Preparation of the Environmental Impact Assessment Directive and the General for Public Participation Process.**

This section is included in Part 2 of the ESHIA Document in Chapter 2, Section 2.1.

2. **The presentation of all content of the document language is Portuguese, given the labelling requirements of the Environmental Legislation.**

The ESHIA and all associated documentation has been translated to Portuguese (including maps and diagrams.

3. **The inclusion of the curriculum vitae of the members of the technical team of EIA not effective at CES Mozambique, Lda.**

The Curriculum vitae of all the technical team members, with the exception of the CES Mozambique, Lda, has been included in Part 2 of the ESHIA Document (ESHIA) in Appendix 3.

4. **The indication of the role of each member of the technical team of the EIA.**

This section has been completed in Part 2 of the ESHIA Document (ESHIA) in Chapter 1, Section 1.3 (1.3.1, 1.3.2, 1.3.3).

5. **Presentation of the objectives / essence of the laws and conventions applicable to the project, as was considered for the Performance Standards of the International Finance Corporation.**

This section is included in Part 2 of the ESHIA Document in Chapter 2, Section 2.1.1 to Section 2.1.15.

6. **The specification of the limits of the areas of direct and indirect influence of the activity.**

All impacts within the consession license area is considered to be a direct impact

7. **An overview of the Mozambican legislation to the project, since part of it was repealed and / or introduced some changes and additions.**

This section is included in Part 2 of the ESHIA Document in Chapter 2, Section 2.1.1 to Section 2.1.15.

8. **The presentation of the ecology of the environmental situation of reference, using common, vernacular and scientific names in accordance with the provisions of Directive General for Development of Environmental Impact Assessments**

This section is included in the ESHIA Document in Chapter 4, Section 4.3. For a detailed description of the ecology of the area please refer to the Fauna as well as Flora Specialist reports

9. The survey area covered by the project to launch the National Register of Lands;

This section is included in the ESHIA Document in Chapter 5

10. The inclusion in the chapter on the legal framework of the activity:

a) Law of Planning, Law 19/2007, of 18 July, and its Regulation approved by Decree No 23/2008 of July 1, in order to reconcile the project implementation with aspects of spatial planning;

This section is included in Part 2 of the ESHIA Document in Chapter 2, Section 2.1.12.

b) Decree No 61/2006 approving the technical Regulation on Safety and Health in Mining Activities Geologic;

This section is included in Part 2 of the ESHIA Document in Chapter 2, Section 2.1.13.

c) Decree No 67/2010 of 31 December amending articles 23 and 24 and Annexes I and V, referred to in Article 7 and Article 16 of the Regulation on Environmental Quality and Effluent Emission 3 approved by Decree No 18/2004 of 2 June and approves attachments 1A and 1B;

This section is included in Part 2 of the ESHIA Document in Chapter 2, Section 2.1.14.

d) Name of Decree 31/2012, of August 8 and its accompanying description.

This section is included in Part 2 of the ESHIA Document in Chapter 2, Section 2.1.8.

11. The inclusion detailed measures to mitigate the environmental impacts associated with dusts and solid particles in suspension, which may affect the health of workers and the surrounding population.

This issue is assessed and mitigation measures are proposed in Chapter 8, Sections 8.2.4, 8.3.4 and 8.4.4 of Part 2 of the ESHIA. This is also discussed specifically from an occupation health and safety perspective in Chapter 11 (Table 11.5) of Part 2 of the ESHIA.

12. The inclusion of geographical coordinates of the study area.

The tables below provide the geographical co-ordinates of the project boundary as well as the positions of the main infrastructural components:

Project boundary:

North-west corner: 13°16'45.40"S 38°37'45.00"E	North-east corner: 13°16'45.14"S 38°44'45.00"E
South-west corner: 13°21'30.00"S 38°37'45.00"E	South-east corner: 13°21'30.00"S 38°44'45.00"E

Project Infrastructure:

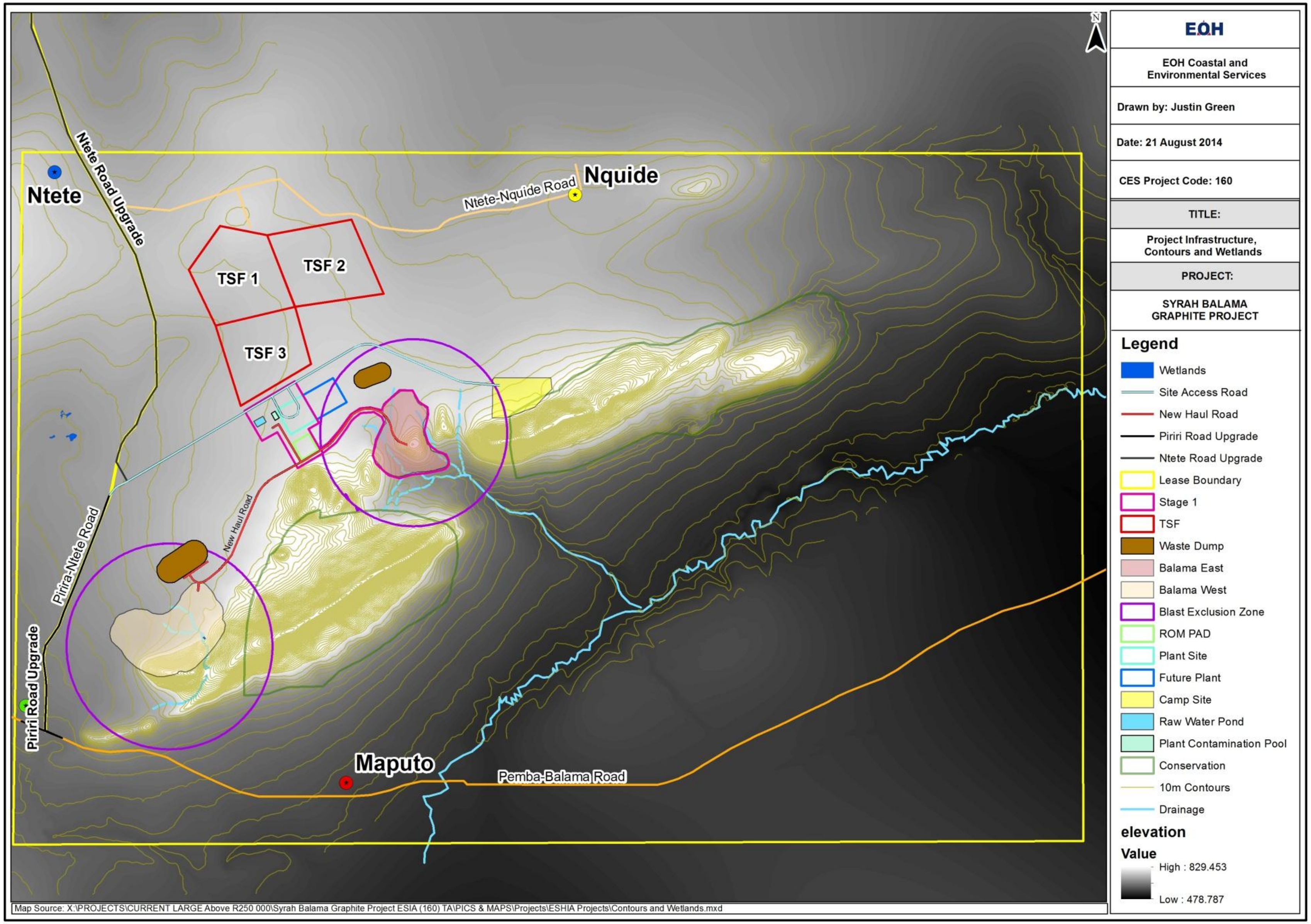
Infrastructure	Latitude	Longitude
Balama East	13°18'38.48"S	38°40'18.59"E
Balama West	13°19'51.19"S	38°38'57.36"E
Camp Site	13°18'24.33"S	38°41'1.11"E
Plant Site	13°18'30.96"S	38°39'41.15"E
Future Plant	13°18'25.37"S	38°39'51.37"E
ROM Pad	13°18'42.24"S	38°39'44.35"E
TSF 1	13°17'42.56"S	38°39'19.83"E
TSF 2	13°17'38.62"S	38°39'50.24"E
TSF 3	13°18'9.38"S	38°39'30.02"E
Waste Dump East	13°18'17.14"S	38°40'8.54"E
Waste Dump West	13°19'22.73"S	38°38'59.87"E

Linear Infrastructure:

	Start		Middle		End	
Roads	**Latitude**	**Longitude**	**Latitude**	**Longitude**	**Latitude**	**Longitude**
New Haul Road	13°19'27.19"S	38°39'2.38"E	13°18'52.14"S	38°39'34.99"E	13°18'41.82"S	38°40'21.16"E
Ntete Road Upgrade	13°18'54.50"S	38°38'40.24"E	13°15'47.09"S	38°38'5.74"E	13°12'58.47"S	38°36'58.85"E
Piriri Road Upgrade	13°20'22.31"S	38°38'10.31"E	13°19'38.04"S	38°38'18.61"E	13°18'59.50"S	38°38'33.77"E
Site Access Road	13°18'59.51"S	38°38'33.63"E	13°18'24.72"S	38°39'32.19"E	13°18'20.71"S	38°40'54.30"E
Ntete-Nquide Road	13°17'18.26"S	38°38'33.48"E	13°17'25.18"S	38°40'10.33"E	13°17'3.68"S	38°41'22.11"E

13. The actual survey in the project area of wetlands, including all systems of depressions and watercourses, with its georeferencing, mapping and description with the definition of specific management measures.

A description of the wetlands and water courses is included in Part 2 of the ESHIA Document in Chapter 4, Section 4.2.7. This is also presented spacially in the map included below. The Mehucua River flows through the southern section of the project site in a south-west to north-east direction. At this point it joins the Montepuez River 25 km downstream of the project site. The Mehucua River has three major tributaries; two of which - the Namiticu and the Naconha rivers - are upstream of the project area, both of which were sampled as part of the aquatic survey. The third tributary joins the Mehucua some distance downstream of the project area. The Namiticu and Naconha Rivers flow parallel to each other, and are both approximately 20 km long from their sources to their confluence, where they join to form the Mehucua River at a point on the southern boundary of the project site. A few small wetlands occur in the project area, the most notable being swampland located approximately 2 km south west of the proposed site and a wetland located approximately 7 km east south-east.


EOH
EOH Coastal and Environmental Services
Drawn by: Justin Green
Date: 21 August 2014
CES Project Code: 160
TITLE:
Project Infrastructure, Contours and Wetlands
PROJECT:
SYRAH BALAMA GRAPHITE PROJECT
Legend
Wetlands
Site Access Road
New Haul Road
Piriri Road Upgrade
Ntete Road Upgrade
Lease Boundary
Stage 1
TSF
Waste Dump
Balama East
Balama West
Blast Exclusion Zone
ROM PAD
Plant Site
Future Plant
Camp Site
Raw Water Pond
Plant Contamination Pool
Conservation
10m Contours
Drainage
elevation
Value
High : 829.453
Low : 478.787
N
Ntete
Ntete Road Upgrade
Ntete-Nquide Road
Nquide
TSF 1
TSF 2
TSF 3
New Haul Road
Pirira-Ntete Road
Piriri Road Upgrade
Maputo
Pemba-Balama Road
Map Source: X:\PROJECTS\CURRENT LARGE Above R250 000\Syrah Balama Graphite Project ESIA (160) TA\PICS & MAPS\Projects\ESHIA Projects\Contours and Wetlands.mxd

14. **The assessment of soil erosion that may arise from implementation of the project, its impacts and their mitigation measures;**

This issue is assessed and mitigation measures are proposed in Chapter 8, Sections 6.2.2 and 6.3.2 of Part 2 of the ESHIA.

15. **A clear indication of the environmental management plan, mitigation of impacts enrolled in the document, especially regarding the proliferation of respiratory, skin, air pollution and contamination of water intentionally.**

Please refer to Chapter 10 of the Environmental and Social Management Plan which details the monitoring which will be undertaking. For specific mitigation measures please refer to Chapter 7 of the ESHIA which deals with the health impacts and provides mitigation measures as well as Chapter 8 of the ESHIA which provides mitigation measures for impacts relating to air quality as well as water resources

16. **The preparation and adoption of frames of reference for the management of risks associated with chemical substances to be used**

This has been covered in the ESHIA Document (ESHIA), Chapter 2; chapter 6 section 6.5.7, 6.6.3; chapter 7 section 7.4.2 and chapter 8 section 8.4.4

17. **The presentation of safety measures for the handling of raw materials and / or products with hazardous chemicals characteristics.**

Please refer to chapter 5 of the ESMP which provides details on awareness training as well as Chapter 7 and 8 which provides recommendations on the handling of hazardous substances to prevent injuries and spillages

18. **The preparation of Plans for Safety and Health at Work.**

This has been covered in the ESHIA Document (ESHIA), Chapter 2, chapter 3 section 3.3; chapter 7 section 7.4.1. Please also refer to the ESMP as it establishes recommendations to ensure health and safety in the work environment

19. **The presentation of the design of tailings ponds and an indication of the monitoring points for groundwater throughout all areas susceptible to contamination;**

The presentation of the design of the tailings ponds has been included in Part 2 of the ESHIA Document (ESHIA), Chapter 3; also more details about tailings ponds are included in chapter 8 sections 8.3.4, 8.4.1, 8.4.5 and chapter 10 setion 10.3.2 and chapter 11 section 11.2.4

20. **The indication of the type of thickening agents for use in thickening of tailings, including their chemical composition.**

Details about tailings ponds are included in chapter 8 sections 8.3.4, 8.4.1, 8.4.5 and chapter 10 setion 10.3.2 and chapter 11 section 11.2.4

21. **The indication of the fate of sediments to be recovered in the process of settling the effluent resulting from dust suppression in Crushing the ore**

This has been covered in the ESHIA Document (ESHIA), Chapters 3 and 6, stions 3.4.9 and 6.3.4 respectively

22. The presentation of the procedures to be used for treatment of effluent from the process.

The has been covered in Part 2 of the ESHIA Document (ESHIA), Chapter 3, Section 3.5.2

23. The indication of the fate of resulting sludge the grinding of graphite.

This has been covered in chapter 8 sections 8.3.1 and 8.5.1

Slurry exits the primary mill and gravitates to a hopper. The mill product is pumped from the hopper to join the primary mill feed screen undersize in the primary classifier. The primary classifier floatation feed product is passed over a trash screen for the removal of oversize, and the undersize discharged into the rougher conditioner tank. Rods will be used as grinding media for the primary mill. A storage area for the rods will be located in close proximity to the mill.

A secondary mill operates in closed circuit with a secondary classifier. The returning coarse stream from the classifier is fed to the secondary mill. The slurry exits the secondary mill and gravitates into a hopper. The mill product is pumped from the hopper to the secondary classifier. Tailings from the third stage cleaning step are recycled back to the second stage regrinding circuit whilst concentrate is fed to the fourth stage cleaner. Tailings from the fourth stage cleaning step are recycled back to the third stage whilst final concentrate is taken through a dewatering step.

24. A careful assessment of the negative impacts that may be caused by the project on the fauna and flora.

This section has been completed in Part 2 of the ESHIA Document (ESHIA) in Chapter 6, Section 6.2.4, 6.2.5, 6.2.6, 6.3.4, 6.3.5, 6.3.6, 6.4.5, 6.4.6, 6.4.7, 6.5.5, 6.5.6, 6.6.7 and 6.6

25. The presentation of specific mitigation measures for socio cultural impacts and monitoring program and water sources that supply the communities around the project.

Mitigation measures related to Socio cultural impacts has been completed in Part 2 of the ESHIA Document (ESHIA) in Chapter 7, Section 7.4.1, 7.4.2, 7.5, 7.6

Mitigation measures related to water sources supplying communities has been completed in Part 2 of the ESHIA Document (ESHIA) in Chapter 6, Section 6.3.3, 6.4.3, 6.4.4, 6.5, 6.6. Impacts on the use of natural resources have also been completed in Chapter 7.

26. Description of the conditions for the involvement of a greater number of stakeholders and affected by the project, government institutions, civil society, NGOs, and other

This has been covered in the Public Participation Report

27. This evaluation of the impacts on the mobility of the population in relation to its activities

This issue is assessed and mitigation measures are proposed in Chapter 7 section 7.4.1. impact 6.1. For Detailed information please refer to the SIA

28. The assessment of the impacts of population dynamics in the study area and its surroundings, during and post project,

These social impacts are descripted in Chapter 7 of the ESHIA, but for a more detailed understanding please refer to the SIA.

29. The effective survey of households affected by the project and improvements;

This has been completed as Part 5 of the ESHIA Document (Specialist Volume) particularly in the Social Impact Assessment (SIA) and the Resettlement Action Plan (RAP), Chapter 5 of both reports.

30. The massive involvement of the population directly affected by the project, the local administrative authorities, relevant government institutions and civil society in the design of proposed resettlement and compensation measures;

This has been completed as Part 5 of the ESHIA Document (Specialist Volume) particularly in the Resettlement Action Plan (RAP), chapters 4, 7 and 8.

31. The inclusion in the resettlement plan, alternative ways of survival of communities who for some reason cannot continue to develop livelihood activities in the project area;

This has been completed as Part 5 of the ESHIA Document (Specialist Volume) particularly in the Resettlement Action Plan (RAP), chapters 4, 7 and 8.

32. The observance of all requirements for the preparation of the resettlement plan said by Regulations on Resettlement Process Resulting from Economic Activities, approved by Decree No 31/2012 of 8 August;

This has been completed as Part 5 of the ESHIA Document (Specialist Volume) particularly in the Resettlement Action Plan (RAP).

33. Compliance with Environmental Regulation for Mining Activities, Decree No. 26/2004, in the drafting of the Mine Closure and Rehabilitation

Please refer to chapter 11 section 11.4

34. The presentation of the Report of Use and Land (DUATs) and the Mining Concession License

República de Moçambique
Ministério dos Recursos Minerais
(Lei n° 14/2002, de 26 de Junho; Leis n°s 11 e 13/2007, de 27 de Junho; e Seus Regulamentos)

Concessão Mineira

6432C

Titular:

Twigg Exploration & Mining, Limitada

Mandatário:

Dinis António Augusto Napido

Recursos minerais abrangidos:

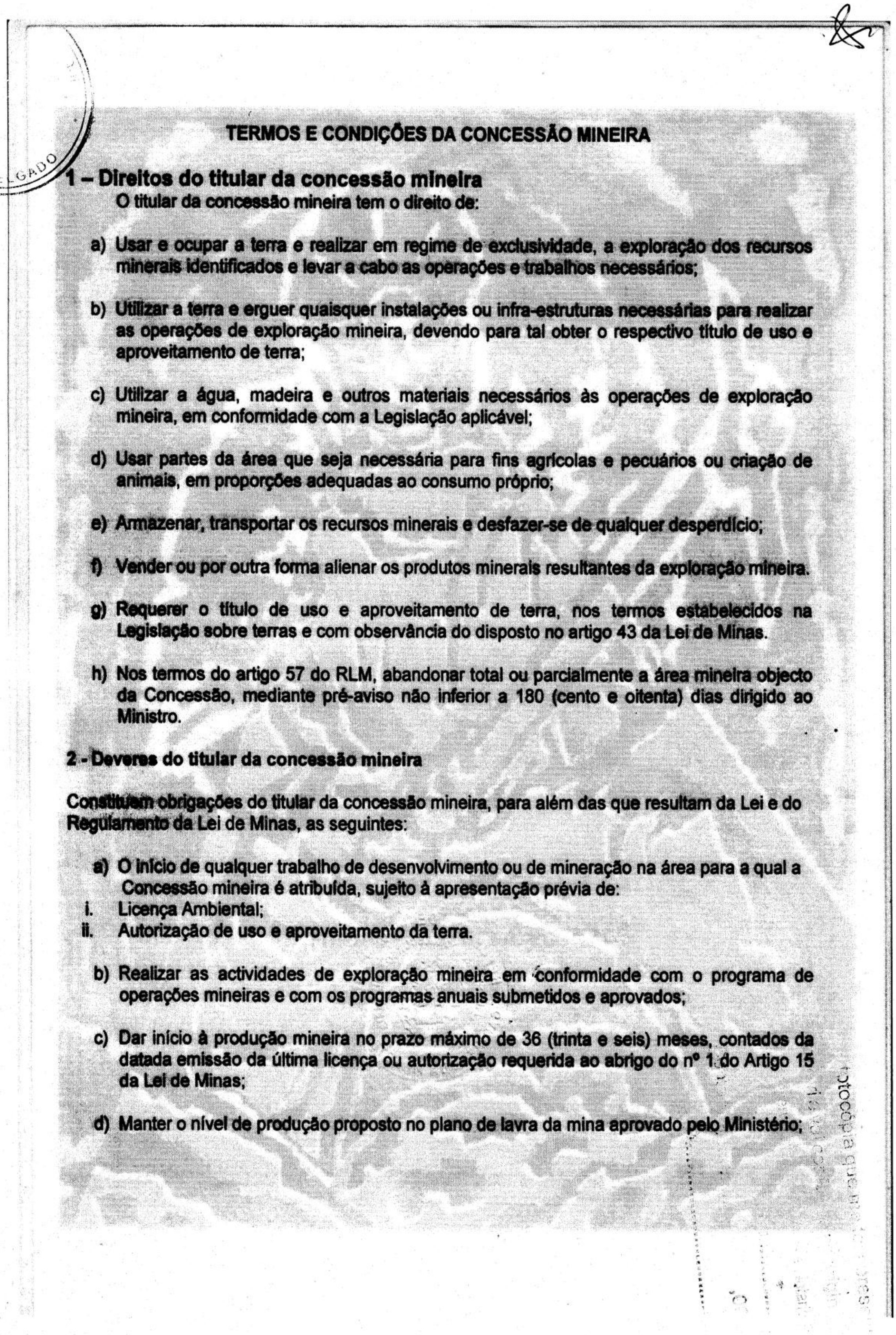
Grafite e Vanadio

Data de emissão: 06-12-2013 **Válido até: 06-12-2038**

A Ministra dos Recursos Minerais

Esperança Laurinda Bias

Esperança Laurinda Francisco Nhiuane Bias



TERMOS E CONDIÇÕES DA CONCESSÃO MINEIRA

1 – Direitos do titular da concessão mineira

O titular da concessão mineira tem o direito de:

a) Usar e ocupar a terra e realizar em regime de exclusividade, a exploração dos recursos minerais identificados e levar a cabo as operações e trabalhos necessários;

b) Utilizar a terra e erguer quaisquer instalações ou infra-estruturas necessárias para realizar as operações de exploração mineira, devendo para tal obter o respectivo título de uso e aproveitamento de terra;

c) Utilizar a água, madeira e outros materiais necessários às operações de exploração mineira, em conformidade com a Legislação aplicável;

d) Usar partes da área que seja necessária para fins agrícolas e pecuários ou criação de animais, em proporções adequadas ao consumo próprio;

e) Armazenar, transportar os recursos minerais e desfazer-se de qualquer desperdício;

f) Vender ou por outra forma alienar os produtos minerais resultantes da exploração mineira.

g) Requerer o título de uso e aproveitamento de terra, nos termos estabelecidos na Legislação sobre terras e com observância do disposto no artigo 43 da Lei de Minas.

h) Nos termos do artigo 57 do RLM, abandonar total ou parcialmente a área mineira objecto da Concessão, mediante pré-aviso não inferior a 180 (cento e oitenta) dias dirigido ao Ministro.

