ANVIL MINING CONGO SARL

DIKULUSHI COPPER SILVER PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT

APRIL 2003

African Mining Consultants
1564/5 Miseshi Road
P.O. Box 20106
Kitwe
Zambia

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Anvil Mining NL have commenced development of the Dikulushi Copper-Silver deposit near Kilwa in the south-eastern Katanga Province of the Democratic Republic of the Congo (DRC). The project is scheduled to produce 250,000 tonnes of ore per annum, initially from an open cast mining operation, and will eventually produce a concentrate containing 60% copper and 1800 ppm silver.

The project is being developed in two phases. In year 1, the open cast mine will feed ore to a heavy media separation (HMS) plant that produces 38% copper in concentrate. In year 2, the HMS plant will be replaced by a 250,000 tpa mill and flotation plant that will produce a 60% copper concentrate and re-treat lower grade material produced during year 1. Concentrates from mining and processing operations will be transported by road to the port of Kilwa on Lake Mweru, from where they will be barged to Nchelenge on the Zambian shore of the lake. From Nchelenge, the concentrates will be transported by road to smelters (initially) in Namibia and South Africa.

The operation will consist of conventional mine and process components. The key site components are the open pit, waste rock dumps, process plant, workshops, tailings dam and associated infrastructure. The environmental management plan has been developed to mitigate any adverse impacts from the construction and operation of these facilities.

The project is expected to make a positive socio-economic contribution to the area which is under-developed. Off-site infrastructure investments include the upgrading of the Dikulushi-Kilwa road, and the construction of improved port facilities at Kilwa in the DRC and Nchelenge in Zambia.

An assessment of baseline environmental conditions has been done. The Dikulushi river is the main water course in the project area. This is an ephemeral stream that will be diverted during later stage mining of the open pit. Stream sediment samples are high in copper, consistent with the presence of an economic ore deposit at the site. The overall water quality of the river is good. The quality of the Lake Mweru water at Kilwa and Nchelenge is also relatively unpolluted.

Groundwater quality at the project site complies with World Health Organisation (WHO) guidelines for drinking water quality, although a few metal values are elevated, possibly due to the presence of the ore deposit.

Soils in the area exhibit high copper values in the immediate vicinity of mineralisation. Away from the immediate mine site, the soils are mostly leached and nutrient deficient. Cassava cultivation is common since this crop is tolerant to aluminium toxicity and strongly leached soil.

Vegetation in and around the mine area is Chipya/Munga and Miombo woodland. Local people living close to the mine area are mainly small-scale farmers. Annual burning of the land takes place during each dry season in preparation for planting before the on-set of the next rains. This type of slash-and-burn subsistence farming is common throughout Central Africa.

There is no air quality data for Dikulushi due to its remote location and the absence of industry. Grassland and forest fires, charcoal burning and slash and burn agriculture generate smoke and dust during the dry season.

Although the region once had abundant wildlife, poaching and cultivation have significantly reduced larger mammal populations, or forced them to move out of the area. Smaller mammals such as the Bush Baby and Vervet Monkey are still occasionally reported, whilst reptiles and birds are commonly seen.

In recent years the economy of the DRC has been severely negatively impacted by civil war. Since 1998 there has been a significant reduction in Government revenues, escalation of external debt and an exodus of foreign businesses. The war has intensified basic problems such as corruption, raging inflation and lack of openness in Government policy.

The Dikulushi area has one of the lowest population densities in the region with 3.64 inhabitants per square kilometre. Almost all the people in the area rely on fishing or subsistence agriculture to survive. There has been little infrastructure development. There are no public utilities and most roads are in a very poor state of repair. Malaria is the number one illness in the study area. There is no information on AIDS/HIV prevalence.

The major potential social and environmental impacts of the project are as follows: -

- Natural vegetation will be completely removed from an area of approximately 110 hectares, once the open pit, waste rock dumps and tailings dam have been constructed. Another 300 hectares of woodland will be affected by the plant area, roads, workshops and other installations. The area where flora and fauna is severely impacted is small in relation to the vast unexploited woodlands in the Katanga region. The impact is local and is not likely to affect the ecology of the region. The duration of impacts on flora and fauna can be reduced by the ongoing re-vegetation and rehabilitation of affected areas. Anvil will develop a detailed Decommissioning and Closure Plan for the open pit, tailings dam, waste dump and plant area.

- Impacts on surface water quality could arise from contamination by surface spillage, accidental release from the plant area or tailings dam, or from mine drainage water entering the Dikulushi River. Controlling direct runoff from contaminated surfaces into local watercourses will reduce the impact of mine operations on surface water. Anvil plan to construction perimeter drains and large sedimentation ponds to minimise the impact of contaminated runoff on the receiving environment. Sedimentation ponds will be monitored and cleaned.