2 - Deveres do titular da concessão mineira

Constituem obrigações do titular da concessão mineira, para além das que resultam da Lei e do Regulamento da Lei de Minas, as seguintes:

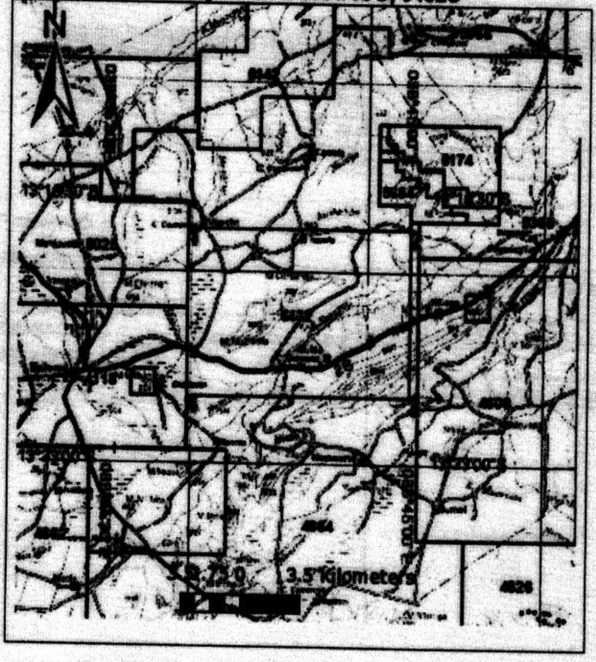
a) O início de qualquer trabalho de desenvolvimento ou de mineração na área para a qual a Concessão mineira é atribuída, sujeito à apresentação prévia de:
 i. Licença Ambiental;
 ii. Autorização de uso e aproveitamento da terra.

b) Realizar as actividades de exploração mineira em conformidade com o programa de operações mineiras e com os programas anuais submetidos e aprovados;

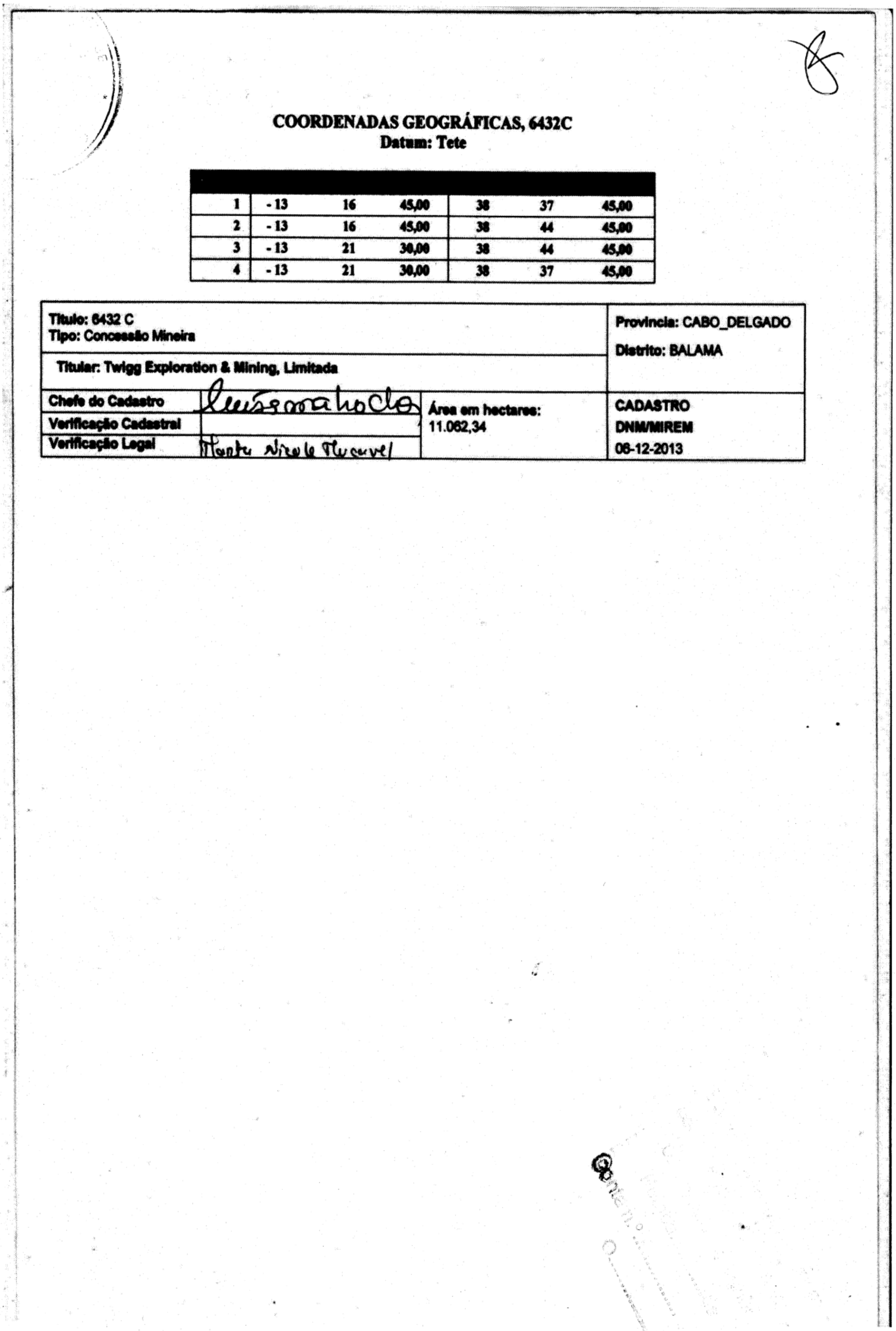
c) Dar início à produção mineira no prazo máximo de 36 (trinta e seis) meses, contados da datada emissão da última licença ou autorização requerida ao abrigo do nº 1 do Artigo 15 da Lei de Minas;

d) Manter o nível de produção proposto no plano de lavra da mina aprovado pelo Ministério;

ESBOÇO TOPOGRÁFICO, 6432C



Título: 6432 C **Tipo: Concessão Mineira**			**Provincia: CABO_DELGADO** **Distrito: BALAMA**
Titular: Twigg Exploration & Mining, Limitada			
Chefe do Cadastro		**Área em hectares:** 11.062,34	**CADASTRO** **DNM/MIREM** **06-12-2013**
Verificação Cadastral			
Verificação Legal			



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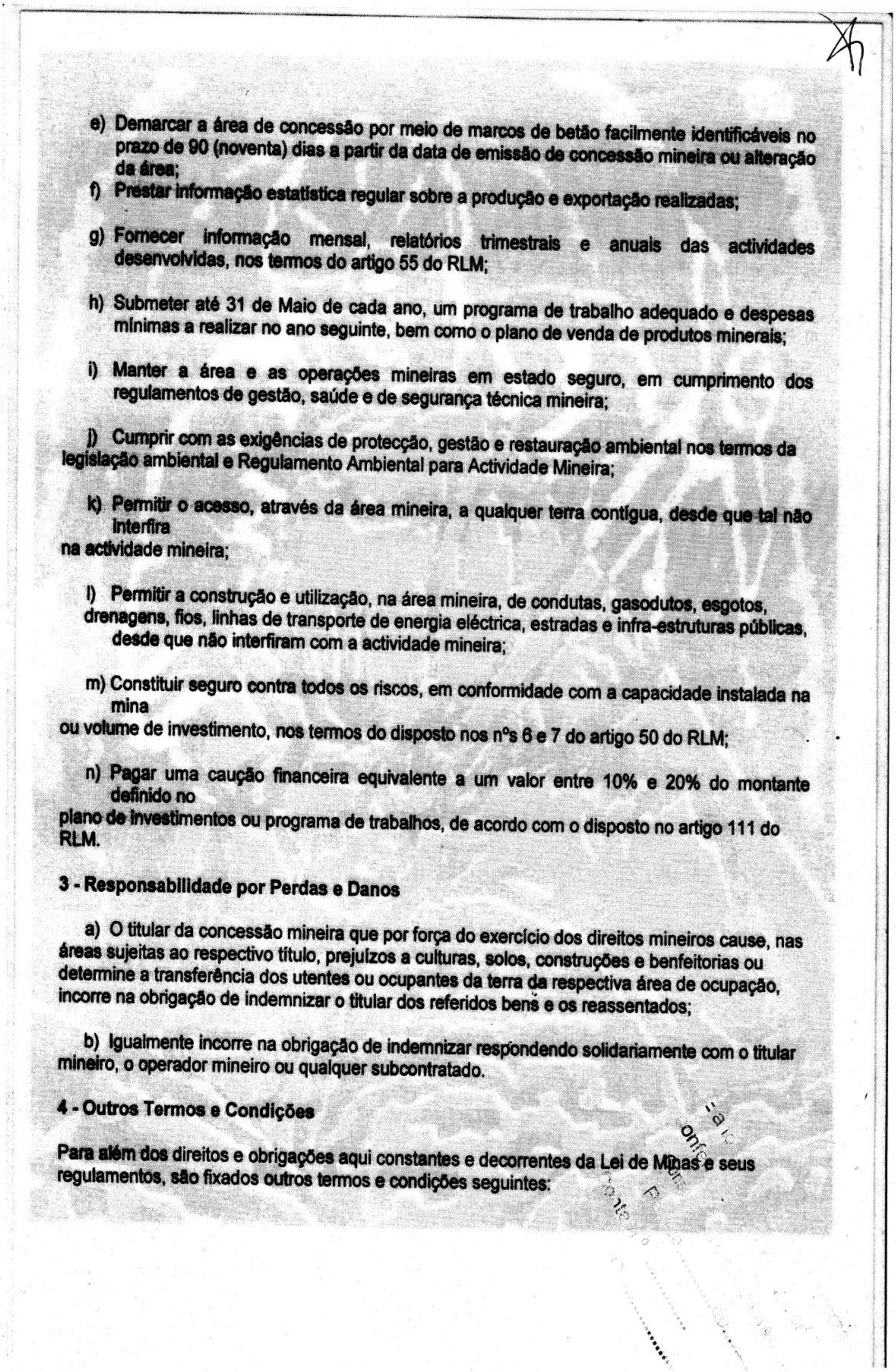
COORDENADAS GEOGRÁFICAS, 6432C

Datum: Tete

1	- 13	16	45,00	38	37	45,00
2	- 13	16	45,00	38	44	45,00
3	- 13	21	30,00	38	44	45,00
4	- 13	21	30,00	38	37	45,00

Titulo: 6432 C **Tipo: Concessão Mineira**			**Provincia: CABO_DELGADO** **Distrito: BALAMA**
Titular: Twigg Exploration & Mining, Limitada			
Chefe do Cadastro		**Área em hectares:** 11.062,34	**CADASTRO** **DNM/MIREM** 06-12-2013
Verificação Cadastral			
Verificação Legal			



e) Demarcar a área de concessão por meio de marcos de betão facilmente identificáveis no prazo de 90 (noventa) dias a partir da data de emissão de concessão mineira ou alteração da área;

f) Prestar informação estatística regular sobre a produção e exportação realizadas;

g) Fornecer informação mensal, relatórios trimestrais e anuais das actividades desenvolvidas, nos termos do artigo 55 do RLM;

h) Submeter até 31 de Maio de cada ano, um programa de trabalho adequado e despesas mínimas a realizar no ano seguinte, bem como o plano de venda de produtos minerais;

i) Manter a área e as operações mineiras em estado seguro, em cumprimento dos regulamentos de gestão, saúde e de segurança técnica mineira;

j) Cumprir com as exigências de protecção, gestão e restauração ambiental nos termos da legislação ambiental e Regulamento Ambiental para Actividade Mineira;

k) Permitir o acesso, através da área mineira, a qualquer terra contígua, desde que tal não interfira na actividade mineira;

l) Permitir a construção e utilização, na área mineira, de condutas, gasodutos, esgotos, drenagens, fios, linhas de transporte de energia eléctrica, estradas e infra-estruturas públicas, desde que não interfiram com a actividade mineira;

m) Constituir seguro contra todos os riscos, em conformidade com a capacidade instalada na mina ou volume de investimento, nos termos do disposto nos nºs 6 e 7 do artigo 50 do RLM;

n) Pagar uma caução financeira equivalente a um valor entre 10% e 20% do montante definido no plano de investimentos ou programa de trabalhos, de acordo com o disposto no artigo 111 do RLM.

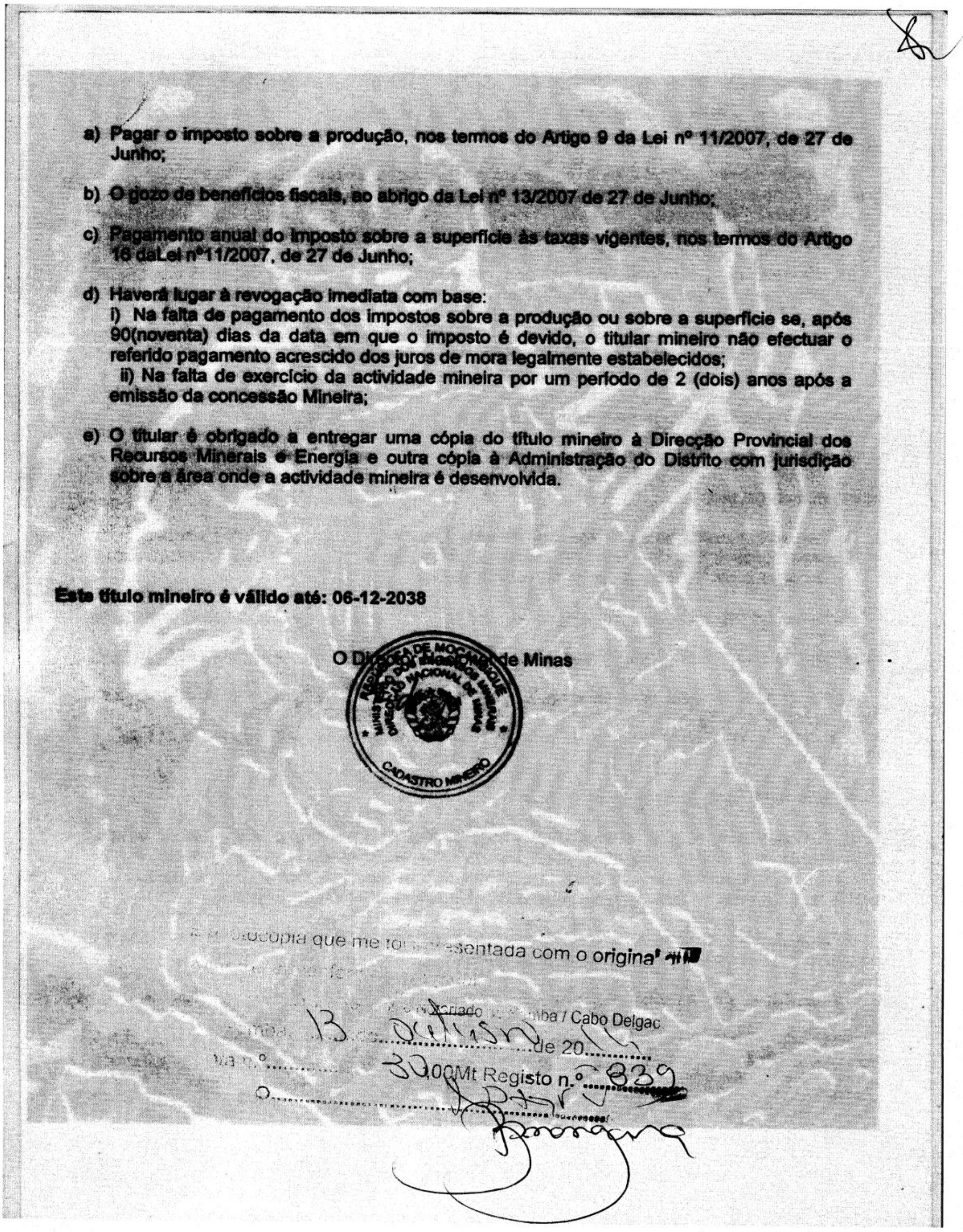
3 - Responsabilidade por Perdas e Danos

a) O titular da concessão mineira que por força do exercício dos direitos mineiros cause, nas áreas sujeitas ao respectivo título, prejuízos a culturas, solos, construções e benfeitorias ou determine a transferência dos utentes ou ocupantes da terra da respectiva área de ocupação, incorre na obrigação de indemnizar o titular dos referidos bens e os reassentados;

b) Igualmente incorre na obrigação de indemnizar respondendo solidariamente com o titular mineiro, o operador mineiro ou qualquer subcontratado.

4 - Outros Termos e Condições

Para além dos direitos e obrigações aqui constantes e decorrentes da Lei de Minas e seus regulamentos, são fixados outros termos e condições seguintes:



a) Pagar o imposto sobre a produção, nos termos do Artigo 9 da Lei nº 11/2007, de 27 de Junho;

b) O gozo de benefícios fiscais, ao abrigo da Lei nº 13/2007 de 27 de Junho;

c) Pagamento anual do imposto sobre a superfície às taxas vigentes, nos termos do Artigo 16 daLei nº11/2007, de 27 de Junho;

d) Haverá lugar à revogação imediata com base:
  i) Na falta de pagamento dos impostos sobre a produção ou sobre a superfície se, após 90(noventa) dias da data em que o imposto é devido, o titular mineiro não efectuar o referido pagamento acrescido dos juros de mora legalmente estabelecidos;
  ii) Na falta de exercício da actividade mineira por um período de 2 (dois) anos após a emissão da concessão Mineira;

e) O titular é obrigado a entregar uma cópia do título mineiro à Direcção Provincial dos Recursos Minerais e Energia e outra cópia à Administração do Distrito com jurisdição sobre a área onde a actividade mineira é desenvolvida.

Este título mineiro é válido até: 06-12-2038

O [illegible] de Minas

CADASTRO MINEIRO

[illegible]ocopia que me foi [illegible]esentada com o original

[illegible]riado [illegible]mba / Cabo Delgac

[illegible] 13 de [illegible] de 20[illegible]

[illegible] n.º .... 30,00Mt Registo n.º 839

O..

35. A clear description of the Programme of Corporate Social Responsibility to the communities directly affected project.

This has not been finalised yet as discussions are still underway. This will be presented in the final ESHIA

APPENDIX 2: IMPACT RATING METHODOLOGY

Methodology for Assessing the Significance of Impacts

Specialists are required to provide the reports in a specific layout and structure, so that a uniform specialist report volume can be produced. To ensure a direct comparison between various specialist studies, standard rating scales have been defined for assessing and quantifying the identified impacts. This is necessary since impacts have a number of parameters that need to be assessed.

Five factors need to be considered when assessing the significance of impacts, namely:

1. Relationship of the impact to **temporal** scales - the temporal scale defines the significance of the impact at various time scales, as an indication of the duration of the impact.

2. Relationship of the impact to **spatial** scales - the spatial scale defines the physical extent of the impact.

3. The severity of the impact - the **severity/beneficial** scale is used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on a particular affected system (for ecological impacts) or a particular affected party.

   The severity of impacts can be evaluated with and without mitigation in order to demonstrate how serious the impact is when nothing is done about it. The word ‘mitigation’ means not just ‘compensation’, but also the ideas of containment and remedy. For beneficial impacts, optimization means anything that can enhance the benefits. However, mitigation or optimization must be practical, technically feasible and economically viable.

4. The **likelihood** of the impact occurring - the likelihood of impacts taking place as a result of project actions differs between potential impacts. There is no doubt that some impacts would occur (e.g. loss of vegetation), but other impacts are not as likely to occur (e.g. vehicle accident), and may or may not result from the proposed development. Although some impacts may have a severe effect, the likelihood of them occurring may affect their overall significance.

Each criterion is ranked as presented in Table A3-1 to determine the overall **significance** of an activity. The criterion is then considered in two categories, viz. effect of the activity and the likelihood of the impact. The overall significance is determined using Table A3-2 and the significance is either negative or positive.

Table A3-1: Ranking of Evaluation Criteria

EFFECT	**Temporal Scale**		
	Short term	Less than 5 years	
	Medium term	Between 5-20 years	
	Long term	Between 20 and 40 years (a generation) and from a human perspective also permanent	
	Permanent	Over 40 years and resulting in a permanent and lasting change that will always be there	
	Spatial Scale		
	Localised	At localised scale and a few hectares in extent	
	Study Area	The proposed site and its immediate environs	
	Regional	District and Provincial level	
	National	Country	
	International	Internationally	
	Severity	**Severity**	**Benefit**
	Slight	Slight impacts of the affected system(s) or party(ies)	Slightly beneficial to the affected system(s) and party(ies)
	Moderate	Moderate impacts of the affected system(s) or party(ies)	Moderately beneficial to the affected system(s) and party(ies)
	Severe/ Beneficial	Severe impacts of the affected system(s) or party(ies)	A substantial benefit to the affected system(s) and party(ies)
	Very Severe/ Beneficial	Very severe change to the affected system(s) or party(ies)	A very substantial benefit to the affected system(s) and party(ies)
LIKELIHOOD	**Likelihood**		
	Unlikely	The likelihood of these impacts occurring is slight	
	May Occur	The likelihood of these impacts occurring is possible	
	Probable	The likelihood of these impacts occurring is probable	
	Definite	The likelihood is that this impact will definitely occurr	

** In certain cases it may not be possible to determine the severity of an impact thus it may be determined: Don’t know/Can’t know*

Table A3-2: Description of Environmental Significance Ratings and associated range of scores

Significance Rate	Description
Low	An acceptable impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in either positive or negative medium to short term effects on the social and/or natural environment.
Moderate	An important impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in either a positive or negative medium to long-term effect on the social and/or natural environment.
High	A serious impact, if not mitigated, may prevent the implementation of the project (if it is a negative impact). These impacts would be considered by society as constituting a major and usually a long-term change to the (natural &/or social) environment and result in severe effects or beneficial effects.
Very High	A very serious impact which, if negative, may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are unmitigable and usually result in very severe effects, or very beneficial effects.

The ***environmental significance*** scale is an attempt to evaluate the importance of a particular impact. This evaluation needs to be undertaken in the relevant context, as an impact can either be ecological or social, or both. The evaluation of the significance of an impact relies heavily on the values of the person making the judgment. For this reason, impacts of especially a social nature need to reflect the values of the affected society.

Prioritising

The evaluation of the impacts, as described above is used to prioritise which impacts require mitigation measures.

Negative impacts that are ranked as being of “**VERY HIGH**” and “**HIGH**” significance will be investigated further to determine how the impact can be minimised or what alternative activities or mitigation measures can be implemented. These impacts may also assist decision makers i.e. lots of **HIGH** negative impacts may bring about a negative decision.

For impacts identified as having a negative impact of “**MODERATE**” significance, it is standard practice to investigate alternate activities and/or mitigation measures. The most effective and practical mitigations measures will then be proposed.

For impacts ranked as “**LOW**” significance, no investigations or alternatives will be considered. Possible management measures will be investigated to ensure that the impacts remain of low significance.

APPENDIX 3: CURRICULUM VITAE

A. Internal Specialists/Consultants

ANTHONY MARK AVIS (DR)

PERSONAL INFORMATION

Name of Staff: Dr Anthony Mark (Ted) Avis
Date of Birth: 26 September 1960
Profession: Environmental Consultant and Managing Director of Coastal & Environmental Services
Name of Firm: Coastal & Environmental Services
Years with Firm/Entity: 24 years Nationality: South African
Married since 1986: Wife Cheryl. Two Children. Jonathan - Born 1996; Luke - born 2002

Qualifications

1983: BSc
1984: BSc (Honours)
1992: PhD (Rhodes)

Dissertation

Coastal Dune Ecology and Management in the Eastern Cape

Associations

- Royal Society of South Africa
- Visiting Fellow; Department of Environmental Science; Rhodes University
- Certified Environmental Assessment Practitioner (since 2002)
- South African Association of Botanists (SAAB)
- South African Council for Natural Scientific Professionals
- South African Institute of Ecologists and Environmental Scientists
- International Association of Impact Assessment

COMMUNITY INVOLVEMENT

- MEC Representative on the Board of the Albany Museum of Natural History (2001 – 2009).
- Member of Grahamstown Round Table service club (1994 -2001)
- Chairman, Grahamstown Trust (1989 – 1997)
- Member of the St Andrews Preparatory School Board of Governors (2009 - present)
- Chairman, St Andrews Preparatory School Board of Governors (2013)

NOTED ACHIEVEMENTS

- Publication of three manuscripts in refereed journals from research undertaken whilst an undergraduate student.
- Involvement as a principal consultant and coordinator of all specialist studies undertaken as part of the St Lucia EIA, being the youngest member of a team of 30 scientists involved in this project.
- Awarded the South African Association of Botanists Junior Medal. This is awarded to the candidate with the best PhD thesis in Botany for the particular year under review (1993).

- Instrumental in establishing the Environmental Science Programme at Rhodes University (in 1996), which later became the Environmental Science Department (2000)

Professional Experience

1998 – present: Full-time Managing Director of Coastal & Environmental Services.
1989 – 1997: Lecturer and Senior Lecturer in Botany at Rhodes University.
Private environmental consultant and partner of Coastal & Environmental Services (CES, established January 1990).
1987 – 1988: Ecological Consultant with Loxton Venn and Associates, responsible for vegetation, soils and land surveys; veld conditions assessments and EIAs.
1983 – 1987: Full time research in ecology, including coastal management studies and Environmental Impact Assessments (EIAs).

Consulting experience

I have consulted in Botswana, Egypt, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mozambique, Mauritius, Namibia, Sierra Leone, South Africa and Zambia. Environmental consulting experience, in no particular order, includes:

SELECTED LARGE Environmental Impact Assessments

1. Principal consultant for the specialist studies for the Environmental Impact Assessments of proposed dune mining on the Eastern Shores of Lake St Lucia.
2. Overall responsibility as EIA project manager for all environmental aspects of Billiton's TiGen mineral sand mining operations in Mozambique, to produce an EIA that meets international standards.
3. EIA project manager for the Corridor Sands mineral sand mining project in southern Mozambique, to produce four EIAs to World Bank standards for the project's bankable feasibility study. EIAs produced for the mine site and smelter, the 400Kv power line, the 87km rail route and a bulk cargo facility at Matola Port. All these EIAs included the preparation of Environmental Management Plans.
4. EIA project manager for Tiomin Resources Inc (Toronto, Canada) for their Kwale mineral sands project in southern Kenya. Responsible for producing all six volumes of the EIA, regarded as the most comprehensive in Kenya to date.
5. EIA project manager for the EIA to support the rezoning of land to special purposes for the establishment of the Coega Industrial Development Zone (IDZ).
6. EIA project manager for the EIA to support the rezoning of land to special purposes for the establishment of the East London IDZ.
7. Numerous small-scale Scoping Reports as part of the Environmental Impact Assessment Process and in accordance with the requirements of the Environmental Conservation Act.
8. Pre-feasibility Environmental Impact Assessments, including one for BHP's mineral sand mining project in northern Mozambique, and similar projects in south-west Madagascar and Mozambique.
9. Study leader for a comprehensive EIA for the World Bank funded 400Kv Mozambique Malawi Interconnector project power line, Malawi sector.
10. EIA for a dedicated haul road, material handling facility and jetty near Praia de Xai Xai, Mozambique for WMC Resources, Australia.
11. EIA Project Manager for the Nuclear Materials Authority of Egypt, to prepare the EIA as part of the Downer EDI Feasibility Study Team. (2007).
12. EIA for a large scale resort development, including two golf courses and three hotels in the Eastern Cape, South Africa. (Ongoing).

13. EIA for the Madiba Bay resort development, incorporating the development of various portions of land within a 5000 hectare site for a range of resort type facilities. (2005 – 2008).
14. Study Leader for an EIA for a large heavy mineral mining project in South West Madagascar for Exxaro (2006 – 2008).
15. Study Leader for an EIA for a proposed heavy mineral mine on the shores of Lake Malawi near Chipoka. (2005 – 2006).
16. Study Leader for an ESIA for a proposed large scale integrated tourism resort development in the Eastern Cape (2007 – 2008).
17. Environmental and Social consultants to the International Finance Corporation for the Kafue Gorge Lower Hydropower project, Zambia.
18. Study Leader for an Environmental, Social and Health Impact Assessment for a proposed large sugar cane to ethanol biofuel project in Sierra Leone for Addax Bioenergy, Geneva (2009 - 2010).
19. Study Leader for an ESHIA for a proposed large scale Jatropha biofuels project in Mozambique (2009 - 2010).
20. Study leader for Environmental Impact Assessment for a proposed large scale copper and nickel mine in the North West Province of Zambia (2010).
21. Lead consultant for an addendum Environmental Impact Assessment for the proposed expansion of a heavy mineral mining project in Nampula Province, Mozambique (2010).
22. Quality control reviewer for approximately 8 EIA’s for various Windfarm Projects in South Africa (2009 – 2010).
23. Study leader for an ESHIA for a proposed large scale palm oil plantation in Sierra Leone (2010).
24. Study leader for ESIA for a rare earths mine in Kangankula, Malawi for the Lynas Corporation.
25. Study leader for ESIA for a large scale copper mine in the North West Province of Zambia for First Quantum Minerals (2011).
26. Study leader for an ESIA for a proposed Cement Plant and for a proposed Limestone quarry in southern Mozambique (2012).
27. Study Leader for an Environmental Impact Assessment of the Mooi-Mgeni Transfer Scheme – Phase 2, KwaZulu-Natal Province, South Africa for TCTA (2012).
28. Study leader for an ESHIA for a proposed large scale palm oil plantation and estate in Liberia, compliant with international sector specific guidelines. For EP Oil (2012).
29. Study leader for an ESHIA for a proposed large scale forestry plantation in Niassa Province, Mozambique for Niassa Green Resources and to be compliant with international sector specific guidelines (2010).
30. Study leader for an EIA for a proposed golf course in Makana District, South Africa (2012)
31. Study leader for an EIA for a proposed housing and residential estate in Makana District, South Africa (2012).
32. Study Leader for an ESHIA for a heavy mineral mining project in South West Madagascar for World Titanium Resources (2013).
33. Study Leader for an ESHIA for a heavy mineral mining project on the West Coast of South Africa for Zirco Resources (2013).

Policy and strategic assessments

1. The development of the Eastern Cape Coastal Management Plan, to be adopted as policy by the Eastern Cape Government
2. Study leader for the preparation of a State of Environment Report, and Environmental Implementation Plan for the Amatole District Municipality, covering an area of approximately 25 000 km^2.
3. Reports on ecological assessments of the damage caused to the environment by alleged illegal developments along the former Transkei coastline.
4. Study leader and project manager for the preparation of a World Bank/Global Environmental Facility funded geographic Strategic Environmental Assessment of the proposed greater Addo Elephant National Park, Eastern Cape, South Africa.

5. A Strategic Environmental Assessment of four land use options in the Centane district of the Wild Coast.
6. SEA covering an area half the size of the Eastern Cape (former Transkei) to identify where afforestation projects could be implemented on a sustainable basis for poverty alleviation. Prepared for the Department of Water Affairs and Forestry (2006 – 2007).
7. Integrated Coastal Zone Management Plan for the Buffalo City Municipality, Eastern Cape South Africa, including numerous Management Plans for estuaries, beaches etc. (2006 – 2007).
8. A Sustainability Analysis of various land use alternatives to determine optimum land use for the future rehabilitation of lease areas at Richards Bay Minerals. (2006).
9. State of Environmental Report and Environmental Management System for the Ukhulambe District Municipality. (2005).
10. Strategic Environmental Overview for two integrated tourism anchor projects in Mozambique for the International Finance Corporation (2010).

Ecological

1. Ecological impact assessment for a proposed Zinc and Phosphoric Acid plant in the Eastern Cape.
2. Ecological specialist reports for the Coega Industrial Development Zone Strategic Environmental Assessment
3. Ecological impact assessment of proposed 800km Wild Coast N2 Toll Road, Eastern Cape.
4. Study leader for the ecological impact assessment of the Wild Coast Toll Road EIA, Eastern Cape and Kwazulu/Natal, South Africa (2004).
5. Study Leader for Baseline Ecological Surveys of coastal lease areas in southern Mozambique for Rio Tinto exploration (2008).
6. Pre-feasibility Ecological Survey of the Skeleton Coast to identify critical impacts linked to Diamond and Mineral Mining exploration (2008).
7. Coordinator for ecological investigations to establish a sound baseline prior to implementing an EIA, North West Province, Zambia (2011).
8. Assessment of the extent and conservation value of forested areas along the Wild Coast within the former Transkei, on behalf of the Eastern Cape Parks Board (2011)

Environmental Management

1. Project manager for a five-year rehabilitation programme of Samancor's Chemfos mine on the West Coast.
2. Development of an Open Space Management Plan for the Coega Industrial Development Zone (IDZ), including the demarcation of open spaces, formulation of uses within the open space, integration with MOSS principles and developing guidelines and a business plan for the management of the open space system.
3. Preparation of numerous Environmental Management Programme Reports, in terms of the Minerals Act, for quarry operations in the Eastern Cape, including EMPRs for both the Eastern and Western Coega Kops.
4. Study Leader for the development of two detailed and definitive Environmental Management Plans for the construction of two large bridges across rivers in the Wild Coast, as part of the Wild Coast N2 Toll Road Project, for South African National Roads Agency Limited. (2006).
5. Joint Study Leader for the development of numerous Construction and Operational Phase Environmental and Social Management Plans for Tiomin's proposed Kwale mineral mine in Kenya.

Other

1. A position paper on the current ecological knowledge of the Eastern Cape Provincial Coastline: implications for planning and research.
2. Environmental training and teaching for a number of professional short courses, and at undergraduate and postgraduate level at Rhodes University.

3. Presented 29 conference papers and published 19 scientific articles in peer reviewed scientific journals.
4. Presented various courses on aspects of Environmental Impact Assessment, most notably as a key presenter on the EIA Short Course offered by CES since 2000.
5. Short course on Strategic Environmental Assessment offered to Rhodes Investec Business School MBA students.

CHANTEL BEZUIDENHOUT (DR)

Date of Birth: 11 March 1978
Languages: Afrikaans, mother tongue
English, excellent

QUALIFICATIONS

- B.Sc. (Botany, Geography)
- B.Sc.(Hons)(Botany: Ecology, Environmental Management, Geographic Information Systems)
- M.Sc. (Botany: Estuarine Ecology)
- PhD (Botany: Estuarine Ecology)

FIELDS OF RESEARCH

- Third year project:
- The Extraction of Agar from Macrophytes
- Honours projects:
- The Management of Phragmites australis in the Mcantsi Estuary
- Assessing the PE Metropolitan Open Space Systems (MOSS) and assigning a conservancy score for the Port Elizabeth Municipality (PEM)
- Masters project:
- Diatoms as indicators of water quality in estuaries
- PhD project:
- Macrophytes as indicators of physico-chemical factors in South African estuaries

OTHER STUDIES AND WORKSHOPS

- The Biodiversity Planning Forum. Mpekweni Beach Resort, Eastern Cape. (March 2008)

PUBLICATIONS AND CONFERENCES

- Adams, J.B., Bornman, T.G. and Bezuidenhout, C. 2005. Specialist Report: Macrophytes. Olifants / Doring catchment. Ecological Water Requirements study, Olifants Estuary. Report submitted to CSIR, Environmentek, Stellenbosch. 39pp.
- Bezuidenhout, C., J.B. Adams and Bornman, T.G. 2005. Specialist Report: Macrophytes. Kromme Estuary Resources Directed Measures Study. Report submitted to the CSIR on behalf of the Department of Water Affairs and Forestry. 61pp.
- Bornman, T.G., Adams, J.B. and Bezuidenhout, C. 2004. Present status of the Orange River mouth wetland and potential for rehabilitation. Prepared for Working for Wetlands, South African National Biodiversity Institute. Nelson Mandela Metropolitan University. IECM Research Report No. 43. 54 pp.
- Bornman, T.G., Adams, J.B. and Bezuidenhout, C. 2004. Adaptations of salt march to semi-arid environments and management implications for the Orange River mouth. Transactions of the Royal Society of South Africa 59(2): 125-131.
- Bornman, T.G., Adams, J.B. and Bezuidenhout, C. 2005. Salt marsh characteristics and freshwater requirements of a cool temperate versus a warm temperate estuary. 12th Southern African Marine Science Symposium. Durban, Kwazulu-Natal.
- UPE Departmental Seminars: Extraction of Agar from Macrophytes (1999); The Application of National Legislation in the Management of and Conservation of Estuaries (2000); The Management of Phragmitesaustralis in the Mcanti Estuary (2000); Assessing the PE Metropolitan Open Space Systems (MOSS), and assigning a conservancy score for the PEM (2000).

CAREER BIOGRAPHY

October 2011 – Present

- Principal Environmental Consultant with Coastal & Environmental Services
- Branch Manager: Port Elizabeth office of Coastal & Environmental Services

February 2008 – September 2011

- Environmental Consultant with CEN Integrated Environmental Management Unit

February 2000 – November 2006

- Botany Department Practical demonstrator, Nelson Mandela Metropolitan University (South Campus).
- Field Research Assistant for research projects conducted in the Botany Department, Nelson Mandela Metropolitan University (South Campus).

February 2002 – November 2002

- Research Assistant in the Botany Department, Nelson Mandela Metropolitan University (South Campus).

February 2001 – August 2001

- Auxillary worker for the Western District Council.

Specialisation in Firm:

Environmental Impact Assessment, Estuarine and Saltmarsh Ecology

RECENT EXPERIENCE – COASTAL & ENVIRONMENTAL SERVICES

- Environmental Impact Assessment for the proposed residential development at the existing golf course in Grahamstown, Eastern Cape Province of South Africa (2012).
- Environmental Impact Assessment for the proposed golf course development at Belmont Valley, Grahamstown, Eastern Cape Province of South Africa (2012).
- Basic Assessment for the proposed development of a 13 MW Photovoltaic energy generating facility in the Coega Industrial Development Zone (Zone 12), Port Elizabeth, Eastern Cape Province. Authorization received 29/02/12.
- Scoping Report for the Mooi-Mgeni Transfer Scheme – Phase 2, KwaZulu-Natal Province, South Africa (2012).
- Scoping Report for the proposed Peddie Wind Energy Project, Ngqushwa Local Municipality, Eastern Cape Province of South Africa (2012).

International Experience

Environmental Impact Assessment

- Environmental Impact Statement for a large scale copper mine in the North-Western Province of Zambia.
- Environmental Impact Statement for a large scale nickel mine in the North-Western Province of Zambia.
- Environmental and Social Impact Assessment for a heavy minerals mine in the Toliara Province, Madagascar.
- Project Manager: Graphite Mine in Cabo-Delgado Province, Mozambique

Specialist Assessment

- Land and Natural Mineral Resources Assessment for a heavy minerals mine in the Toliara Province, Madagascar.
- Land and Natural Mineral Resources Assessment Iron ore mine in Tete Province, Mozambique

PREVIOUS EXPERIENCE – SELECTED PROJECTS

- CEN Integrated Environmental Management Unit: (2008) Basic Assessment for the proposed establishment of 2 jetties, improvement of the existing, licensed slipway and stabilization of the river banks on Portion 12 of the Farm Nocton 441 (Gamtoos ferry Hotel). (Port Elizabeth, Eastern Cape Province)

- CEN Integrated Environmental Management Unit: (2008) Basic Assessment for the proposed establishment of a Town Lodge Hotel on Erf 2150, Summerstrand. (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2008) Basic Assessment for the proposed Rezoning and Subdivision of Erf 10501 and the remainder of Erf 5023, Walmer, Nelson Mandela Metropolitan Municipality, for the purpose of establishing a residential development. (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2008) Basic Assessment for the proposed rezoning and the establishment of a hospital and associated infrastructure and facilities on a portion of the remainder of Erf 1226, Fairview, Port Elizabeth, Eastern Cape. (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2008) Basic Assessment for the proposed rezoning of Portion 1 of the Farm Bucklands (No. 108), the Farm SchrikwatersPoort (No. 109) and the remainder of the farm Bucklands (No. 108) for the development of a Luxury Lodge, Makana Municipal Area, Eastern Cape. (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2008) Basic Assessment for the proposed subdivision of Erf 2686, Parsonsvlei for a Residential Development Port Elizabeth, Eastern Cape. (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2008) Basic Assessment for the proposed subdivision or Erf 2687, Parsonsvlei for a Residential Development, Port Elizabeth, Eastern Cape. (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2008) Environmental Assessment for the proposed Rezoning and Subdivision of Portions 22 and 40 of the Farm Witteklip No 466, Nelson Mandela Bay Municipality. (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2009) Environmental Assessment for the proposed subdivision of the remainder of Erf 1226, Fairview, Port Elizabeth, Eastern Cape for a Residential Development. (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2009) Basic Assessment for the establishment of a new 2.5 Ml Kruisfontein Reservoir on Erf 2088 and a portion of the remainder of Erf 2, Humansdorp, Kouga Municipality, Eastern Cape. (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2009) Basic Assessment for the proposed extension of an existing 36m lattice mast to a 46m lattice mast on Erf 8917, Uitenhage, Nelson Mandela Bay Municipality, Eastern Cape. (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2009) Basic Assessment for the proposed extension of an existing 36m lattice mast to a 46m lattice mast of Erf 1296, Summerstrand, Port Elizabeth, Eastern Cape. (Port Elizabeth, Eastern Cape).
- CEN Integrated Environmental Management Unit: (2009) Basic Assessment for the proposed extension of an existing 36m lattice mast to a 56m lattice mast on Erf 1345, Walmer, Port Elizabeth, Eastern Cape. (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2009) Basic Assessment for the proposed rezoning and subdivision of a portion of Erf 1721, Aberdeen, Camdeboo Municipality, Eastern Cape to develop subsidized housing and related community facilities (Lotusville Extension). (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2009) Basic Assessment for the proposed rezoning and subdivision of a portion of Erf 1721, Aberdeen, Camdeboo Municipality, Eastern Cape to develop subsidised housing and related community facilities (Thembalesizwe Extension). (Port Elizabeth, Eastern Cape)

- CEN Integrated Environmental Management Unit: (2009) Basic Assessment for the proposed stabilization of the river banks on Portion 2 of the Farm Nocton 441 (Adjacent to the Gamtoos Ferry Hotel). (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2010) Environmental Impact Assessment for the proposed construction and upgrading of the new Glen Hurd Road as well as the construction of the Baakens River Bridge, Port Elizabeth, Eastern Cape. (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2010) Environmental Impact Assessment for the proposed subdivision of the remainder of Erf 982, Parsonsvlei, Port Elizabeth, Eastern Cape for a residential development. (Port Elizabeth, Eastern Cape)
- CEN Integrated Environmental Management Unit: (2010) Environmental Impact Assessment for the proposed rezoning and subdivision of erven 1070, 409 and the remainder of Erf 385, Theescombe, Port Elizabeth, Eastern Cape for a residential development. (Port Elizabeth, Eastern Cape)

KIM BRENT

Date of Birth: 16-11-1987
Languages: Afrikaans – Mother tongue
English - excellent

QUALIFICATIONS

B.Sc degree (Botany, Geography)*
B.Sc Honours (Botany: environmental management, landscape ecology, geographic information systems)*

Obtained as '*van Huyssteen'

FIELDS OF RESEARCH

Third year project:

What is eating the critically endangered Honeybush tea?