- Destruction of a 700m stretch of the Dikulushi river to make way for the Stage III open pit extension will have a significant environmental impact. Construction of a diversion channel will take place during the dry season to minimise the impact on stream flow rates. The significance of the impacts of the Dikulushi River Diversion Scheme on the Dikulushi river are rated as moderate as the Dikulushi River is relatively small and there is no domestic or agricultural water usage within 7 km downstream of the deposit.

- The spillage of an entire cargo of concentrates into Lake Mweru could have a significant impact on surface water quality in the lake. This impact would be extremely localised. Cumulative small spills could also affect local water quality, flora and fauna, and domestic water use. Experience with current shipping operations indicate that local spillage is not occurring and that a large spillage is very unlikely to occur. Measures will be implemented to mitigate impacts in the event of small discharges and to clean up a major spill.

- Groundwater quality may be affected by seepage from the mine, tailings dam, waste rock dump or ore stockpile. Groundwater contamination could be associated with acid rock drainage (ARD) and seepage could occur at any time during the mine life or post-closure. The degree of groundwater contamination will depend on the chemical composition of the ore and waste components and their propensity for ARD. The acid generating potential of dumps and stockpiles will be fully defined by Anvil and appropriate remediation measures, if required will be implemented. This could include monitoring boreholes, perimeter drains and the recycling or treatment of seepage.

- The project investment will introduce multiplier effects in the regional and local economy. The project will promote the business of local suppliers and contractors providing goods and services to the mine. The direct economic impact of the project in Dikulushi will be the additional employment earnings generated in the local community. These earnings should improve the local economy by facilitating the purchase of additional good and services.

- From a social perspective, the project is likely to attract people from surrounding areas seeking employment. This will put the local population in direct competition with outsiders, a concern already expressed by local residents. Depending on ability and the availability of jobs, local residents should be employed in preference to outsiders. The construction of social infrastructure such as clinics for the welfare of mine workers and their dependents is an important positive impact for the community.

An environmental and social management plan to manage these impacts has been developed and is described in this report. The approach is based on Anvil company policy, World Bank guidelines and industry best practice.

1 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK.

1.1 Project Proponents

Anvil Mining Congo SARL (Anvil Mining Congo) is a wholly owned subsidiary of Anvil Mining NL (Anvil), an integrated Australian explorer and resource development company listed on the Australian and Berlin Stock exchanges. Anvil Mining Congo is the owner and developer of the Dikulushi Copper-Silver Project located in Katanga Province in the south-east of the Democratic Republic of Congo (DRC).

Anvil Mining Congo holds mining and exploration rights over the Dikulushi deposit and the surrounding 20,000 km^2 area. Anvil also has certain priority rights to other areas of the DRC. Exploration efforts are focused on copper, gold, and platinum group metals (PGM's). The company's copper and precious metals projects include the Dikulushi mine; and the Kapulo, Kalemie and Lungeshi exploration tenements in the south-eastern DRC. In addition, Anvil has exploration interests in south-east Asia and Australia.

First Quantum Minerals Limited (FQM) owns a 17.5% interest in the ordinary shares of Anvil. FQM is a Canadian resource company quoted on the Toronto Stock Exchange focussed mainly on the copper and cobalt sectors in Central Africa. FQM's main producing assets include the Bwana Mkubwa SX-EW facility in Zambia and the Lonshi mine in the DRC.

Institutional and private investors based mainly in Australia own the balance of the equity in Anvil. Approximately 12% of shares are owned or available to the Anvil Board of Directors and Senior Managers in the form of ordinary and/or contributing shares.

RMB Resources Ltd (RMB Resources), part of the Rand Merchant Bank group of South Africa, provided a US$ 4.5 million project finance facility to bring the Dikulushi deposit into production. RMB Resources specialises in resource development and has financed a number of mineral projects in Africa and elsewhere.

1.2 Corporate Environmental Policy

Anvil is committed to the development of mines with due regard for the environment, including the social and economic well being of the communities located in the areas in which it operates. Anvil's Corporate Environmental Policy is presented on the following page.

1.3 Regulatory Framework

The Government of the Democratic Republic of the Congo (DRC) promulgated new mining legislation during 2002, "Loi 007/2002 de 11 Julliet 2002, Portant Code Minier". Under proposed new mining regulations, mining projects in the DRC will be required to submit an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) to the relevant Government authorities for approval before project commencement. Mining projects already in operation, such as Anvil's Dikulushi Mine, will be required to submit an EIA and EMP to the DRC authorities within 12 months of the new regulations coming into effect.

Anvil Mining Congo SARL

Environmental Policy

Anvil is committed to responsible environmental impact assessment and environmental management practice, through the application of international best practice and technology. Anvil will protect human health, minimize the impact of the Company's activities on the environment and return operational sites to a condition compatible with a healthy environment.

Specifically, Anvil Mining Congo SARL is committed to:-

As a minimum, complying with all applicable environmental laws and regulations in force in the DRC and Zambia.