Honours projects:

- The biotic management of the Velddrif solar saltworks
- The short term effects of increase in temperature on the potential distribution of *Syncarpha paniculata*(thunb.) B.nordenstam and *Syncarpha recurvata*(l.f.) B.nordenstam, as determined by its physiological responses

CAREER BIOGRAPHY

February 2010-November 2010

- Practical demonstrator at Nelson Mandela Metropolitan University (South Campus)

January 2011 – January 2014

- Environmental consultant at CEN Integrated Environmental Management unit

February 2014 –Present

- Environmental Consultant at EOH Coastal & Environmental Services

CONSULTING EXPERIENCE (PREVIOUS EMPLOYER)

- Review document for the Aggeneis-Oranjemond 400kV power line and substations upgrade, Northern Cape: Scoping Report.
- Review document for the Aggeneis-Oranjemond 400kV power line and substations upgrade, Northern Cape: EIA Report.
- Aston Bay Swanlake EMP
- Construction of a social housing project and associated infrastructure on Erf 3937, Fairview, Port Elizabeth: Environmental auditing process
- Kragga Kamma Road refuse transfer station: 24G application, Public participation and rectification assessment report.
- Pearston solar farm – assisted in the Environmental Impact Assessment Report
- Pearston solar farm (Phase 2 & 3) – assisted in the Environmental impact assessment report;
- Hemsley Family Trust: Subdivision and rezone of portion 176 (A and B) of the farm Goedgeloof nr 745, in St Francis Bay, Kouga district: Basic assessment
- Dondolo Family Trust: The construction of a Shopping centre on Erf 24296, KwaNobuhle: Basic assessment

- Dondolo Family Trust: The development of formalized parking on Erf 1, KwaNobuhle: Basic assessment and water use permit application
- Environmental Audits for the construction of a residential development and associated infrastructure on Erf 7023 (Ptn of 14935), Walmer: Environmental control officer
- Construction and upgrading of the new Glen Hurd Road as well as the construction of the Baakens River Bridge, Port Elizabeth, Eastern Cape: Water use Permit Applications
- Jefferey's Bay Wind farm –Environmental control officer – auditing process
- Ntshekisa - Ferguson- Sheya Kulati integrated public transport system (IPTS), Port Elizabeth, Eastern Cape: Environmental management plan – in progress
- Proposed rezoning and subdivision of Portion 12 (a portion of Portion 4) of the farm Vetmaak Vlakte No. 312, Uitenhage RD, in the Nelson Mandela Bay Municipality, Eastern Cape for a mixed use development: Scoping and EIA Report
- Proposed clearing of bush for the cultivation of Lucerne fields and the construction of a dam (approximately 30 000 m^3) to irrigate the lands, in Addo, Sundays River Valley Municipality: Basic assessment
- Proposed construction and operation of a a fuel filling station with rest and retail facilities, an agri-business retail/wholesale facility and a farm store with tourism and related facilities on Remainder of Portion 8 of the Farm Nanaga Hoogte No. 229 in the Sundays River Valley Municipality: Basic assessment
- Proposed construction of a cemetery on a portion of Erf 1814 in Graaff-Reinet, Eastern Cape: Basic assessment
- Proposed Establishment of a Low Density Leisure Estate and the redesign of the existing Skuitbaai golf course on Portions 12, 13 and 70 of the Farm Eerste Rivier 626: Basic assessment
- Upgrade of the Donkin Reserve, Port Elizabeth: Environmental auditing process
- Vegetation mapping for various projects

CONSULTING EXPERIENCE (CURRENT EMPLOYER)

Kim has assisted and worked on the following projects:

- Augmentation of the Lusikisiki Regional Water Supply Scheme, Eastern Cape Province, South Africa – Scoping and Environmental Impact Assessment
- Balama Graphite Mine in the Cabo Delgado Province in the District of Balama in Northern Mozambique - Environmental and Social Health Impact Assessment
- Calmag Limestone Prospecting Application – Public Consultation and Environmental Management Plan
- Enterprise Deposit, North Western Province, Zambia – Environmental Impact Statement
- Existing Innovative Mouldings Plastic Recycling Facility, Holland Park, Port Elizabeth - Application For A Waste Licence & Basic Assessment Process

- Gibson Bay Wind farm in the Kouga Local Municipality - Environmental Management Programme
- Kouga Wind Farm in the Kouga Municipality – Environmental Auditing
- Masakhane Housing Development in Kwazakhele, Port Elizabeth – Basic Assessment report
- Zirco Roode Heuwel, Kamiesberg Project, Northern Cape – Scoping and Environmental Impact Assessment

DR. ERIC E IGBINIGIE (Pr. Sci. Nat.)

Date of birth: 21 March 1974

QUALIFICATIONS

2008: PhD. Biotechnology. Rhodes University, South Africa
2004: MSc. Environmental Biotechnology. Rhodes University, South Africa
2003: Environmental Management Training. Received training in Industrial Environmental Management
1999: BSc. Hons. Biochemistry. Ambrose Alli University, Nigeria (formally Edo State University)

Training

2014: Facilitator – Soil Remediation Workshop (ARC - Institute for Soil, Climate and Water)
2014: Environmental Management System ISO 14001:2004 Lead Auditor Training (BUREAU VERITAS)
2013: Contaminated Land Workshop (IMBEWU Sustainability Legal Specialist (Pty) Ltd / GEO Pollution Technologies).
2011: Climate Change: Adaptation and Mitigation – Swedish Metrological and Hydrological Institute, Sweden (Part I Sweden and Part II Namibia).
2010: Environmental Impact Assessment Certificate – Coastal & Environmental Services / Rhodes University, South Africa
2003: Industrial Environmental Management & Process Biotechnology – MSc Module, Rhodes University, South Africa

MEMBERSHIP

- South African Council for Natural Scientific Professions (Environmental Science: 400201/09).
- Water Institute of Southern Africa (WISA) (20783).
- International Water Association (IWA, UK) (00895495.)

PROFESSIONAL EXPERIENCE

May 2010 – Present: Senior Environmental Consultant (Coastal & Environmental Services, South Africa). I serve as a specialist consultant and project manager in projects that are rooted in my areas of specialisation including Basic Assessment, Environmental Impact Assessment, Environmental Due Diligence (Phase 1, 2 & 3), Environmental & Social Due Diligence, Management Systems and Auditing, Bioremediation and Waste valorisation processes. My project management duties include active project opportunity search, developing expression of interest and proposals as well as the management and maintenance of prospective and existing clients.

July 2009 – April 2010: Senior Research Scientist / Post graduate co-ordinator (Institute for Environmental Biotechnology, Rhodes University (EBRU)). Led a research group tasked with the bioremediation of coal spoils. Lectured Sustainable Environmental Biotechnology at M.Sc and Honours levels.

January 2008 – April 2009: Post-Doctoral Fellowship / Course leader: Environmental Biotechnology at EBRU.

June 2000 – November 2002: Water quality control analyst (Edo Pharmaceuticals Benin city, Nigeria). Duties included water supply and quality analyst, general wet chemistry analyst, National water quality report compilation and presentation and computer lab manager.

March 1999 – February 2000: Field officer, National Programme on Immunization (NPI) (National Youth Service Corps (NYSC) Kano State, Nigeria). Duties included rural health educator, data collection for the NPI and Implementation of Polio vaccination in rural areas.

CONSULTING EXPERIENCE

Environmental Due Diligence (Contamination Assessment)

South Africa:

- Jan. 2013: Environmental Due Diligence Assessment (Phase 1 and 2) for the Coega Brick at the Industrial Development Zone, Port Elizabeth, South Africa.
- Feb. 2012: Contaminated Land Assessment – Fishwater Flats Wastewater Treatment Works. Port Elizabeth, South Africa.
- Jun. 2011: Environmental Due Diligence Assessment (Phase 1 and 2) for the Coega Zone 6 Industrial Development Zone, Port Elizabeth, South Africa.
- Nov. 2011: Environmental Due Diligence Assessment (Phase 1 and 2) for the Coega Zone 13 Industrial Development Zone, Port Elizabeth, South Africa.

Environmental Monitoring, Training and Implementation

South Africa:

- 2012 to date: EIA Short Course Rhodes University: (i) Post EIA implementation and monitoring, (ii) Development of Environmental and Social Monitoring Plan.

Mozambique:

- 2011: Kenmare Moma mine Environmental Monitoring Programme update.
- 2011: Water and effluent monitoring requirements based on the IFC, MIGA and the Mozambican legislation for the purpose of the environmental completion for Kenmare Moma Mines Mozambique. Designed, developed and implemented a water and effluent monitoring programme. Contributed to the design and development of 3 portable water treatment plants and three domestic waste water treatment plants for the mine.
- 2011: Developing a wet chemistry manual for Kenmare Moma mine and trained personnel on effluent and water monitoring including sampling, analysis and result interpretation. Training also included the management of the onsite portable water treatment plant and sewage plant.

Madagascar:

- Feb. 2013: Toliara Sands' Renobe Mine Project Environmental and Social Monitoring Plan.

Sierra Leone:

- 2012: Developed a wet chemistry manual for Addax Bioenergy Sierra Leone and trained personnel on effluent and water monitoring including sampling, analysis and result interpretation.

Zambia:

- Jan. 2014: First Quantum Minerals Environmental Monitoring Plan for the Enterprise, Zambia.

Environmental and Social Management Plan

Liberia:

- Mar. 2013: Equatorial Palm Oil Environmental and Social Management System in accordance with the IFC Performance Standard 1.

Madagascar:

- Feb. 2013: Toliara Sands' Renobe Mine Project: Environmental and Social Management System in accordance with the IFC Performance Standard 1.

Mozambique:

- May, 2013: Niassa Green Resource Forestry Environmental and Social Management

Plan.
- Sep. 2011: GS Cimentos Cement Plant Environmental and Social Management Plan
- Sep. 2011: GS Cimentos Limestone Quarry Environmental and Social Management Plan.
- 2010: Developed the EMS ISO 14001 for Kenmare Moma Mines, Mozambique.

Zambia:
- May, 2013: Trident Copper and Nickel Project, Enterprise deposit, North Western Province, Zambia: Environmental and Social Management Plan.

Waste Management Specialist Studies

Ghana:
- Jun. 2012: African Plantation for Sustainable Development Biomass Power Plant Project: Waste and Wastewater Assessment Specialist Report in accordance with National Legislation and the IFC Industry Specific EHS Guidelines for Forest Harvesting Operations and Thermal Power Plant.

Liberia:
- Mar. 2012: Equatorial Palm Oil Waste and Wastewater Specialist Assessment Report in accordance with National Legislation and the IFC Industry Specific EHS Guidelines for Plantation Crop Production and Vegetable Oil Processing.

Madagascar:
- Jun. 2012: Toliara Sands’ Renobe Mine Project Waste and Wastewater Specialist Assessment Report in accordance with National Legislation and the IFC Industry Specific EHS Guidelines for Mining.

Malawi:
- Nov. 2010: Kangankunde Monazite Mine, Malawi: Waste and Wastewater Specialist Assessment Report in accordance with National Legislation and the IFC Industry Specific EHS Guidelines for Mining.

Mozambique:
- May, 2010: Kenmare Moma Titanium Mining Project: Sanitation Assessment Report.

Sierra Leone:
- Nov. 2012: Samshi Steel Mill and Power Plant Project Sierra Leone: Waste and Wastewater Specialist Assessment Report in accordance with National Legislation and the IFC Industry Specific EHS Guidelines for Integrated Steel Mill and Thermal Power Plant.

Zambia:
- Feb. 2011: Trident Copper and Nickel Project, Sentinel Deposit North Western Province, Zambia: Assessment of Infrastructure, Waste and Process Related Issues.

Environmental and Social Due Diligence (Compliance Audits)

Kenya / Uganda:
- Current: Independent Environmental Monitor for the Rift Valley Railway Kenya and Uganda.

Mozambique:
- 2012: IFC PS deviation assessment and implementation for heavy mineral mining project, Kenmare Moma Mines, Mozambique.
- Sep. 2010: Rehabilitation Plan for Kenmare Moma Titanium Minerals Project, Mozambique.

Nigeria:
- Current: Olokola Single Point Mooring and Tank Farm ESIA gap analysis based on the International Finance Corporation (IFC) Performance Standards (PS) and Industry Specific guidelines and requirement.
- Jan. 2013: Environmental and Social Due Diligence for the proposed Ossiomo Petrochemical Ammonia-Urea project, Ologbo, Edo State, Nigeria – SWEDFUND.

Climate Change – Adaptation and Mitigation

Nigeria:

- May, 2011: Integrated Municipal Solid Waste management: A Potential Waste-to-Energy Project in Nigeria.

Zambia:

- Feb. 2011: Effects of the Trident Project on Global Climate Change: Trident Copper and Nickel Project, Sentinel Deposit North Western Province.

Environmental Impact Assessment and Pre-Feasibility Assessment

South Africa:

- 2012: Basic Assessment for the Healdtown College Sewage Treatment Package Plant, Forth Beaufort, South Africa.
- 2012: Environmental Impact Assessment Report and Environmental Management Plans for the upgrade of the Fishwater Flats Wastewater Treatment Works, Coega Development Zone, Port Elizabeth.
- 2011: Scoping Report – Upgrade of the Fishwater Flats Wastewater Treatment Works, Coega Development Zone, Port Elizabeth.
- 2011: Pinedale Eco-Estate Environmental Impact Assessment. Bathurst, Eastern Cape Province South Africa.
- 2010: Basic Assessment Report – Wood Energy Biomass Project, Grahamstown, South Africa.

RESEARCH & TEACHING EXPERIENCE

2012 - Environmental Impact Assessment Short Course at Rhodes University

- Facilitator for the EIA short course.
- Lectured - Post EIA implementation and monitoring.

2009 – Current: Post-graduate Supervision

- PhD Supervision: Development of a broad spectrum biocatalyst tool for coal & petroleum contaminated soil. (Current).
- MSc Supervision: Stacked-Heap coal bioreactor process in coal dumps rehabilitation. (Current).
- 2011: Coal-derived humic acid as a sustainable material for soil amendment. (Honours).
- 2011: The role of *Cynodon dactylon* root exudates in coal spoils rehabilitation. (Honours).
- 2010: Characterization and beneficiation of weathered coal-derived humic acid. (Honours).

July 2009 – April 2010: Senior Research Scientist - EBRU

- Supervise and lead the coal dump bioremediation and beneficiation research group and was responsible for its deliverables.
- Lectured Sustainable Environmental Biotechnology at Post-graduate level.
- Reviewer - The South African Journal of Science.
- Responsible for the safety and health environment of EBRU.
- Responsible for research logistics.

July 2009 – April 2010: Anglo Coal land rehabilitation (FungCoal) project, Phase III (AngloCoal)
Research: Integrated approach for beneficiating acid mine drainage (AMD) in conjunction with coal spoils and its applications in coal dump rehabilitation strategy that is channelled towards a clean development mechanism (CDM).
Responsibility: Supervised and lead the research team and was responsible for its deliverables
Funder: Anglo Coal South Africa.

May 2008 – January 2009: Flue gas beneficiation (SASOL)
Research: The beneficiation of algal sequestered industrial CO_2 (derived from flue gas) for the production of biofuel (Bio-methane and Bio-diesel) and other fine chemicals.
Responsibility: Research deliverables.

Funder: Sasol.
Outcome: Confidential Feasibility report submitted to Sasol, South Africa (2009).

January 2004 – December 2007: Anglo Coal land rehabilitation (FungCoal) project, Phase II (AngloCoal)
Research: The microbial biotransformation of coal materials for coal dump rehabilitation purpose and the beneficiation of coal waste spoils
Responsibility: Research deliverables.
Funder: Anglo Coal South Africa.
*Outcome*s:

- Patented technology (See Patent & Publications).
- Publications (See Patent & Publications).
- PhD thesis (2007). (See Patent & Publications)
- Anglo Coal FungCoal Report, Phase I and II. (See Patent & Publications)
- Grant awarded for FungCoal Phase III: Research grant for 4-year duration.

February 2003 – January 2004: Anglo Platinum wastewater treatment project (Anglo Platinum)
Research: Investigating the enzymatic recovery of platinum from platinum waste streams
Responsibility: Responsible for the research outcome
Funder: Anglo Platinum South Africa.
Outcomes:

- MSc thesis (2004) (See Patent & Publications).
- Beneficiation of platinum wastewater - Confidential report submitted to Anglo Platinum South Africa (2004)

SELECTED PUBLICATIONS AND PATENT

2013: Lerato M. Sekhohola, **Eric E. Igbinigie** and A. Keith Cowan. Biological degradation and solubilization of coal: A review. Biodegradation. 24(3):305-318.

2011: South African Patent Office Patent Number 2010/02354 - Rhodes University (Stacked-Heap Coal Bioreactor). Contributors: Rose, P.D., **Igbinigie, E.E**., Horan, M.P., Dames, J.F & Mukasa-Mugerwa, T.T.

2010. **Igbinigie, E.E**., Mutambanengwe, C.Z. & Rose, P.D. Phyto-bioconversion of hard coal in *Cynodon dactylon*/coal rhizosphere. *Biotechnology Journal*. 5:292-303.

2008. **Igbinigie, E.E.,** Atkins, S., van Breugel, Y., van Dyke, S., Davies-Coleman, M.T. & Rose, P.D. Fungal biodegradation of hard coal by a newly reported isolate, *Neosartorya fischeri*. *Biotechnology Journal*. 3:1407-1416.

2007. **Igbinigie, E.E.** The rhizosphere as a bioprocess environment for the bioconversion of hard coal. PhD Thesis. Rhodes University.

2007. Rose, P.D., **Igbinigie, E.E**., Horan, M., Atkins, S., van Dyk, S., van Breugel, Y., Mukasa-Mugerwa, T., Dames, J., Mutambanengwe, C.Z., Bowker, M. & Laubscher, R. Biotechnology of coal biosolubilization and applications in waste coal beneficiation. Anglo Coal FungCoal Report, Phase II. 1-349.

2004. Rose, P.D., Clarke, A. & **Igbinigie, E.E**. Biotechnology of coal biosolubilization and applications in biological treatment of mine drainage wastewaters and waste coal beneficiation. Anglo Coal FungCoal Report, Phase I. 1-100.

2004. **Igbinigie, E.E.** The enzymatic use of hydrogenase in sulphate reducing bacteria for the removal of platinum from industrial wastewater. MSc Thesis. Rhodes University.

KEVIN JOHN WHITTINGTON-JONES (Ph.D)

Date of Birth: 17-01-1972

QUALIFICATIONS

2005 - Post Graduate Diploma in Higher Education (Rhodes University)
2000 - Ph.D. Biotechnology (Rhodes University)
1997 - M.Sc Zoology (Rhodes University)
1994 - B.Sc Hons. Marine Biology with distinction (Rhodes University)
1993 - B.Sc Microbiology & Zoology (Rhodes University)

PROFESSIONAL REGISTRATIONS

- Associate Member - Institute of Environmental Management & Assessment (IEMA) (No. 0014994)
- Member - The Institute of Waste Management of South Africa (IWMSA) (No. 40105035)
- South African Council for Natural Scientific Professions (Environmental Scientist: No. 400027/07)
- Roundtable on Sustainable Biomaterials (RSB) - Auditor (No. 2013 – 10010)

PROFESSIONAL EXPERIENCE

June 2014 – Present:
Executive and Head Office Manager (EOH Coastal & Environmental Services)

January 2013 – June 2014:
Director & Head Office Manager (Coastal & Environmental Services)

March 2009 – June 2014:
Director (Coastal & Environmental Services)

January 2006 – February 2009:
Principal Environmental Consultant (Coastal & Environmental Services)

January 2007 – February 2009:
Senior Lecturer & Coordinator of the MBA Environmental Management Elective Programme (Rhodes Investec Business School)

January 2004 – December 2006:
Senior Lecturer (Department of Environmental Science, Rhodes University) & Coordinator of the MBA Environmental Management Elective Programme (Rhodes Investec Business School). Acting Head of Department from August – December 2006

January 2002 – January 2004:
Lecturer in Biotechnology (Dept. Biochemistry, Microbiology & Biotechnology, Rhodes University, Grahamstown). Duties included development and coordination of the Environmental Biotechnology Masters Degree Course and a 3-week short course in Industrial Environmental Management. I was Acting Head of Department (Biotechnology) from May – December 2003.

January 2001 – January 2002:
Research Assistant and Course Coordinator for Environmental Biotechnology MSc Programme (Dept. Biochemistry, Microbiology & Biotechnology, Rhodes University).

2000 – 2001:

Accounts Assistant, Skandia Life, Southampton, UK. My primary duty during this period was to investigate the financial implications of new UK carbon tax legislation.

CONSULTING EXPERIENCE

Environmental consulting experience as project manager or team member is broad and covers a number of key areas. Specific experience includes the following:

Environmental Impact Assessment and pre-feasibility assessments

- ESIA for the Enterprise Copper Mine, Zambia (specialist and report review)
- ESIA for the Sentinel Copper Mine, Zambia (specialist and report review)
- Rapid Site Assessment for proposed resettlement village, Palma, Mozambique for WorleyParsons
- ESIA for Lurio Green Resources 120 000ha commercial plantation development, Mozambique
- ESIA for the Niassa Green Resources commercial plantation development, Mozambique
- ESIA for EcoFarm organic sugar and beef production facility, Mozambique [ongoing]
- ESHIAs for two heavy mineral mining projects for Kenmare Resources (Mozambique) [ongoing]
- Environmental assessment of the impact of the breach of a slimes settling pond for a corporate client
- EIA for Waainek wind energy facility outside Grahamstown (Eastern Cape)
- EIA for 1 million m^3 per year sugarcane-to-ethanol biofuel development (Chemba, Mozambique)
- Scoping study for one large wind farm near Cookhouse (Eastern Cape)
- Environmental pre-feasibility assessment for 14 wind farms in the Western Cape, South Africa
- Basic Environmental Assessment for a 3MW wood to energy project near Grahamstown (Eastern Cape) for the Nollen Group
- Basic Environmental Assessments for wind measurement masts (InnoWind) and large-scale cattle feedlot (Roodepan Feedlot)
- EIAs for the proposed Exxaro AlloyStream and Kalagadi manganese smelters in the Coega IDZ
- Environmental Impact Assessment of the proposed regional hazardous waste site (Port Elizabeth, Eastern Cape)
- Environmental Scoping study and EMPR amendment for proposed salt mining and beneficiation plant (Coega IDZ, Eastern Cape)
- Scoping-level environmental assessment for a stainless steel strip mill (Coega IDZ, Eastern Cape)

Strategic Environmental Assessment

- Scoping-level Strategic Environmental Assessment (SEA) for the Port of Mossel Bay as well as contributions to the SEAs for the Ports of Port Elizabeth and East London

Climate change

- Climate change adaptation and mitigation policy for the Eastern Cape Province, South Africa (ongoing)
- Preliminary carbon footprint assessment for Kenmare Moma Heavy Mineral Sands Mine, Mozambique
- Climate change risk assessment for the South African Ports (TNPA)

Waste Management

- Waste management specialist studies for the following:
    - International heavy mineral mining projects including El Burulus (Egypt), Malawi Monazite (Malawi), and Tolira Sands (Madagascar);
    - Syrah graphite mine, Mozambique
    - First Quantum Trident copper mines (Zambia)
    - Two manganese smelters at the Coega IDZ, South Africa (for Exxaro Resources and Kalagadi Manganese);
    - Rabai power station (Kenya)
    - Large agro-industrial (bio-ethanol and palm oil) projects for Addax Bioenergy (Sierra Leone), Equatorial Palm Oil (Liberia), Grown Energy (Mozambique)
    - African Plantations for Sustainable Development (APSD) wood to energy plant (Ghana).
- Integrated Waste Management Plan for the Port of Mossel Bay
- Development of strategies and biological systems for the treatment and beneficiation of domestic grey water within the Scenery Park low-cost "eco-village" (Buffalo City, Eastern Cape)

Environmental Due Diligence and Business Risk

- IFC Performance Standards audit for Kenmare Resources' Moma Heavy Mineral Sands Mine, Mozambique
- Environmental & social due diligence on forestry operation for Global Solidarity Forest Fund for plantation development in Mozambique.
- Environmental & social due diligence for Cennergi on a proposed gas power plant and powerline (Mozambique)
- Environmental and social due diligence assessment for a forest plantation in Uganda on behalf of the German Development Bank (DEG)
- Environmental and social due diligence assessment for a pulp mill and forest plantation in Swaziland on behalf of the German Development Bank (DEG)
- Environmental risk assessment of alternative bunkering modes for the Port of Port Elizabeth (PE, Eastern Cape)
- Environmental risk assessment for private developer on the west coast, South Africa
- Environmental liability assessment for the Port of Durban
- Environmental due diligence (Phase 1 and 2) assessment for Zones 5, 6 and 13 of the Coega Industrial Development Zone
- Phase 1 and 2 contaminated land assessments for a private manufacturer and one parastatal organization

Policy and Guidelines

- Development of a municipal sanitation policy for Buffalo City Municipality
- Development of EIA guidelines for the Roundtable on Sustainable Biofuels

Environmental Auditing and compliance

- Environmental and Social management systems audit and ESMS development, Econet Wireless Zimbabwe (EWZ), Zimbabwe.
- Multiple environmental and social audits for Kenmare Resources' heavy mineral mine, Mozambique.
- Project management of the environmental component of the Completion Test for Kenmare Resources' heavy mineral mining project, Mozambique.
- IFC Performance Standards deviation assessment for Kenmare heavy mineral mining project, Mozambique (2010 and 2012)
- Environmental audit for mechanical sugarcane harvesting operation, Swaziland

- Development, implementation and auditing of industry-specific environmental management system for brick manufacturing companies in the Eastern cape, South Africa (2001 – 2004)
- Internal ISO 14001 audits at SAB Ibhayi Brewery (Port Elizabeth, Eastern Cape) [2001 – 2004]
- Trainee Auditor: Certification audit of car component manufacturer

RESEARCH & TEACHING EXPERIENCE

I have successfully supervised 3 PhD, 6 research and 15 coursework MSc / MBA students. Research has been published in peer-reviewed journals and presented at conferences. A full list of publications is available upon request. Areas of research include environmental biotechnology, integrated waste management and environmental management in business. From 2001 – 2003 I was responsible for coordinating the Environmental biotechnology MSc programme (Department of Biotechnology, Rhodes University) where I taught bioremediation. I have also taught environmental management and integrated pollution & waste management at the undergraduate and Honours level for the Department of Environmental Science (2004 – present) and have taught extensively on the Rhodes University MBA programme (2004 – present). Subjects taught at the MBA level include business and sustainable development, environmental risk assessment, technology assessment, life cycle assessment and climate change risk.

CHERIE-LYNN MACK

Date of Birth: 05-08-1980

QUALIFICATIONS

PhD Environmental Biotechnology (Rhodes University), M.Sc Environmental Biotechnology with distinction (Rhodes University), B.Sc Hons. Biotechnology (Rhodes University), B.Sc Microbiology & Biochemistry (Rhodes University)

Completed the SASS5 aquatic macroinvertebrate monitoring course (2012) conducted by Groundtruth (Dr Mark Graham)

MEMBERSHIP

- The Water Institute of Southern Africa (WISA)
- International Association for Impact Assessment (South Africa)

PROFESSIONAL EXPERIENCE

November 2009 – Present: Principle Environmental Consultant (Coastal & Environmental Services)

October 2008 – July 2009: Water Scientist (Golder Associates Africa)

January 2008 – June 2008: Postdoctoral Research student (Department of Microbiology, Stellenbosch University)

CONSULTING EXPERIENCE

October 2009 – present Principle Environmental Consultant, Coastal & Environmental Services

As a principle consultant, my role in the company is to manage and provide input into the compilation of Environmental Impact Assessments for a wide variety of clients, and for a wide variety of developments. To date, these projects have included:

Renewable Energy Projects

- Great Kei Wind Energy Facility
- Qumbu Wind Energy Facility
- Ngqamakhwe Renewable Energy Facility EIA
- Ncora Renewable Energy Facility EIA
- Qunu Renewable Energy Facility EIA
- Thomas River Renewable Energy Facility EIA
- Chaba Wind Energy EIA
- Lushington Park Wind Energy Facility EIA

Wastewater Specialist Assessments:

- Wastewater Specialist Impact Assessment for St Patricks Hospital Wastewater Treatment Works
- Environmental Management Plan as part of the Alfred Nzo District Municipality Effluent Management Plan
- Wastewater Specialist Impact Assessment for Jamestown Wastewater Treatment Works
- Wastewater Specialist Impact Assessment for Qolora Aquaculture Zone EIA
- All Saints Wastewater Treatment Works, Wastewater Specialist Impact Assessment
- Project Manager and Waste Specialist: Scoping and Environmental Impact assessment for Sunningdale Dairy Processing Facility

Water Quality Specialist Assessments:

- Surface and Groundwater Assessment Report. EcoFarm Sugar Plantation Project, Mozambique
- Water Quality Specialist Impact Assessment for the proposed abstraction works in the Lower Fish River. Ndlambe Local Municipality
- Surface Water and Groundwater Quality Annual Report, for Kenmare Mining, Mozambique
- Project Manager and Surface Water Quality Specialist: Surface and groundwater quality monitoring program for the East London Industrial Development Zone

Aquatic Ecology Specialist Assessments:

- Aquatic Ecology Baseline Survey and Impact Assessment (Macroinvertebrates and Water quality). Syrah Resources Graphite Mine, Mozambique.
- Aquatic Ecology Baseline Survey and Impact Assessment (Macroinvertebrates and Water quality). Baobab Iron Ore Mine, Mozambique.

Other:

- Waste License for the DAS Electro-coating Facility Wastewater Treatment Works EIA
- Eastern Cape Parks and Tourism Authority Upgrade of the Water and Wastewater Treatment works at Double Mouth Camp site EIA
- Department of Water Affairs: Lusikisiki Regional Bulk Water Supply Scheme EIA
- Ndlambe Local Municipality Bulk Water Supply Scheme EIA
- TNPA Foreshore Reclamation Project EIA, Port of East London
- Eskom Distribution Power line EIAs (x4)

October 2008 – July 2009 Water Scientist, Golder Associates Africa

Surface and Groundwater Specialist Assessments:

- Surface water specialist information gap analysis for LIFEX coal mine extension project for AngloCoal.
- Water quality trainee: Comprehensive reserve determination for the Lower and Middle Vaal Water Management Areas (DWAF).
- Water quality trainee: Intermediate reserve determination of the Crocodile (West) and Marico Water Management Areas (DWAF)

Other:

- The linear flow channel reactor for oxidation of sulphide in semi-treated acid mine drainage for the Water Research Commission (WRC)
- Construction and operation of an Integrated Managed Passive (IMPI) demonstration scale acid mine drainage treatment plant for BHP Billiton
- Metal removal using sulphate reducing bacteria (SRB) from acid mine drainage for Landau Colliery (AngloCoal)

RESEARCH & TEACHING EXPERIENCE

I have had my research published in peer-reviewed journals and have presented at various international conferences. A full list of publications is available upon request. My area of research is environmental biotechnology, with emphasis on industrial wastewater treatment technologies, particularly from the mining sector.

BILL ROWLSTON

Full name:	William Stuart John Rowlston
Date of Birth:	6th June 1949
Nationality	South African (by naturalisation); English (by birth)
Languages:	English (fluent, all aspects), Afrikaans (understand)

PRESENT POSITION

Director, Coastal and Environmental Services (Pty) Ltd, Grahamstown, South Africa

ACADEMIC QUALIFICATIONS

BSc Honours Class 1, Civil Engineering, University of Salford, England, 1971

PROFESSIONAL MEMBERSHIPS

- Fellow of the Water Institute of Southern Africa
- Member of the South African Society of Aquatic Scientists (Silver Medal holder)

PROFESSIONAL EXPERIENCE (in reverse date order)

2007-Present: Coastal & Environmental Services, Grahamstown, RSA

- International Lenders' Environmental and Social Compliance reviews / monitoring for:
    - Two solar concentrated power facilities, Northern Cape Province of South Africa.
    - Small-scale hydroelectric project, North Eastern Zimbabwe.
    - Corporate E&S Review for electricity transmission and distribution company, North-West Province, Zambia.
    - Two large hydro-electric projects, Zambia.
    - The rehabilitation of the Rift Valley Railway, Kenya and Uganda.
    - Solar PV facility in, Northern Cape Province of South Africa
    - Agri-Industrial conglomerate, South Africa
- Project manager for:
    - ESHIA for a mini-steel mill in Port Loko, Sierra Leone
    - EIAs for two ferro-manganese smelters in the Coega IDZ, Port Elizabeth.
    - EIA for the Mooi-Mgeni Water Transfer Scheme, Phase 2, KZN Province, South Africa.
    - Determination of the environmental water requirements for the Kafue River, downstream of a proposed hydro-electric project.
    - Determination of environmental water requirements for the Musangezhi River, Zambia, downstream of a major copper mining operation.
    - A number of Basic Assessments (agri-industrial, residential, commercial), Eastern Cape Province, South Africa
- Water resources specialist for a number of mining, agri-industrial and bio-fuel projects in Mozambique and Zambia.
- Team member (water policy and institutional specialist) for the review and revision of Vietnam's Law on Water Resources (in Hanoi).
- Strategic advisor in the development of South Africa's National Groundwater Strategy.
- Contributor to a review of South Africa's experience with environmental water requirements. Lead author for two chapters on the history of the development of water law in South Africa, and institutional arrangements.
- Co-author of a Technical Report for the Ramsar Convention on Wetlands: Determining and Implementing Environmental Water Requirements (not published – reasons unknown).

- Technical support and training for Catchment Management Agencies in developing catchment management strategies.
- Project manager / specialist water studies for various environmental impact assessments.
- Team member for the regulatory Impact Assessment for the SA Department of Environmental Affairs' Integrated Coastal Management Bill.
- Legal review for Knysna's Estuary Management Plan.

1992-2007: Department of Water Affairs & Forestry, Pretoria, RSA – policy and strategy development

- Formulation and analysis of policies and strategies for water resources management, including nine years' involvement with the development and formulation of the National Water Policy (1997), the National Water Act (1998), and the National Water Resource Strategy, First Edition (2005).
- Co-authored and compiled the National Water Resource Strategy, First Edition, 2004
- Project leader for the development of guidelines for the preparation of catchment management strategies
- Contributed to investigations into the effects on water resources and the implications for water resources management of global climate change. Member of the National and Government Climate Change Committees.
- Investigations into the potential for augmenting water resources by artificially enhancing rainfall by cloud seeding.
- Co-ordination of activities to implement the National Water Act, 1998, including ensuring coherence with other legislation related to, *inter alia*, the provision of water services, the management and conservation of the natural environment, agriculture, industrial development and financial management in the public sector.

1982-1993: Department of Water Affairs & Forestry, Pretoria, RSA – hydraulic analysis and modelling

- Hydraulic analysis, and physical and mathematical modelling of weirs, dam spillways, pipelines and fixed and mobile bed open channels.
- Conceptual and hydraulic design of fish passage facilities.
- Hydraulics aspects of the development of a methodology for determining the instream flow requirements for the maintenance of ecological functioning of rivers - the Reserve of the National Water Act. (Principal author of the chapter dealing with the hydraulic aspects of determining in-stream flow requirements in the Building Block Methodology Manual, King *et al* 2000).
- Hydraulics specialist in environmental impact assessments and environmental water requirement assessments for dams and associated water resources developments.

1971-1982: various English engineering consultants and water organisations

- Planning, design and supervision of construction of small and large scale works of sewerage and sewage treatment in rural and urban areas (various English consultants)
- Planning, design and construction supervision of large water supply schemes (North-West Water Authority, England)

CONFERENCE PRESENTATIONS

▸ Invited/keynote speaker at a number of national and international conferences and congresses, including -

- The International Congress on Large Dams, Durban, 1994: The South African approach to determining the instream flow requirements of rivers.

- Biennial conference of the South African National Committee of the International Association of Hydrologic Sciences, Pretoria, 1998: The South African National Water Policy.
- South African Institution of Civil Engineers annual conference, Johannesburg, 2001: The National Water Resource Strategy.
- International Conference on Environmental Flows, Cape Town, 2002: A brief history of environmental flows in South Africa with special reference to the policy, legislative and water research regimes.
- Joint South Africa / Australia workshop on water resources management (under the auspices of the SA Academy of Engineers and the Australian Academy of Engineering and Technological Sciences), Melbourne, 2003: Approaches to water pricing and funding new water resources infrastructure.
- VIIth International Rangeland Congress, Durban, July 2003: A National Strategy for Implementing South Africa's National Water Act: Opportunities for Synergy with Rangeland Management.
- Biennial Groundwater Conference of the Groundwater Division of the Geological Society of South Africa, Pretoria, March 2005: The National Water Resource Strategy: Implications for Groundwater Management.
- International workshop iin Volunteerism, Democracy, Administration and the Evolution of Future Landscapes (invited participant), organised by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Perth Australia, April 2006.

In addition, a large number of presentations on aspects of the National Water Policy, the National Water Act and the National Water Resource Strategy to a wide range of audiences from 1998 to 2006.

TARRYN MARTIN (M.Sc)

Date of Birth: 17-11-1982

QUALIFICATIONS

- M.Sc Botany with distinction (Rhodes University)
- B.Sc Hons. African Vertebrate Biodiversity (Rhodes University)
- B.Sc Botany and Zoology (Rhodes University)

COURSES

2012 – EIA Short Course, Rhodes University and CES, Grahamstown

MEMBERSHIP

- South African Council of Natural Scientific Professions (SACNASP). Registered as a Professional Natural Scientist (400018/14).
- Member of the South African Association of Botanists (SAAB)
- Member of Golden Key International Honour Society

THESIS

Photosynthetic and evolutionary determinants of the response of selected C3 and C4 (NADP-ME) grasses to fire.

AWARDS AND NOTABLE ACHIEVEMENTS

2011 - Junior Captain Scott-Medal (Plant Science) for producing the top MSc of 2010 from the South African Academy of Science and Art

2010 - Award for Outstanding Academic Achievement in Range and Forage Science from the Grassland Society of Southern Africa

SELECTED PUBLICATIONS

Martin, T; Osborne, C and Ripley, B. (2012). Fire ecology of C3 and C4 grasses: a comparison of four co-occurring lineages. Submitted for review.

Ripley, B; Donald, G; Osborne, C; Abraham, T and Martin, T. (2010). Experimental investigation of fire ecology in the C3 and C4 subspecies of Alloteropsis semialata. Journal of Ecology. 98 (5): 1196 - 1203

South African Association of Botanists (SAAB) conference, Grahamstown.
January 2010 Title: Responses of C3 and C4 Panicoid and non-Panicoid grasses to fire.

South African Association of Botanists (SAAB) conference, Drakensberg.
January 2008. Title: Photosynthetic and Evolutionary determinants of the response of selected C3 and C4 (NADP-ME) grasses to fire.

PROFESSIONAL EXPERIENCE

May 2012 – Present: Environmental Consultant and Botanical Specialist (Coastal and Environmental Services, Grahamstown). Duties include conducting botanical and ecological assessments for local and international EIAs in southern Africa, identifying and mapping vegetation communities and sensitive areas, designing and implementing monitoring plans, designing rehabilitation and biodiversity offset plans, managing project budgets, coordinating specialists and site visits.

October 2011 – January 2012: Accounts Manager (Green Route DMC, Cape Town). Duties included project and staff co-ordination, managing large budgets for incentive and conference groups travelling to southern Africa, creating tailor-made programs for clients, negotiating rates with vendors and assisting with the ground management of inbound groups to ensure client satisfaction.

April 2011 – September 2011: Camp Administrator and Project Co-ordinator (Windsor Mountain International Summer Camp, New Hampshire, USA). Co-ordinated staff and camper travel arrangements, coordinated main camp events, assisted with marketing the camp to prospective families.

October 2010 – April 2011: Freelance Project Manager (Green Route DMC, Cape Town). Duties included project and staff co-ordination, managing large budgets for incentive and conference groups travelling to southern Africa, creating tailor-made programs for clients, negotiating rates with vendors and assisting with the ground management of inbound groups to ensure client satisfaction.

June 2010 – October 2010: Camp Counselor (Windsor Mountain International Summer Camp, New Hampshire, USA)

April 2009 – May 2010: NERC Research Assistant (Botany Department, Rhodes University, Grahamstown in collaboration with Sheffield University, Sheffield, England). Set up and maintained experiments within a common garden plot experiment, collected, collated and entered data, assisted with the analysis of the data and writing of journal articles.

March 2007 – October 2008: Head Demonstrator (Botany Department, Rhodes University, Grahamstown).

September 2005 – February 2007: Operations Assistant (Green Route DMC, Cape Town). Project co-ordination.

CONSULTING EXPERIENCE

Environmental consulting experience as project manager or team member is broad and covers a number of key areas. Specific experience includes the following:

Forestry Projects

- Lurio Green Resources Plantation Project Botanical Assessment, Vegetation and Sensitivity Mapping, Specialist Co-ordination and Mozambique

Mining Projects

- Toliara Mineral Sands Rehabilitation and Offset Strategy Report, Madagascar
- Syrah Resources Ecological Assessment, Cabo del Gado, Mozambique
- Baobab Mining Ecological Assessment, Tete, Mozambique

Ecological Monitoring Projects

- Kenmare Terrestrial Monitoring Program Project Manager and Specialist Survey, MOMA, Mozambique (ongoing)

Ecological Baseline Surveys

- LHDA Botanical Survey and Impact Assessment, Lesotho
- Eco Planet Bamboo Baseline Study and Ecological Assessment, Eastern Cape, South Africa

Wind Energy Facility Projects

- Dassiesridge Wind Energy Facility Project Manager, Eastern Cape, South Africa
- St Lucia Wind Energy Facility Scoping Report, Kwa-Zulu Natal, South Africa
- Inyanda Wind Energy Facility Scoping Report , Eastern Cape, South Africa
- Tsitsikamma Wind Energy Facility Community Power Line Ecological Assessment, Eastern Cape, South Africa
- Golden Valley Wind Energy Facility Power Line Ecological Assessment, Eastern Cape, South Africa
- Middleton Wind Energy Facility Ecological Assessment and Project Management, Eastern Cape, South Africa
- Mossel Bay Power Line Ecological Assessment, Western Cape, South Africa

Ecological Groundtruthing Projects

- Harvestvale botanical groundtruthing assessment, Eastern Cape, South Africa
- Groundtruthing the turbine sites for the Waainek Wind Energy Facility, Eastern Cape, South Africa
- Cob Bay botanical groundtruthing assessment, Eastern Cape, South Afica

Due Diligence

- Solar Capitol Solar Photovoltaic Energy Facility Environmental and Social Compliance Monitoring Project Manager, Northern Cape, South Africa

DR GREER LEIGH HAWLEY

Date of birth: 30 May 1978

QUALIFICATIONS

BSc (University of Cape Town)
BSc (Botany Hons) (University of Cape Town),
PhD (Rhodes University)
Training in Greenhouse Gas Accounting for Forest Inventories (Greenhouse Gas Management Institute)

ASSOCIATIONS

- South African Association of Microbiology
- International Association for Impact Assessment
- South African Association of Botany

PROFESSIONAL EXPERIENCE

1998 : Botanical consultant: University of Cape Town
Laboratory assistant: University of Cape Town
1999 : Undergraduate Tutor: University of Cape Town
2000- 2001 : Temporary administrative position: Robert Half International,
London
Assistant Office Manager: Warwick House, London
Office administration: West London Magistrates Court, London
2002 : Laboratory Assistant: Amphigro
2002- 2007 : Undergraduate Tutor: Botany and Microbiology, Rhodes
University
2006- 2007 : Laboratory researcher: Abalone Probiotic isolation and testing,
Rhodes
University
2007 : Laboratory assistant and product quality control: Mycoroot
(Pty) Ltd,
Grahamstown
2007- present : Principal Environmental Consultant - Coastal & Environmental
Services

- Environmental Impact Assessments
- Ecological and Carbon Stock Specialist studies
- Provide input, report writing and management of Spatial Development Frameworks
- Provided input and carry out report writing of Environmental Feasibility studies

RESEARCH INTERESTS

In the last 10 years, Dr Greer Hawley has been involved in a number of diverse activities. The core academic focus has however, been directed in the field of taxonomy both in the plant and fungal kingdom. The theory of taxonomy and phylogenetic analysis has been applied to further knowledge of species identification and understanding of biodiversity in South Africa. Greer's research ranges from studying fresh and marine algae, estuarine diatoms, *Restio* species classification in the fynbos vegetation and fungal species identification and ecology in *Pinus* plantation in Mpumalanga. Greer's microbiological study of Ectomycorrhizal fungi has also contributed towards an understanding of soil ecology and “below ground” networks, including saprotrophic and mutual symbiotic micro-organisms.

POST GRADUATE STUDENT SUPERVISION

2005 – 2007: 3 Honours students in the Mycology Unit, Rhodes University
2006: MSc student in the Mycology Unit, Rhodes University.

SELECTED RECENT PUBLICATIONS

Hawley GL and Dames JF. 2004. Mycorrhizal status of indigenous tree species in a forest biome of the Eastern Cape, South Africa. South African Journal of Science 100, 633-637.

Hawley GL and Dames JF. **(2008).** Ectomycorrhizas in association with *Pinus* in South Africa. South African Journal of Science.

RECENT CONFERENCE PAPER/PUBLICATIONS

2010: Hawley, GL, McMaster AR and Carter AR. The Environmental and Social Impact Assessment, and associated issues and challenges associated with Biofuels. African, Caribbean and Pacific Group of States (ACP), Science and Technology Programme, Sustainable Crop Biofuels in Africa.

2009: Hawley, GL, McMaster AR and Carter AR. Carbon, carbon stock and life-cycle assessment in assessing cumulative climate change impacts in the environmental impact process. International Association of Impact Assessors.

2008: Hawley GL and Dames JF. Ectomycorrhizal species diversity above- and below ground comparison in *Pinus patula* (Schlecht et Cham) plantations, South Africa. South African Society for Microbiology (Poster presentation).

2006: Hawley,GL and Dames,JF. Morphological and molecular identification of ectomycorrhizal fungi in *Pinus* plantations. South African Society of Microbiology.

RECENT ENVIRONMENTAL MANAGEMENT EXPERIENCE

Specialist Ecological/Biodiversity studies

- ***Addax BioEnergy (2009/2010), Biodiversity and Ecological Impact Assessment AND Carbon Stock Impact Assessment, Sierra Leone.***

The above specialist studies were submitted as separate deliverables and are described separately.

Biodiversity and Ecological Impact Assessment: This study involved the survey of a 60 000 ha site in Sierra Leone. The vegetation types were described and assessed in terms of biodiversity and overall ecological sensitivity. In addition, the area was surveyed by local experts for the presence of rare and endangered faunal species, for inclusion into the report. All vegetation types were mapped using GIS. The assessment was compiled for international review in accordance with World Bank standards.

Carbon Stock Impact Assessment: In accordance with the EU directive, Biofuel production needs to demonstrate a 30% reduction in carbon emissions compared to fossil fuels. For this reason, a Carbon Stock study was carried out to determine site specific carbon stocks. ***This study included field calculations, vegetation and soil sampling and carbon stock calculations according to internationally accepted standards and using best practice guidelines.*** Using the detailed GIS vegetation maps, total carbon stocks could be calculated. Sample collection included local academic soil scientists. This study and associated methodology was compiled according to the International Panel on Climate Change (IPCC) standards.

- ***Wild Coast Forest Survey: (2009-2010) Department of Water and Forestry / Eastern Cape Parks Board initiative***

The forest survey included substantial field work and data collection of the following: plant species identification, GPS mapping of forest boundaries, forest-typing and identifying and quantifying disturbance impacts.

- ***Mncwasa Water Scheme (2009): Ecological Sensitivity Assessment***

This assessment involved a detailed vegetation survey of forest vegetation and wetlands along anticipated and alternative pipeline routes. The survey included an assessment of the environmental sensitivity along the route and recommendations for mitigation and environmentally acceptable alternatives.

- ***Peregrine Dunes Golf Estate (2009): Vegetation Rehabilitation Plan and Ecological Impact Assessment***

The Ecological Impact Assessment and Rehabilitation Plan were represented as two reports for the same project. The work carried out on the Ecological Impact Assessment included report revision writing.

The Rehabilitation Plan was submitted as part of the Environmental Management Plan and incorporated elements of re-vegetation, alien plant removal and rehabilitation, landscape restoration, based on widely accepted concepts of soil ecology and plant succession ecology.

Feasibility studies

- ***Nkanya Lodge Feasibility Study: Eastern Cape Development Corporation (ECDC) initiative***

Aspects of this study included the consideration of the economic and financial viability of the proposed project as well as the environmental risks and alternative technologies.

Full Scoping and Environmental Impact Assessments (South African National Environmental Management: EIA regulations)

- ***Buffalo City Municipality R72 national road re-alignment (2007-2008): Sleeper site***

Responsibilities included: Project Management, budget management, written report, public participation and engagement with key stakeholders throughout the EIA process. Environmental approval obtained.

- ***Wild Coast Abalone expansion and processing plant (2008)***

Responsibilities included: Project management, budget management, written reports, public participation and stakeholder engagement with key stakeholders. Environmental approval obtained.

- ***All Saints Hospital Waste Water Treatment Works (2012)***

Responsibilities included: Project management, budget management, written reports, public participation and stakeholder engagement with key stakeholders. Environmental approval obtained.

- ***Qolora Aquaculture Development Zone (2011)***

Responsibilities included: Project management, budget management, written reports, public participation and stakeholder engagement with key stakeholders. Environmental approval obtained.

- ***Jamestown Waste Water Treatment Works (2012)***

Responsibilities included: Project management, budget management, written reports, public participation and stakeholder engagement with key stakeholders. Environmental approval obtained.

- ***Ntabankulu Waste Water Treatment Works (2012)***

Responsibilities included: Project management, budget management, written reports, public participation and stakeholder engagement with key stakeholders. Environmental approval obtained.

- ***Qamata: No-gate Waste Water Treatment Works (2012)***

Responsibilities included: Project management, budget management, written reports, public participation and stakeholder engagement with key stakeholders. Environmental approval obtained.

- ***St Patricks Hospital Waste Water Treatment Works (Current)***

Responsibilities included: Project management, budget management, written reports, public participation and stakeholder engagement with key stakeholders.

State of Environment (SoER) and Environmental Management Plans (EMP) for:

- OR Tambo District Municipality, Eastern Cape Province, South Africa (2009-2010). Accepted by council.
- Ukhahlamba (Joe Gqabi) District Municipality, Eastern Cape Province, South Africa. (2011)
- Mnquma Local Municipality, Eastern Cape Province, South Africa (2012)

Activities:

- Field survey of district municipality through aerial surveying and field work reporting of whole district municipality (incorporating 4-7 local municipalities).
- Continued interaction with municipal representatives and key stakeholders
- Workshops held with key role-players and decision-makers
- Review of planning document and integrated development programs.
- Identification of key environmental issues
- Selection of priority environmental issues
- Development of Environmental Management Action Plans directly aimed at mitigated priority issues.

Responsibilities:

- Overall project manager,
- Budget management,
- Report writing,
- Team delegation and management and
- Client liaison.

Additional Specialist studies

- Sensitive Ecology Assessment: Mncwasa Water Scheme
- Vegetation Rehabilitation Plan: Peregrine Dunes Golf Estate
- Ecological Impact Assessment: Peregrine Dunes Golf Estate
- Vegetation Assessment: Atterbury Development
- Wild Coast Forest Survey: (current) DWAF/EC Parks initiative
- Biodiversity and Ecological Impact Assessment, Sierra Leone, Addax Biofuels
- Land use Impact Assessment, Sierra Leone, Addax Biofuels

- Thyspunt – Melkhout Eskom Power line, Ecological Impact Assessment
- Ecological Impact Assessment: Chaba Wind Energy Facility
- Ecological Impact Assessment: Chaba Wind Energy Facility
- Ecological Impact Assessment: Qunu Renewable Energy Facility
- Ecological Impact Assessment: Ncora Renewable Energy Facility
- Ecological Impact Assessment: Ngqamakwe Renewable Energy Facility
- Ecological Impact Assessment: Qumbu Wind Energy Facility
- Terrestrial Ecology Impact Assessment: Qolora Aquaculture Zone
- Toboshane Valley Estate: Ecological Impact Assessment
- Toboshane Valley Estate: Conservation Management Plan
- Floral Biodiversity and Impact Assessment: Niassa Green Resource, Mozambique

THOMAS KING

Date of Birth: 13-10-1987

QUALIFICATIONS

- BSc Honours Biodiversity and Conservation (Rhodes University)
- BSc Zoology (University of Pretoria)

MEMBERSHIP

- South African Council for Natural Scientific Professions (Candidate Environmental Scientist)

PROFESSIONAL EXPERIENCE

January 2006 – December 2006: Field assistant (Remote Exploration Services)
January 2011 – April 2011: GIS technician (Conservation Support Services)
April 2011 – Present: Environmental consultant (Coastal & Environmental Services)

CONSULTING EXPERIENCE

Environmental consulting experience as a project manager, report writing and GIS manager for various development types. Specific experience includes the following:

Forestry

- Lurio Green Resources Forestry Environmental and Social Impact Assessment.
- Niassa Plantation Environmental and Social Impact Assessment.
- Equatorial Palm Oil Liberia Environmental, Social and Health Impact Assessment.
- Ugandan Palm Oil Environmental and Social Impact Assessment.

Renewable energy

- EIA for Richards Bay Wind Energy Project, EAB Astrum Energy
- EIA for Hluhluwe Wind Energy Project, Kimocode (Pty) Ltd
- EIA for Plan 8 Wind Energy Project, Infinite Plan 8
- EIA for St Lucia Wind Farm, St Lucia Wind Farms (Pty) Ltd
- EIA for Coega Wind Farm, InnoWind (Pty) Ltd
- EIA for Brakkefontein Wind Farm, Terra Power Solutions

Agriculture and waste management

- Basic environmental assessment for the development of a chicken rearing facility in the Paterson district of the Eastern Cape, Eco Pullets (Pty) Ltd.

Mining

- Pre-feasibility risk assessment for the development of a heavy minerals mine on the West Coast of South Africa, Zirco Resources (Pty) Ltd.
- Environmental Control Officer for the Kenmare Heavy Mineral Mine, Nampula Province, Mozambique.

SPECIALIST ASSESSMENTS

- Visual Impact Assessment for the Syrah Resources Graphite Mine, Cabo Delgado, Mozambique. Completed: August, 2013.
- Visual Impact Assessment for the Zirco Roode-Heuwel Mine in the Northern Cape of South Africa. Completed: March, 2014.

RESEARCH & TEACHING EXPERIENCE

I have completed a study on the rate at which Sub-tropical Thicket (an Eastern Cape vegetation type) recovers after heavy grazing by ostriches. This study was done as part of my honours degree at Rhodes University.

JAN ANTON HOUGH (MA Sociology)

Date of Birth: 30-05-1986
Unmarried

QUALIFICATIONS

MA (Sociology) 2011 - University of Stellenbosch (South Africa)
Hons (Sociology) 2009 - University of Stellenbosch (South Africa)
Accredited Resettlement Action Planning Training Course (Rhodes University) 2013
Microsoft Access Training Course 2014 (South Africa)

MEMBERSHIP

None currently

PROFESSIONAL EXPERIENCE

April 2012 – Present: Social scientist (Coastal and Environmental Services)

- **March 2011 – March 2012:** Employed as a social scientist for Umsizi Sustainable Social Solutions (Umsizi), a social science consultancy firm in Johannesburg working within the mining sector. Worked extensively with mining communities, developing and implementing Socio-Economic Development (SED) programmes.
- **January 2010 – December 2010:** Intern for an internet-based African research consultancy firm (Consultancy Africa Intelligence). Writing discussion papers on socio-environmental matters in Africa. Gaining experience in writing and editing papers, developing an environmental publication series, while gaining insight into relevant environmental policies and debates.
- **January 2009 – December 2011:** Masters thesis: Beneficiary dependence on the National Working for Water Programme in the Western Cape (one published article in the ISI-accredited *Social Dynamics*). MA bursary from the DST-NRF Centre of Excellence for Invasive Biology (C.I.B). Extensive experience in large-scale socio-economic baseline studies, quantitative and qualitative data analysis and fieldwork coordination.
- **January - December 2008:** Honours mini thesis: Involuntary resettlement of the Coleske residents living within the Baviaanskloof Nature Reserve (one published article in the ISI-accredited *South African Geographical Journal*). Gained in-depth experience in resettlement issues and debates in Africa and quantitative and qualitative data analysis and report writing.

CONSULTING EXPERIENCE

Social scientific consulting experience obtained at Umsizi:

- Baseline Socio-Economic Study Surveys (BSESS) and Socio-Economic Development
- 2011. Eskom Holdings South Africa. Conducted extensive desktop research and compiled a Socio-Economic Development (SED) Research Report and Framework;
- 2011. Tendele Mining Group. Conducting a Baseline Socio-Economic Survey Study (BSESS) of both the employees and labour-sending and surrounding communities of the Somkhele Mine in KwaZulu-Natal [Tendele Mining group] in 2010. Compilation of a community BSESS Report, an Employee BSESS Report as well as an Integrated Sustainable Management Framework Report. I was a fieldwork coordinator for this project for about 15 fieldworkers;
- 2011. Eskom Holdings South Africa. Conducted research (face-to-face interviews and focus groups) of the new Eskom building plant, Kusile, and compiling a Baseline Socio-Economic Development Assessments Report for the new station’s labour-sending and surrounding communities; and
- Integrated Reporting project manager for Evraz Mapochs Mine in South Africa, subsidiary mine of Evraz Highveld Steel and Vanadium. Monthly reporting on its SED, sustainability and social investments.

- Strategic Environmental Assessment

- 2012: Assisted in the compilation of a Scoping Report for Nuco Chrome Mine in South Africa

Projects involved in at CES

- *General*
- 2012: Environmental and Social Due Diligence for First Quantum Minerals Ltd
- 2012: Socio-Economic Baseline Study (SEBS) for Liberian Palm Developments (LPD) oil palm estate projects (Liberia)
- 2012-2014: SEBS for the Lesotho Highlands Development Authority (Lesotho)
- Lender group: Environmental and Social Due Diligence Gap-Analysis for the Kabompo Gorge Hydro-Electric Power Project in Zambia
- 2012. First Quantum Minerals Ltd: Social Due Diligence Gap-Analysis in accordance with the Performance Standards (PS) of the IFC
- Social and Labour Plan for Zirco Resources Pty Ltd (South Africa)
- Grievance Address and Dispute Resolution Procedure for Lurio Green Resources (LGR) in Mozambique
- Stakeholder Engagement Plan for Savannah Environmental Pty Ltd.

- *Resettlement Action Plans (RAPs)*
- 2013-present: RAPs for LPD oil palm estate projects (Liberia)
- 2013-present: RAP for Syrah Resources Ltd in Mozambique
- 2013-present: RAP for EcoFarm Lda. Irrigation and Sugarcane Scheme, Mozambique

- *Social Impact Assessments (SIAs)*
- 2012: SIA for Samshi Ltd. (Sierra Leone)
- 2013: SIA for LPD oil palm estate projects (Liberia)
- 2013: SIA for Syrah Resources Ltd. in Mozambique
- 2013: SIA for EcoFarm Lda. Irrigation and Sugarcane Scheme, Mozambique
- 2014: SIA for Zirco Resources Pty Ltd. (South Africa)
- 2014: SIA for Mainstream South Africa (Waaihoek Wind Energy Facility) (South Africa)

- *Socio-Economic Baseline Study (SEBS)*
- 2014: Socio-Economic Baseline Study of the Bisie Tin Project in the Democratic Republic of the Congo (DRC) for Mining Processing Congo (MPC) SPRL and Alphamin Resources Corp

- *Environmental, Health and Social Impact Assessment (ESHIA)*
- 2012-2013: Part of a team that is conducting an ESHIA of the LPD oil palm estate projects (Liberia)
- 2012. Green Resource Niassa: Niassa Green Resources Plantation Project in Mozambique. Assisted with the report compilation of the ESHIA
- 2014. Part of a team that is conducting an ESIA of the Garoua and Maroua oil mills in Cameroon for Society of the Development Corporation of Cotton (SODECOTON).

Selected publications and conferences presented:

- *Web publications:*

Hough, J.A. 2010. Carbon trading: the real threat facing Africa? [Online]. Available: http://www.consultancyafrica.com.
Hough, J.A. 2010. The protection of coastal marine ecosystems in sub-Saharan Africa. [Online]. Available: http://www.consultancyafrica.com.
Hough, J.A. 2010. Understanding invasive alien species in Africa. [Online]. Available: http://www.consultancyafrica.com.
Hough, J.A. 2010. The battle to save Africa’s horn: rhino poaching depletes conservation efforts in Southern Africa. [Online]. Available: http://www.consultancyafrica.com.

Hough, J.A. 2011. Climate talks in Cancún, Mexico: a step forward? [Online]. Available: http://www.consultancyafrica.com.

- *ISI-listed scientific journals:*

Hough, J.A & Prozesky, H.E. 2010. “But we don’t spoil it, we protect it” A case study of the Coleske residents’ conceptualisations of the Baviaanskloof Nature Reserve and its protection. South African Geographical Journal, 92(2): 1-13.

Hough, J.A & Prozesky, H.E. 2011. “I don’t want to go back to the farm”: A multi-site case study of Working for Water beneficiaries’ fear of returning to farm work. South African Journal of Science. [being published]

Hough, J.A & Prozesky, H.E. 2011. Beneficiaries’ aspirations for permanent employment within the South African Working for Water Programme. *Social Dynamics*, 39(2): 331-349.

- *Conferences presented*

Hough, J.A. “No boss shouting at you”: A multi-site case study of Working for Water beneficiaries’ fears of returning to farm work. Paper presented at the ASSAf-DST-NRF First Annual South African Young Scientists’ Conference, Pretoria, 12-13 October 2010.

Hough, J.A. & Prozesky, H.E. Creating independent entrepreneurs? A multi-site case study of beneficiaries’ aspirations for permanent employment within the South African Working for Water Programme. Paper presented at the 6th European Conference on Biological Invasions NEOBIOTA: ‘Biological Invasions in a Changing World -from Science to Management’, Copenhagen, 14-17 September 2010.

Presented MA thesis’ preliminary findings at the New Social Forms Seminar, Department of Sociology and Social Anthropology, May 2010: Stellenbosch.

Presented MA thesis’ preliminary findings at the National WfW’s Training and Social Development Meeting, May, 2010: Cape Town.

Presented thesis research proposal at the Sociology and Social Anthropology Department, June 2009: Stellenbosch University.

Presented thesis proposal at the CapeNature AVM Quarterly Meeting, June 2009: Oudtshoorn.

South African Sociology Association (SASA) Conference, in June/July 2009. Presented an article (based on honours thesis) with co-author, Dr. H.E.: “Why would they destroy it?” A case study of contested conceptualisations of the environment and its protection: Johannesburg.

Presented thesis proposal as part of the DST-NRF Centre of Excellence for Invasive Biology’s (bursary holder) Annual Research Meeting, Nov 2009: Stellenbosch.

Poster presentation of thesis proposal as part of the DST-NRF Centre of Excellence for Invasive Biology’s (C.I.B.) Annual Research Meeting, Nov 2009: Stellenbosch.

LUNGISA ROSEMAN BOSMAN

Date of birth: 9 July 1968

QUALIFICATIONS

1993	UCT	B Soc. Sci. (Public Administration and Sociology)
1997	UCT	Post Graduate Diploma in Organisation and Management
2002	Rhodes	Certificate in Management

WORK EXPERIENCE

1995	Contract supervisor for Kat River Citrus Co-op
1998	Part-time site supervisor for Ikamva Builders
2001	Social Facilitator for the *Learn to Value Water* project (Institute for Water Research, IWR)
2002	Part-time post at the National Science Festival: *Bringing Science to the People* (Institute for Water Research, IWR)
2002	Commissioned by the Water Research Commission (WRC) to co-ordinate a short course on *How Ecosystems Work – Goods and Services* (Institute for Water Research, IWR)
2002	Environmental Impact Assessment for a bridge at Hertzog (worked with environmental consultant, Anton Bok)
2002	Sub-consultant to Coastal & Environmental Services (CES) in a project for developing an Environmental Implementation Plan for the Amatole District Municipality
2002 – 2003	Junior Research Officer with the *Working for the Wetlands* inventory group (Institute for Water Research, IWR)
April 2003 – 2004	Full-time Environmental Consultant – joint post with Coastal & Environmental Services (CES) and the Institute for Water Research (IWR)
2004- present	Senior Environmental Consultant – (CES)

PROJECTS INVOLVING STAKEHOKDER ENGAEMENT/ PUBLIC PARTICIPATION

- Development of a State of Environment Report for Amatole District Municipality
- Development of an Environmental Management System for Ukhahlamba District Municipality
- Development of an Environmental Management Plan for Chris Hani District Municipality
- Doing a Social Impact Assessment for Coffee bay Hole-in-the Wall
- Development of the Great Kei Strategic Environmental Assessment
- Knysna N2 Toll Highway – Public Participation
- Fishwater Flats Wastewater Treatment Upgrade- Public Participation
- Tsitsa River Basin Land Use Plan – Project manager and Public Participation

- Qolora Abalone Fish Farm- Public Participation
- Kalagadi Manganese Smelter- Public Participation
- Innowind Ncora Wind Energy Project- Public Participation
- Innowind Ngqamakhwe Wind Energy Project- Public Participation
- Malawi Kangankunde Monazite Mine- Social Impact Assessment
- Joe Gqabi District Municipality EMP- Public Participation and Institutional Arrangements
- Ndakana Zero Waste Agricultural Project- Public Participation and Institutional Arrangements
- Laguna Bay Resort EIA- Public Participation
- Coega Filling Station EIA- Public Participation
- Egazini Memorial Centre- Project Manger and Public Participation
- Witsand Dune Stabilisation- Project Manager and Public Participation
- Uitenhage Bulk Storwater Upgrade – Project Manager and Public Participation
- Mondile Street Stormwater Upgrade – Project Manager and Public Participation
- EP Oil Liberia Resettlement Action Plan

SOCIAL IMPACT ASSESMENTS

- Chibuto Corridor Sands EIA Mozambique
- N2 Wildcoast Toll Road
- Malawi Monazite Mine
- Madiba Bay Leisure park
- Coleske
- Ncora Wind Farm
- Peddie Wind Farm
- Great Kei Wind Farm
- Lurio Green Resources
- Syrah Graphite Mine
- Lusikisiki Regional Water Supply Scheme
- Innowind Ngqamakhwe
-

GENERAL PROJECT INVOLVMENT

- Port Alfred Waste Water Treatment Works
- Uitenhage Bulk Sewer Upgrade
- Jamestown Wastewater Treatment Works
- Ukhahlamba District Municipality Integrated Environmental Management Plan (IEMP)
- Mnquma Local Municipality IEMP
- Egazini Memorial Precinct Project, Grahamstown, Eastern Cape Province (Basic Assessment);
- Eskom Albany Mimosa Powerline Basic Assesment
- Eskom Hombe Substation and powerline
- Eskom Mfinizo substation and powerline
- Gansbaai Waste Water treatment Works (WWTW) EMP development, Western Cape

PROFESSIONAL MEMBERSHIP

- International Association for Impact Assessment (IAIAsa – Member No: 2416)

ROY DE KOCK (M.Sc.)

Date of Birth: 22-06-1976

QUALIFICATIONS

M.Sc. in Rehabilitation Ecology (Nelson Mandela Metropolitan University, 2010)
B.Sc Honours in Geology (Nelson Mandela Metropolitan University, 2008)
B.Sc Geology/Botany (Nelson Mandela Metropolitan University, 2007)
Diploma in Marketing (University of Witwatersrand, 2003).
EIA Course (Rhodes University, 2010)

MEMBERSHIPS

Environmental

- Registered as a Candidate Environmental Scientist with the South African Council for Natural Scientific Professions (SACNASP).

PROFESSIONAL EXPERIENCE

April 2010 – Present: Environmental Consultant (Coastal & Environmental Services)

June 2008 – March 2010: Laboratory Technician (Nelson Mandela Metropolitan University)

March 1995 – November 2003: Financial Advisor (ABSA Bank)

CONSULTING EXPERIENCE

Environmental consulting experience as project manager or team member is broad and covers a number of key areas. Specific experience includes the following:

Environmental Impact Assessment and pre-feasibility assessments

- Stone Vegetation Assessment, Kaizers Beach (2010)
- Eskom Vegetation Assessment, Elloit-Ugie-Sappi (2010)
- Eskom Melkhout 132kV Distribution EIA, Oyster Bay (2011)
- Bizana Mixed-use Development Scoping and full EIR, Bizana; Eastern Cape (Current)
- Toboshane Valley Estate EIA, East London (2011)
- Toboshane Valley Estate Visual Impact Assessment (2011)
- Thomas River Windfarm EIA, Cathcart (2010)
- Chaba Windfarm EIA, Komga; Eastern Cape (2010)
- Lushington Park Windfarm EIA, East London (2011)
- Lushington Park Windfarm Ecological Impact Assessment, East London (2011)
- Langa Solar Facility EIA, Berlin (2011)
- Red Cap 66kV Power line EIA, St. Francis, Eastern cape (2011)
- Red Cap 66kV Power line Ecological Impact Assessment, St. Francis, Eastern cape (2011)
- N9 road upgrade in Middelburg EIA, Eastern Cape (2012)
- Hard rock quarry licence and EMPr, Middelburg, Eastern Cape (2012)
- Ecological Impact Assessment in Hombe, Eastern Cape for a new Eskom 132kV power line (2012)
- Ecological Impact Assessment in Taweni, Eastern Cape for a new Eskom 132kV power line (2011)
- Ecological Impact Assessment in Mfinizo, Eastern Cape for a new Eskom 132kV power line (2011)

- ADM Sleeper site basic Assessment Report and Soil Contamination Assessment (2012)
- Eskom Mfinizo, Taweni and Hombe Basic Assessment Reports (2011).
- Tsolwane Road upgrade EIA, Tarkastad EIA (2012)
- Centane Road road upgrade EIA, Mazeppa Bay, Eastern Cape (Current)
- Innowind Peddie Solar facility EIA, Eastern Cape (2012)
- Innowind Peddie Solar and Wind facility Agricultural Impact study, Eastern Cape (2012)
- Innowind Peddie Solar facility Visual Impact study, Eastern Cape (2012)
- Innowind Peddie Solar facility Ecological Impact study, Eastern Cape (2012)
- Innowind Qumbu Solar and Wind facility Agricultural Impact study, Eastern Cape (2012)
- Innowind Qumbu Solar facility Visual Impact study, Eastern Cape (2012)
- Kangankunde Rare Minerals mine, Malawi, Rehabilitation Management Plan and Mine Closure Plan (2011)
- Kenmare Moma Titanium mine, Mozambique, Weed Control Plan and Species of Special Concern Management Plan (2011)
- GS Cimentos limestone mine, Maputu, Mozambique, Rehabilitation Management Plan and Mine Closure Plan (2011)
- Upgrade of the R61 between Baziya and Umthatha BAR (2012)
- Upgrade of the R61 between Baziya and Umthatha Ecological Impact Assessment (2012)
- Amatola Water Bulk Water Pipeline Ecological Report – Cannon Rocks to Alexandria (2012)
- Amatola Water Bulk Water Pipeline Ecological Report – Port Alfred Borehole Extraction & Treatment (2012)
- Amatola Water Bulk Water Pipeline Ecological Report – Bushmansriver to Cannon Rocks (Current)
- Ndabakazi Mixed-use Development Ecological Report (Current)
- Ndabakazi Mixed-use Development Geotechnical Assessment (Current)
- Goba water pipeline, Katberg, Eastern Cape Vegetation Assessment (2012)
- SSI Botanical Compliance for EA (2012)
- Terra Wind Middleton Wind Energy Facility Agricultural Impact Assessment (Current)

Policy and Guidelines

- Ukhahlamba District Municipality EMP, Eastern Cape (2010)
- Qamata LSDF, Eastern cape (2010)
- Water use license applications x 12 for N9 road upgrade, Middelburg, Eastern Cape (Current)
- Tsolwane Water use lisence applications, Tarkastad EIA (2012)
- Section 24G NEMA application for an unauthorised bridge build over the Black Kei river, Tarkastad, Eastern Cape (Current).
- Centane Road Water use license application, Mazeppa Bay, Eastern Cape (Current)
- Centane Road borrow pit license applications, Mazeppa Bay, Eastern Cape (Current)
- Upgrade of the R61 between Baziya and Umthatha Water use licence application (Current)
- Upgrade of the R61 between Baziya and Umthatha Mining License (Current)

Environmental Auditing and compliance

- TNPA Car Berth Dredging ECO, Port of East London (2010)

- Kenmare Moma Titanium mine, Mozambique. Development of Rehabilitation KPI's (2011)
- Eskom Zebra substation ECO, Cradock, Eastern Cape (2011)
- Tsolwane Road upgrade ECO, Tarkastad EIA (Current)
- Centane Road Upgrade ECO, Mazeppa Bay, Eastern Cape (Current)
- N9 road upgrade in Middelburg ECO, Eastern Cape (Current)
- Red Cap Kouga Windfarm ECO, St Francis Bay, Eastern Cape (Current)

RESEARCH

I assisted the Nelson Mandela Metropolitan University; Botany Department, headed by Prof. Janine Adams, in a 3 year monitoring program of Mangrove forests along the South African East Coast. We monitored growth of the different types of Mangroves as well as human impacts on the survivability of these forests.

B. External specialists

WILLIAM ROY BRANCH

Date of Birth: 12 May 1946
Nationality: British

QUALIFICATIONS

B.Sc.,	University of Southampton, 1968
Ph.D,	University of Southampton, 1971

PROFESSIONAL EXPERIENCE:

1972-1976	Scientist; Life Sciences Division, Atomic Energy Board, Pretoria, South Africa
1976-1978	Post-Doctoral Research Fellow; Department of Biology, University of Southampton, United Kingdom
1979-ongoing	Curator of Herpetology; Port Elizabeth Museum, South Africa

APPOINTMENTS

Member	IUCN SSC Captive Breeding Specialist Group (Herpetology), 1990 - ongoing
Board of Directors	IUCN SSC Declining Amphibian Population Task Group, 1991 - 1994
Chair	IUCN SSC African Reptile and Amphibian Group, elected for 1997-2000 and 2001-2004 triennia
Editor	Journal Herpetological Association if Africa; initially elected June 1983; re-elected 1985, 1987, 1989, 1991; retired Nov. 1993.
Committee Member	Herpetetological Association of Africa, 1989-2002
Editorial Board	*African Journal of Herpetology* 1994-ongoing
International Committee	First World Herpetological Congress, Canterbury, U.K., September 1989.
	Second World Herpetological Congress, Adelaide, December 1993 -January 1994.
Executive Committee	Third World Herpetological Congress, Prague - elected Adelaide 1994
Scientific Committee	Third World Herpetological Congress, Prague - elected July 1995
Executive Committee	Fourth World Herpetological Congress, Sri Lanka - elected Prague 1997
Scientific Committee	Fourth World Herpetological Congress, Sri Lanka - elected 2000
Editor	Revised South African Red Data Book - Reptiles and Amphibians S. Afr. Nat. Sci. Prog. Rpt 151: i-iv, 242p, 1988.
Board of Directors	International Congress Chelonian Conservation, Nice, France, 1994-5 (6-10 July, 1995).
Board of Directors	2nd International Congress Chelonian Conservation, Saly, Senegal, 2002-3 (18-220 June, 2003).
Editorial Review Board	Chelonian Conservation and Biology, international journal of the Chelonian Research Foundation; March 1997 - ongoing
Board	International Herpetological Society, May 1997- ongoing
Executive committee	Invited for nomination to Executive committee of the International Society for Vertebrate Morphology, September 2000. Appointment declined due to prior committments.
Keynote address	Invited to give the annual Distinguished Herpetologist Lecture at the combined Herpetologist League and Society for the Study of Amphibians and Reptiles 44th annual meeting, Indiana University, 26-30 July 2001.

Research Associate	Smithsonian Institute, Center for Tropical Biodiversity, Washington DC, 2003-ongoing.

PUBLICATIONS

Major scientific articles in peer-reviewed journals	112
Scientific notes in peer-reviewed journals	122
Popular articles	68
Book Reviews	74
Books	7
Television: SABC TV 50/50 Environmental Programmes	11
Radio programmes on wildlife, conservation, etc.	28
Environmental impact assessment reports	31

SELECTED RESEARCH PUBLICATIONS

BRANCH, W. R. (ed.), 1988. *South African Red Data Book - Reptiles and Amphibians.* S. Afr. Nat. Sci. Prog. Rpt **151:** I-iv, 242p.

SPAWLS, S. and W. R. BRANCH, 1995. *Dangerous Snakes of Africa*. Blandford Press, London, 192p. (released in southern Africa under Southern Book Publ, and in USA by Ralph Curtis Books.)

BRANCH, W. R., G. A. BENN and A. T. LOMBARD, 1995. The tortoises (Testudinidae) and terrapins (Pelomedusidae) of southern Africa: Their diversity, distribution and conservation. *S. Afr. J. Zool.* 30(3): 91-102.

BRANCH, W. R., A. M. BAUER & D. A. GOOD, 1996. A review of the Namaqua gecko, *Pachydactylus namaquensis* (Reptilia: Gekkonidae) from southern Africa, with the description of two new species. *S. Afr. J. Zool*. 31(2): 53-69.

BRANCH, W. R., 1997. A new adder (*Bitis*; Viperidae) from the Western Cape Province, South Africa. *S. Afr. J. Zool.* 32(2): 37-42.

BAUER, A. M., D. A. GOOD, & W. R. BRANCH, 1997. The taxonomy of the southern African leaf-toed geckos, with a review of Old World *Phyllodactylus* (Squamata: Gekkonidae) and the description of five new genera.. *Proc. Cal. Acad. Sci.* 49(14): 447-497.

BRANCH, W. R. & M. J. WHITING. 1997. A new *Platysaurus* (Squamata: Cordylidae) from the Northern Cape Province, South Africa. *Afr. J. Herpetol.* 46(2): 124-136.

BRANCH, W. R., 1998. *Field Guide to the Snakes and other Reptiles of Southern Africa.* rev. ed. Struiks Publ., Cape Town, 399 pp, 112 col. pls.

HAAGNER, G.V. , BRANCH, W.R. & HAAGNER, A.J.F. 2000. Notes on a collection of reptiles from Zambia and adjacent areas of the Democratic Republic of the Congo. *Annals Eastern Cape Prov Mus.* 1: 1-25.

BRANCH, W. R. & RYAN, P. G. 2001. Additions to the Mozambique Herpetofauna: Two new lizards from the Namuli Massif, Mozambique. *Herpetol. Rev*. 32(4): 281-282.

BRANCH, W.R, 2002. The Conservation Status of South Africa's Threatened Reptiles. pp 89-103. In: "*The State of South Africa's Species"* Proceedings of a conference held at the Rosebank Hotel in Johannesburg 4 - 7 September 2001, Endangered Wildlife Trust and WWF-SA.

BROADLEY, D.G. & BRANCH, W.R. 2002. A review of the small East African *Cordylus* (Sauria: Cordylidae), with the description of a new species. *Afr. J. Herpetol.* 51(1): 9-34.

BAUER, A.M. & BRANCH, W.R. 2000 (2003). The herpetofauna of the Richterveld National Park and the adjacent northern Richtersveld, Northern Cape Province, Republic of South Africa. *Herpetol. Nat. Hist.* 8(2): 111-160.

BRANCH, W. R. & RÖDEL, M.-O. 2003. Herpetological survey of the Haute Dodo and Cavally Forests, western Côte d'Ivoire. Part 2. Trapping results and Reptiles - *Salamandra*. 39(1):

LAMB, T., MEEKER, A.M., BAUER, A.M. & BRANCH, W.R. 2003. On the systematic status of the desert plated lizard (*Angolosaurus skoogi*): phylogenetic inference from DNA sequence analysis of the African Gerrhosauridae. *Biol. J. Linn. Soc.* 78: 253-261.

ANTON H BOK (DR)

PERSONAL INFORMATION

MARITAL STATUS:	Married
NATIONALITY:	South African
LANGUAGE:	English
DATE OF BIRTH:	22 April 1945
SEX:	Male

PRESENT POSITION

Private Environmental Consultant (specializing in aquatic ecosystems)

Honorary Research Associate of JLB Smith Institute of Ichthyology, Grahamstown.

ADDRESS:

WORK/HOME:

Anton Bok & Associates (trading as *Anton Bok Aquatic Consultants cc*)
5 Young Lane
Mill Park, Port Elizabeth (6001)
Tel: 041-333 464; Fax: 086 646 4620
E-mail: antonbok@aquabok.co.za

FORMAL QUALIFICATIONS

1.	B.Sc. (Zoology), 1968.	University of Cape Town
2.	B.Sc. Hon. (Zoology), 1969)	Rhodes University
3.	M.Sc. (Zoology), 1974	University of Port Elizabeth
4.	Ph.D. (Ichthyology), 1984	Rhodes Univ., JLB Smith Institute of Ichthyology

PROFESSIONAL MEMBERSHIPS

- Registered Professional Natural Scientist with The South African Council for Natural Scientific Professions (Reg. No. *400406/11*).
- Professional member of South African Institute of Ecologists and Environmental Scientists.
- Member of Southern African Society of Aquatic Scientists.
- Honorary Research Associate of the South African Institute for Aquatic Biodiversity (SAIAB)

PROFESSIONAL EXPERIENCE

1975 to 1985: Cape Nature Conservation

Employed as aquatic scientist with (the ex) Directorate of Cape Nature Conservation based in Grahamstown. Activities included research on the biodiversity of aquatic ecosystems and the conservation and sustainable utilization of all aquatic resources in the Cape Province.

1985 to 1994: Cape Nature Conservation

Employed as Specialist Scientist based in East London at the Departmental Amalinda Fish Research Station as leader of a number of research projects and conservation management activities related to aquatic biota (mainly fish) and freshwater and estuarine ecosystems. Management advice included specialist input into EIA's relating to environmental impacts caused by development and utilization of freshwater and estuarine ecoystems. This specialist advisory work was conducted in close liaison with various regulatory bodies (e.g. DWAF, Provincial Government and local authorities).

1994 to end February 1996: Eastern Cape Nature Conservation

Transferred to Port Elizabeth Regional Office where work entailed:

(i) Supervision of research projects and management advice and formulating departmental policy guidelines on conservation management of estuarine and freshwater ecosystems,

(ii) Specialist advice on potential environmental impacts of proposed developments (EIA's), particularly related to the aquatic ecosystems,

(iii) Specialist input into workshops, advisory committees, joint projects with various organizations (e.g. DWAF, university and museum staff) concerned with development, management and conservation of aquatic ecosystems, particularly regarding IFR (Instream Flow Requirements) of rivers.

February 1997 to present date: Private environmental consultant

Formed **Anton Bok Aquatic Consultants cc** (trading as *Anton Bok & Associates)*, an environmental consultancy, specializing in environmental impact assessments (EIAs) of developments, mainly those associated with aquatic ecosystems and specifically freshwater fish . Anton Bok is the principle member of the Closed Corporation, and there is one part-time secretary/accountant.

FIELDS OF SPECIAL EXPERTISE

- **Environmental Impact Assessments (EIAs)**
  Extensive experience involving undertaking EIAs for a wide variety of developments, including assessment of impacts associated with bridge construction on rivers, waste water treatment works, bulk water supply pipelines and storage reservoirs, abstraction of groundwater and surface water from rivers to augment existing bulk water supplies, etc.
- **Aquatic Ecosystem Conservation**
  Experience with Ecological Water Requirements or "Ecological Reserve" determinations of rivers in relation to fish populations; EIA's of developments in rivers (e.g. dams, weirs construction) and mitigation measures required; assessment and biomonitoring of river ecosystem health; EIA's for proposed developments (industrial, agricultural and mining projects) impacting on aquatic ecosystems, with specialist studies on the impact on the fish fauna.
- **Design and Operation of Fishways (Fish ladders)**
  A number of studies and reports involving the necessity for, the conceptual design of and monitoring of fishways (catering for indigenous fish including eels) in southern Africa have been conducted over the last 12 years.

EXAMPLES OF RECENT CONSULTANCY WORK UNDERTAKEN

2013-2014	**Lesotho.** Specialist fish & aquatic habitat study forming part of the EIA by Coastal & Environmental Services, CES (<u>client</u>: Lesotho Highlands Development Authority) for potential impacts of the proposed Polihali Dam on the Senqu (Orange) River, including impacts on fish migration and recommended mitigation measures.
2012	**Madagascar.** Specialist aquatic (ichthyofauna) study forming part of the EIA for the proposed Toliara Sands Mine – with emphasis on ecological impacts on the seasonal (sand) Fiherehana River due to water abstractions for mining operations (Sub-contracted by Coastal & Environmental Services (CES), Grahamstown).
2011-2012	**Zambia**: Specialist Study on Fish Biodiversity & Aquatic Habitat Integrity Assessment for EIA for proposed Kalumbila Minerals Copper Mine, NW Zambia (contracted to CES).
2011	**South Africa**. Specialist input (fish) on Habitat Integrity and Ecological Reserve (EWR) study on the Wildebees River, as part of licence application for the proposed Ugie Dam, contracted to Scherman Colloty & Associates cc.
2010	**South Africa**: specialist Studies (fish fauna) on the impact of bridge construction on the Habitat Integrity and Present Ecological Status

	(PES) in 4 Transkei rivers as part of Wild Coast Meander DR 08029 upgrade project – contract to Terraco Consulting cc.
2008 & 2009	**Democratic Republic of Congo (DRC).** Specialist baseline study on fish fauna and aquatic habitats forming part of the Environmental and Social Impact Assessment (ESIA) Plan for the Kalukundi Copper-Cobalt Mine Project. Contracted to Africo Resources.
2007	**South Africa**. Specialist input (fish) on Rapid/Intermediate Ecological Reserve (EWR) study on selected rivers in the Outeniqua Region, contracted to IWR Source to Sea.
2004/2007	**South Africa – Fishway Research**. Member of a team for a research programme sponsored by the Water Research Commission (WRC) on fishways in South Africa. Deliverables (final reports) from this programme include: a) WRC Report No. 1270/2/04. *Guidelines for the planning, design and operation of fishways in South Africa* by A Bok, J Rossouw and A Rooseboom (2004).) b) WRC Report No. 1310/105. *Development of criteria for the design of fishways for South African Rivers and Estuaries*. R Heath, A Bok, PSO Fouche, MK Mastenbroek & AT Forbes (August 2005). c) WRC Report No.TT 287/07. *Guidelines for the planning, design and operation of fishways in South Africa*. A Bok, P Kotze, R Heath & J Rossouw.
2004/2005	**South Africa**. Project leader for EIA studies to obtain environmental authorisation for the construction of 5 gauging weirs on various rivers in Transkei, including Habitat Integrity and Present Ecological Status (PES) and fish surveys of impacted river reaches order to assess the need for and conceptual design of fishways. DWAF: Hydrology Division.

PUBLICATIONS

Papers based on research on the following topics have been written:

- the ecology and captive of breeding of mullet (*Mugilidae*) in the Eastern Cape;
- freshwater fish production under intensive and extensive conditions;
- captive breeding (including hormone -induced spawning) of threatened indigenous fishes;
- fish distribution in eastern Cape estuaries, and
- the conceptual design and monitoring of fishways for southern African fish species.

These papers have been published in local and international journals and presented at workshops and conferences, both national and international. They include one chapter in a book, two theses (M.Sc. and Ph.D.), 7 published workshop/symposium proceeding, 3 Water Research Commission Report Publications, 4 semi-popular articles and 13 papers in scientific journals. A full publications list is available on request.

DIGBY WELLS
ENVIRONMENTAL

MATTHEW OJELEDE

Dr Matthew Ojelede
Air Quality Specialist
GIS & Air Quality Department
Digby Wells Environmental

EDUCATION

1994 - 1998: Bachelor of Science (Hons): Majored in Geology (University of Benin)
2002 - 2004: MSc Environmental Science (Graduated with overall score of 73%).

Courses:

- Environmental Chemistry
- Environmental Management
- Air Quality –Physics and Chemistry of the Urban Atmosphere
- Global Environmental Change: Adaptation and Mitigation
- Geographic Information System
- Mining and the Environment.

2005 – 2012 - PhD Environmental Management: Risk assessment of atmospheric emissions from gold mine tailings on the Witwatersrand
The thesis addressed a major environmental concern in Gauteng, namely the public health risk posed by atmospheric dust emissions from gold mine tailings on the Witwatersrand. Economic opportunities to reprocess the legacy tailing storage facilities to extract residual gold, removal of the protective layer of vegetation, and urban densification of the Witwatersrand combined to create adverse conditions, particularly during the windy season August to October, when dust levels frequently become a serious nuisance and may pose a threat to public health. Despite widespread public awareness of the hazard, no prior systematic evaluation of the risk posed by the dust from the dumps was conducted. My research reported on a systematic study of the hazard posed by the respirable silica dust; of the historical development of residential suburbs in proximity to the dumps; measurements of ambient concentrations of dust during severe wind storms; and a risk assessment to the neighbouring communities.

LANGUAGE SKILLS

English and Edo language

EMPLOYMENT

June 2012 – September 2012	University of Johannesburg (Researcher)
October 2012 to present	Digby Wells Environmental

EXPERIENCE

Air pollution specialist in the Air Quality Department. Graduated with a PhD in Environmental Management. I conducted research projects for mining companies i.e. Crown Gold Recoveries, Eastplat, Anglogold Ashanti and several mining companies. In the past, I worked closely with the University of the Witwatersrand, University of Pretoria and the National Health Laboratory Service (NHLS) in looking at the “Adverse Health Impacts Associated with Dust Emissions from Gold Mine Tailings” for the Mine Health and Safety Council.

EXPERIENCE

Countries worked in South Africa, Mali, Mozambique, Malawi and Liberia

PROJECT EXPERIENCE

AIR QUALITY BASELINE ASSESSMENTS, EMISSION INVENTORIES, DISPERSION MODELLING AND AIR QUALITY MANAGEMENT AND MITIGATION PLANS

Air Quality Impact Assessment study for an IPP power station and associated infrastructure, Limpopo, South Africa

Ventersburg Gold Mine Air Quality Impact Assessment study, Free State, South Africa

Air Quality Baseline Assessment study for Falea Uranium Project, Mali

Air Quality Scoping report for the Harwar Colliery Mpumalanga, South Africa

Baseline Air Quality Assessment study for Mkango Resources Limited, Songwe Rare Earth project, Malawi

Air Quality Impact Assessment study for the proposed Balama Graphite Mine, Mozambique

Air Quality Impact Assessment study for New Liberty Gold Mine, Liberia

Air Quality Impact Assessment study for Loulo Gold Mine, Mali

TRAINING

Basic Fire Fighting – Accreditation number: HW591PA0808095

NACA : Introduction to Dispersion Modelling

PROFESSIONAL AFFILIATIONS

National Association for Clean Air (NACA)

South African Society for Atmospheric Sciences (SASAS)

Geo Information Society of South Africa (GISSA)

International Association of Impact Assessment South Africa (IAIAsa)

PUBLICATIONS

- **Ojelede, M. E**., Annegarn, H. J. and Remy, B. Levels of quartz in the ≤ 5 µm and ≤ 10 µm fractions of gold mine tailings: Implications for exposed residents on the Witwatersrand (In progress).
- **OJELEDE, M. E.**, Kneen, M. A., Annegarn, H. J. HOUSING SPRAWL NEAR TAILINGS STORAGE FACILITIES: HISTORICAL AND CURRENT SCENARIO ON THE CENTRAL WITWATERSRAND. *Journal of Housing and Built environment* (In progress).
- **OJELEDE, M. E.**, Annegarn, H. J., Kneen, M. A (2012). Evaluation of Aeolian emissions from gold mine tailings on the Witwatersrand. *Journal of Aeolian Research 3 (4),* 477 - 486.
- **OJELEDE**, **M**. **E**., Annegarn H. J., Mlondo M. (2008). Grain-size analysis and elemental composition of the PM10 and PM5 fractions of gold-tailings, in ***Mine Closure 2008***, A.B. Fourie, M. Tibbett, I.M. Weiersbye, P.J. Dye (eds), Australian Centre for Geomechanics, Perth, Australia, ISBN 978-0-9804 185-6-9, *Proceedings of the Third International Conference on Mine Closure* , Johannesburg, October 2008, pp. 609-616.
- **OJELEDE**, **M**. **E.**, Liebenberg-Enslin H., Annegarn H. J. (2009). Tailings dust — evolution over fifty years of gold mine tailings sources and sensitive receptors on the central Witwatersrand, in ***Mine Closure 2009***, A.B. Fourie, M. Tibbett (eds) © 2009 Australian Centre for Geomechanics, Perth, ISBN 978-0-9804185-9-0, *Proceedings of the Fourth International Conference on Mine Closure*, 9-11 September 2009, Perth, Australia, pp. 375–388.
- **Ojelede**, **M**. **E**., Annegarn, H. J., Price, C., Kneen, Goyns, P (2008). Lightning-produced NOX budget over the Highveld region in South Africa. *Atmospheric Environment 42,* 5706-5714.
- **Ojelede**, **M. E**., Annegarn, H. J., Mlondo, M. (2007). Evaluation of respirable particle matter in gold mine tailings on the Witwatersrand, *Proceeding of the Mining and the Environment IV International conference*, Sudbury, 19 – 26 October, 7pp ISBN 978-0-

88667-072-6. Refereed Conference Paper

- Bhikha, B., **Ojelede**, **M**. **E**., Annegarn, H. J., Kneen, M. (2006). Advancing lightning counts by using LIS efficiency factor derived from comparison with SAWS lightning detection network, *Proceedings of the Lightning Imaging sensor International Workshop*, Huntsville, Al, USA, 11-14 September, 4pp
- **Ojelede**, **M**. **E**, Annegarn H. J., Price, C. G. (2005). Lightning NOx estimations over southern Africa, *proceedings of International Association of Meteorology and Atmospheric Sciences*, Beijing, 2 – 11 August**,** p. 20. (Abstract)
- **Ojelede**, **M**. **E**., Annegarn, H. J., Price, C., Kneen M. A., Zulu J., Nhlahla, N. (2004). Lightning frequency distributions over southern Africa from satellite and ground based observations, *Proceedings of the 5th AARSE conference*, Nairobi, 18 – 21 October, 9 pp.
- **Ojelede**, **M**. **E**., Annegarn, H. J., Price, C., Kneen., M. A. Spatial and temporal variability of Lightning over southern Africa insight from satellite and ground-based observations (In progress).

Selected Technical Reports

- Annegarn, H.J., **OJELEDE**, **M**. **E**., Umba-Ndolo, G., Kneen, M.A. (2010), Anglogold Ashanti Dust Monitoring Project. Report No. DMP/2010/UJ-01.
- Annegarn, H.J., **OJELEDE**, **M**. **E**., Kneen, M.A. (2008), Wind Generated Dust: Identification of High Risk Areas Within Anglo's Vaal River and West Wits Operations – UJ-GEMES Report No 2008.01 AngloGold_A_VR/WW.
- Annegarn, H.J., Kneen, M.A., **OJELEDE**, **M**. **E**., Josipovic , M. (2005), Special Investigation: Source Apportionment of Soiling Dust in the Vicinity of Richards Bay Coal Terminal, Specialist report to the Richards Bay Coal Terminal. Report No. 25.115.
- Annegarn H. J., Kneen, M. A., **Ojelede, M**. **E**., Josipovic M. (2005). Special investigation: Grab samples of dust and ash collected near ERPM dumps after a significant incident. Report submitted to Crown Gold Recoveries (Pty) Ltd. Report No. AER 25_Spec ERPM, 42 pp.
- Annegarn, H.J., Kneen, M. A., Josipovic, M., **OJELEDE, M. E.** (2004), Vegetation and Fire report (R99-00778), Eskom contracted project; own participation from July 2004 to December 2004 – RES/RR?04/02/24473
- Annegarn, H.J., **OJELEDE**, **M**. **E**., Maseloa, P., Rantlaleng, L (2008), Eastplats Crocodile River Mine Tailings Toxicity Assessment – AER 28.322S_EC.

DIGBY WELLS
ENVIRONMENTAL

VUMILE DLAMINI

Miss Vumile Dlamini
Environmental Health Consultant
Social Sciences Department – Community Health Impact Assessment Unit
Digby Wells Environmental

Vumile Dlamini is an Environmental Health Consultant employed within Digby Wells' Community Health Impact Assessment Division where she is involved in conducting Health Impact Assessments in various mining operations throughout Africa. Her responsibilities include the compilation of Health and Environmental Management Plans, in accordance with both local South African standards and International standards. Vumile holds a Bachelor of Social Sciences (Honours) degree in Environmental Analysis and Management from the University of Pretoria, and is currently completing her Masters Degree (at the University of the Witwatersrand) in Environmental Science focussing on Air Quality: The Respiratory Health Impacts of Open-cast Coal Mining. Before joining Digby Wells, Vumile has spent time as a Client Services Executive under Ernst and Young's Climate Change and Sustainability Services Department, offering Environmental Auditing and advisory services around sustainable development strategies and frameworks. Vumile has six years in the consultancy environment and is well versed in Environmental Impact Assessments, Environmental Auditing, GIS and Remote sensing, as well as Environmental Law practices.

EDUCATION

BSocSc. (Geography and Environmental Management) University of KwaZulu Natal (2007)
BSocSc. Hons. (Environmental Analysis and Management) University of Pretoria (2011)
MSc. (Environmental Science) WITS University (current)

LANGUAGE SKILLS

- English (excellent)
- Zulu (excellent)
- Swati (excellent)
- Xhosa (excellent)
- Sotho (intermediate)
- Afrikaans (intermediate)
- Portuguese (basic)

EMPLOYMENT

March 2012 - present:	Environmental Health Consultant Human Sciences Department, Digby Wells Environmental, South Africa

- Provide technical input into the environmental management field.
- Specializing in Strategic Environmental Advice, Environmental Impact Assessment studies, environmental authorization and permitting, public participation, Environmental Management Plans and Programmes, environmental policy, strategy and guideline formulation, and integrated environmental management.
- Support the Community Health Impact Assessment Division, evaluating the baseline health levels and health needs of communities and development of health plans for development various projects across Africa.

I am part of the Community Health Impact Assessment Unit, responsible for the compilation of new tendered projects. Contributions to Compilations of Health and Environmental Management Plans in accordance with both local South African standards (NEMA and MPRDA) and International standards (IFC). Consistently involved in Project management and Budget tracking.

March 2010 – December 2010: GIS Technician
Niara Environmental Consultants

- Using ArcMap tools, wizards, and extensions to accomplish project objectives.
- Create custom and standard map products for internal and external use as requested.
- Enter and manage data through database front-end and through raw tables.
- Manipulating digital land base data in ArcMap environment (such as GPS points, aerial photography, parcel lines, street centrelines etc).
- Handling multiple tasks simultaneously while meeting client and project objectives. Clearly and concisely communicating technical information and concepts with co-workers and management.

October 2008 – May 2009: Client Service Executive
Ernst & Young

- Working in a team, responsible for delivering high quality work for review by the Manager to ensure the client's objectives are met.
- Assurance of reports and/or process.
- Verification of key performance indicators and advisory services around sustainable development strategies.
- Frameworks and leading practice; develop and implement a personal, professional and technical development plan.
- Perform moderately complex, high risk or high profile individual sustainable development projects in line with the client's requirement and methodologies previously developed or developed for specific assignments.
- Quality delivery within the scope of work, to ensure effective management of Ernst & Young's engagement risks and agreed budget.

July 2007 – August 2008: GIS technician/ data Capturer
Geospace International
(City of Tshwane Public Works and Infrastructure Development Department: Roads and Storm Water Division Project.)

- Provide support on GIS projects, particularly relating to capturing and verification of data into the municipalities GIS.
- Validating and corrections of storm water point features and selective line features 2003-2006 Data Capture and queries.
- Use of ESRI ArcGIS to identify and correct anomalies.
- Capturing of additional Planning Applications as directed by the Planning Technician, Engineers or GIS Manager.
- Appropriate provision of GIS support to Specialists.
- Undertaking ad-hoc duties as and when required.

April 2007 – July 2007: Mineral information Management Intern
Department of Minerals and Energy

- Usage of Mineral Resources Management System - GIS based software to capture information, check the availability of farm portions, and prepare reports there forth.
- Customer focused interactive communication and various departmental operations engagement.
- Create and modify documents using Microsoft Office.
- Perform general administrative functions and duties which included photocopying, faxing, mailing, filing, maintaining hard copies and electronic filing systems.

PROJECT EXPERIENCE

Sasol Syferfontein Block 4 Expansion Project;
Sasol Sigma Colliery Underground Ash Backfilling Project;
Exxaro: Annual External Sustainable Development Data assurance audits. Auditing Health, Safety, Socio-economic and Environmental KPI's. Exxaro KZN Sands
Crown (DRD Gold) – Amendment to City Deep EIA/EMP for the inclusion of Dump 3/L/40 and 3/L/42 (Project Manager) (awaiting authorisation);
Xstrata South Africa (Pty) Ltd – Nooitgedacht EMP Amendment;
Scoping HIA for Rockgate Capital at their Faléa Uranium Project, Mali;
Comprehensive HIA for Severstal at their Putu Iron Ore Project, Liberia;
Scoping HIA for Syrah Resources at their Balama Graphite Mine, Mozambique;
Baseline community Health Assessment for Koidu Holdings at their Proposed Tonguma Project: Diamond Mining (2012);
Baseline community Health Assessment for Vedanta Zinc International's Vedanta Power Plant and associated Transmission Lines Project IFC ESIA;
Baseline community Health Assessment for Gold One at their proposed Geluksdal Tailings Storage Facility and Pipeline Infrastructure (2012); and
Baseline community Health Assessment for Platreef Resources' Proposed Underground Platinum Mine.

PROFESSIONAL AFFILIATIONS

International Association of Impact Assessment South Africa (IAIASA)

DIGBY WELLS
ENVIRONMENTAL

FRANCIS KOM

Mr Francis Kom
Hydrogeologist
Water Geosciences Department
Digby Wells Environmental

EDUCATION

- MSc Contaminant Hydrogeology, University of Pretoria, (Currently studying).
- Honours in Hydrogeology, Institute for Groundwater Studies, University of the Free State, South Africa, 2011.
- BSc major in Geology and minor in Chemistry, Geology Department, University of Buea, Cameroon, 2008.

EMPLOYMENT

- Digby Wells and Associates, Johannesburg, South Africa (October 2011 to current)

EXPERIENCE

Francis is a French and English speaking Hydrogeologist at Digby Wells with over 2 years of experience, as a consultant.
Francis' key experiences include:

- Mine dewatering management and EIA/EMP assessments.
- Drilling supervision, realisation and logistics
- Expertise in realisation and interpretation of hydraulic test (packer test, slug test, pumping test).
- Technical and financial management of drilling operations for mining and water supply
- Groundwater Contamination Investigations,
- Groundwater Geophysical Explorations,
- Groundwater resource assessment and management.
- Knowledge of Hydrogeology and GIS based softwares: WISH, Aquifer Test Pro, Aquiworx, Crystal ball, Surfer, ArcView, Global Mapper, PM-Win 5.

PROJECT EXPERIENCE

MMG Limited – Kinsevere Copper Mine (DRC): Site Hydrogeologist, Drilling Supervisor
Randgold Resources– Kibali Gold Mine (DRC): Project Field Hydrogeologist
Platinum Group Metals (PTY) – Blouberg Area: Hydrogeology of Blouberg and Mogalekwena Magisterial District
Anglo Platinum (PTY) – Witbank Area: Hydrogeology of Witbank Magisterial District
Rockgate Resources – Falea Uranium Project Mali: Hydrocensus, Drilling and Pumptest Supervision
Syrah Resources – Balama Graphite Project Mozambique: Hydrocensus, Ground geophysical survey, Drilling, Pump test characterisation
Crown Mines – Withok TSF: Hydrocensus, ground water and surface water monitoring
Mashala Coal Mines – Delta plant: Groundwater and surface water monitoring
Mashala Coal Mines – Ferreira plant: Groundwater and surface water monitoring
Mashala Coal Mines – Penumbra plant: Groundwater and surface water monitoring

STEPHEN FONKEM

Mr. Stephen Fonkem
Senior Environmental Consultant/Hydrogeologist
Water Geoscience Department
Digby Wells Environmental

EDUCATION

MSc. Geohydrology, University of the Free State, 2010.
BSc. (Hon) Geohydrology, University of the Free State, 2008.
BSc. Geology and Computer Sciences, University of Buea, 2007.

EMPLOYMENT

2014-Present, Senior Environmental Consultant, Digby Wells Environmental
2011- 2014, Hydrogeologist, Digby Wells Environmental, Johannesburg.
2010-2011, Hydrogeologist, Aqua Earth Consulting, Johannesburg.
2009-2010, Research Assistant, Institute for Groundwater Studies, Bloemfontein.
2008-2009, Junior Hydrogeologist, ERM, Johannesburg

EXPERIENCE

Stephen is a senior environmental consultant and hydrogeologist at Digby Wells with extensive experience on hydrogeological assessment for a wide range of mining and mineral development projects in relation to coal mining, metal mining, and industrial minerals sectors. Stephen is fluent in French, English and Pidgin English.

PROJECT EXPERIENCE

Recent 10 assignments include:

Xstrata Coal South Africa – Trichardtsfontein Mine: Numerical modelling for groundwater impact assessment for EIA and IWUL applications.

Uranex Tanzania – Nachu Graphite Exploration: Hydrogeological assessment to initiate an early groundwater monitoring system in the project area.

Syrah Resources Mozambique- Balama Graphite Mine: Numerical modelling for groundwater impact assessment for ESIA application.

Sasol Mining South Africa –Sigma Colliery: Numerical modelling for underground mine ash backfill to assess the impacts of ash backfilling on groundwater.

Randgold Resources Mali- Morila Gold Mine: Groundwater model update to revise the closure according to a pushback plan and in-pit deposition of reprocessed tailings.

Randgold Resources DR Congo- Kibali Gold Mine: Delivered a WISH (Windows Interpretation System for Hydrogeologists) course training program to the mine’s principal environmental manager and senior hydrogeologist.

Cluff Gold Burkina Faso- Seguenega Gold Mine: Hydrogeological assessment (geophysical surveying, borehole drilling, aquifer testing, and numerical modelling) for groundwater impact assessment for ESIA application.

Randgold Resources Mali- Loulo Gold Mine: Six months ssecondment as project hydrogeologist, for detailed open pit and underground dewatering studies and numerical modelling;

Universal Coal South Africa – Rodekoop Mine: Hydrogeological assessment (geophysical surveying, borehole drilling, aquifer testing, and numerical modelling) for groundwater impact assessment for EIA and IWUL applications.

Universal Coal South Africa- Kangala Mine: Conceptual modelling for groundwater impact assessment for EIA application.

PROFESSIONAL AFFILIATIONS

International Association of Hydrogeologists (IAH)
Ground Water Division of the Geological Society of South Africa

PUBLICATIONS

Fonkem, S. (2013). The Structural Hydrogeology of a Gold Mine in Mali. Biennial South African Groundwater Conference, Durban, 17-19 September 2013.

DIGBY WELLS
ENVIRONMENTAL

HLAYISEKO MASHABA

Mr Hlayiseko Mashaba
Junior Closure Consultant
Closure/Noise Department
Digby Wells Environmental

EDUCATION

2012: Bsc honours Environmental Analysis and Management
University of Pretoria

Modules: Environmental principles, Environmental Impact Assessment, Urban Geography of SA, Environmental Compliance etc.

2009 to 2011: Bachelor of Geology (Bsc)
University of Pretoria

Modules: Sustainable Development, Igneous petrology, Environmental interaction, Remote sensing, Engineering Geology etc.

EMPLOYMENT

2013 – To date: Digby Wells Environmental
Junior Closure Consultant

- Consultant with specialised focus on closure planning, rehabilitation and noise monitoring. I have been involved in projects with clients such as Harmony Gold, Xstrata Coal, Ivanhoe Platinum etc.
- Project management and project administration; and
- Compilation of proposals for various projects;

EXPERIENCE

2012: Tutor – University Of Pretoria
Chemistry tutor at University of Pretoria in 2012. I assisted students with chemistry questions and also monitoring them throughout their practical sessions.

PROJECT EXPERIENCE

2013: Digby Wells Environmental Projects
Harmony Gold- Closure cost assessment
Bokoni Platinum mine- Closure cost assessment
Lanxess Chrome Mine- Closure cost assessment
Xstrata Coal- Noise monitoring studies
Ivanhoe Platinum-Closure cost assessment and Noise monitoring studies

DIGBY WELLS
ENVIRONMENTAL

BRETT COUTTS

Mr. Brett Coutts
Ecologist/GIS Specialist/Rehabilitation Consultant
Biophysical Department - Rehabilitation
Digby Wells Environmental

EDUCATION

2006 – 2007: BSc Honours in Ecology, Environment and Conservation - University of the Witwatersrand
2003 – 2006: Undergraduate BSc - University of the Witwatersrand

EMPLOYMENT

September 2012 – Present: Digby Wells Environmental – Unit Manager: Rehabilitation
October 2008 – August 2012: Terra Pacis Environmental (Pty) Ltd – Environmental Consultant
November 2007 – September 2008: Hydromulch (Pty) Ltd – Junior Project Manager

EXPERIENCE

Current Work at Digby Wells

Brett is the Rehabilitation Unit manager and has been appointed to assist with the management and co-ordination of all relevant studies related to rehabilitation. This includes the management of rehabilitation projects, compilation of rehabilitation plans and undertaking of rehabilitation assessments. In addition to this Brett assists within the Biophysical Department with the management of specialist studies that are undertaken by the department and is also responsible for the compilation of the Geographic Information System (GIS) component of Biodiversity Land Management Plans (BLMP) ad undertaking ecological assessments.

Prior to joining Digby Wells Environmental (November 2007 – August 2012)

Prior to his appointment, he gained experience as a junior project manager on environmental rehabilitation projects at Hydromulch and then was appointed by Terra Pacis as an Environmental Consultant where his roles and responsibilities included the compilation of Basic Assessment (BA) reports, Scoping &Environmental Impact Reports, compilation of Environmental Management Plans (EMP), GIS mapping and Biophysical Studies.

PROJECT EXPERIENCE

The following project list is indicative of Brett's experience, providing insight into the various projects, roles and locations he has worked in.

Project	Role	Activities	Resource	Client	Location
Bokoni Platinum Mine	Key Accounts Manager	Overall management and coordination of projects	Platinum	Bokoni Platinum Mine	South Africa
Anglo Operations	Key Accounts Manager	Overall management and coordination of projects	Platinum	Anglo American	South Africa

Project	Role	Activities	Resource	Client	Location
Anglo Operations	Technical specialist	Compilation of rehabilitation and closure plan	Coal	Anglo	South Africa
Balama Graphite Mine	Technical specialist	Compilation of rehabilitation and closure plan	Graphite	Syrah Resources	Mozambique
Putu Iron Ore Mine	Technical specialist	Compilation of rehabilitation and closure plan	Iron ore	Putu Iron Ore Mine	Liberia
Anglo Operations	Technical specialist	Update of Closure Plan for Greenside Colliery	Coal	Anglo	South Africa
Sekoko Rehabilitation Plan	Technical specialist	Compilation of rehabilitation and closure plan	Coal	Savannah Environmental	South Africa
Rehabilitation Plan for Consbrey and Hawar Projects	Technical specialist	Compilation of rehabilitation and closure plan	Coal	Msobo Coal	South Africa
Rehabilitation Plan for IPP Station	Technical specialist	Compilation of rehabilitation and closure plan	Power Station	Vedanta Resources	South Africa
Rehabilitation Plan	Technical specialist	Compilation of rehabilitation and closure plan	Platinum	Platreef	South Africa
Preliminary Closure Plan for New Liberty	Technical specialist	Compilation of rehabilitation and closure plan	Gold	Aureus mining	Liberia
Environmental and Social Impact Assessment	Project Manager	Project Manager	Gold	Aureus mining	Liberia
Thabametsi Coal Mine	Project Manager	Project Manager	Coal	Exxaro	South Africa
Wetland Offset Strategy	Project Manager	Project Manager	Coal	Exxaro	South Africa
Compilation of GIS Training Manual	Project Manager	Project Manager	GIS	In house	South Africa
Invasive Alien	Technical	Compilation	Smelter	BHP Billiton	South Africa

Project	Role	Activities	Resource	Client	Location
Plant control Procedure	specialist	of management plan	Operations		
Vegetation, Invertebrate and Wetland Assessments and GIS Mapping	Technical Specialist	Compilation of report	Residential Development	Business Venture Investments	South Africa
GIS mapping for a range of Scoping and Environmental Impact Reporting	Technical Specialist	Public Participation and Report Writing	Smelter Operations	BHP Billiton	South Africa
Biodiversity Management Plans (for two operations)	GIS Specialist	Technical input & project management	Gold	Randgold Resources	Mali and Ivory Coast
Biodiversity Management Plans (for six operations)	GIS specialist	Technical input & project management	Coal	Anglo American	South Africa

SHORT COURSES

2009: IEMA Approved Carbon Footprint Management Course: An Introductory Programme
2010: Exclusive Panel Discussion on: The Copenhagen Climate Change Conference
2011: International Association for Impact Assessments conference at the Wild Coast
2012: Centre for Environmental Management, North-West University: Environmental Law for Environmental Managers

PROFESSIONAL REGISTRATION

2009: IAIAsa - International Association for Impact Assessment (South Africa)
2012: Registered as a Candidate Natural Scientist with the South African Council for Natural Scientific Professions

AWARDS

2006: Certificate of Merit and Ecology, Environmental and Conservation Prize
2006: Postgraduate Merit Award to the Value of R30 000

DIGBY WELLS
ENVIRONMENTAL

LUKAS SADLER

Mr. Stephen Fonkem
Environmental Consultant
Noise Unit
Digby Wells Environmental (Pty) Ltd

EDUCATION

2013: Course in Environmental Noise Control
2010: Short course in Air Quality Management
2009: Short course in Occupational and Environmental Noise
2002 – 2004: BCom Environmental Management (North West University)

EMPLOYMENT

November 2007 - Present: Digby Wells Environmental
May 2006 – July 2007: West View Rail (Pty) Ltd (London)

EXPERIENCE

During my two year stay in London from September 2005 – September 2007, I worked for West View Rail (Pty) Ltd on the London Underground Railway.

I am currently working at Digby Wells Environmental in the Environmental Noise Unit, where I am responsible for the Noise Impact Assessments relating to EIA/EMP's, as well as assisting with the compilation of reports such as environmental impact assessments. This includes experience working with projects in accordance with the International Finance Corporation (IFC) and World Bank standards, in countries such as Namibia, Mali, Senegal, Ghana, Mozambique Liberia, DRC and Sierra Leone.

My core focus is working on Environmental Noise Impact Assessments, which includes the assessment, remediation and management of impacts related to noise nuisance for the construction, mining and petrochemical industry.

Further responsibilities and experience gained at Digby Wells Environmental currently include, but are not limited to:

Assisting with the compilation of EIA's and EMP's; and
Noise monitoring (baseline as well as continuous compliance monitoring).

PROJECT EXPERIENCE

Noise Impact Assessments:
Boikarabelo Colliery – RSA
Putu Iron Ore Project – Liberia
New Liberty Gold Mine – Liberia
Thabametsi Colliery – RSA
Temo Coal Project – RSA
Cooke Uranium Project – RSA
Kibali Gold Project - DRC
Sadiola ESIA – Mali
Mmamabula Optimisation Project - Botswana
Koidu – Sierra Leone
Dust Monitoring Experience:
Mashala Resources – South Africa
Anglo Gold Ashanti Iduapriem Mine – Ghana
Eastplats – South Africa
Universal Coal – South Africa

PROFESSIONAL AFFILIATIONS

The National Association for Clean Air (NACA)