■

Regularly monitoring the environmental impact of the Company's activities through all stages from exploration through mine operations and closure, identifying environmental issues of concern to stakeholders and establishing objectives and strategies for effective environmental management.

■

Ensuring environmental management programs are adequately funded and environmental reclamation work is carried out progressively throughout the life of any operation in order to minimize the accrued environmental liability at any one time and to achieve desirable cost efficiencies in environmental reclamation.

■

Communicating openly with all stakeholders on matters of environmental concern in the region in which the Company is active.

■

Informing all employees, suppliers and service providers of the Company's environmental policy and their responsibilities in relation to Anvil Mining Congo SARL's business.

■

Establishing and maintaining management systems to ensure appropriate and timely implementation of the Company's environmental policy.

The new DRC mining environmental regulations will define standards relating to effluent quality, air quality and noise. As at the date of compiling this EIA these guidelines were not available. In the absence of specific environmental standards, Anvil has adopted World Bank Standards and Guidelines as specified in the World Bank Environment, Health and Safety Guidelines, 1995 and the World Bank Pollution Prevention and Abatement Handbook, 1998.

The DRC government is responsible for EIA review and approval, and the subsequent monitoring of Anvil's Environmental Management Plan for the Dikulushi mine and plant site. Anvil has maintained close contact with senior officials in the Government and compiled an Environmental Scoping Study in December 2001, which described the project and its major environmental impacts. Government inspectors from the Provincial Department for the Environment and Conservation, visited the project in March 2003 and described exploitation conditions as satisfactory.

Anvil also compiled an Environmental Scoping Study for the Nchelenge Port facility in Zambia in December 2001, and in response to an official request from the Environmental Council of Zambia (ECZ) compiled an Environmental Project Brief for the same facility in December 2002. As a result of these submissions, certain modifications to materials handling at this site are planned.

Although the Dikulushi project could possibly be classified as a Category "B" project under World Bank guidelines, Anvil decided in November 2002 to undertake full EIA per a Category "A" project (a project likely to have significant environmental impacts that are sensitive, diverse or unprecedented), in order to fulfil its corporate and co-financier environmental responsibilities.

From an international environmental perspective, the DRC is a party to the following international agreements:-

- Rio Declaration, 1992;
- Convention on the International Trade in Endangered Species of wild Flora and Fauna, CITES (signed 1976);
- UN Framework Convention on Climate Change 1992;
- UN Convention to Combat Desertification (signed 1997);
- UN Convention on the Law of the Sea (signed 1989);
- Montreal Protocol 1987 (UN Convention on Ozone Layer Protection);
- International Tropical Timber Agreement 1994; and
- The Ramsar Convention on Wetlands 1998.

1.4 The EIA Review Process

This EIA report focuses on the significant environmental issues pertaining to the project and contains the following sections in line with the requirements for a Category "A" EIA report under World Bank Guidelines:-

1. Executive Summary
2. Policy, Legal and Administrative Framework
3. Project Description
4. Baseline Data
5. Environmental Impacts
6. Analysis of Alternatives
7. Environmental Management Plan

Under the new DRC mining legislation, copies of the EIA are to be submitted to the authorities in Kinshasa for review. Community based organisations and interested and affected parties will also be given access to the report and the opportunity to make comments which can, where relevant, be incorporated into future planning.

Once the new environmental legislation and accompanying regulations are in full force and effect, a complete list of relevant Laws and Standards will be included in a future addendum to this report.

1.5 International EIA Guidelines

Most modern project EIA's are based on World Bank Guidelines for Environmental Assessment (operational Policy 4.01– January 1999). The World Bank's environmental policy reflects current international environmental standards, which are collectively known as the World Bank Group (WBG) standards.

Although alternate protocols do exist, the WBG standards are considered to be the international benchmark for environmental assessment. An EIA performed to WBG standards will satisfy most financial institutions and was a requirement for the provision of finance by RMB Resources.

The outline and content of this EIA (in the absence of standards yet to be included in the DRC's Environmental Regulations) have been undertaken in accordance with the following World Bank guidelines:

- Operational Policy OP 4.01, Environmental Assessment, (1999)
- Operational Policy OP 4.02, Environmental Action Plans (2000)
- Operational Policy OP 4.04, Natural Habitats (1995)
- Operational Policy OP 4.07, Water Resources Management (1999)
- Operational Policy OP 4.09, Pest management, (1998)
- Operational Policy OP 4.11, Management of Cultural Property (1999)
- Operational Policy OP 4.12/OD 4.30, Involuntary Resettlement, (1990)
- Operational Policy OP/OD 4.20, Indigenous Peoples (1991)
- Operational Policy OP 4.36, Forestry (1993)
- Operational Policy OP 4.37, Safety of Dams (1996)
- Pollution Prevention and Abatement handbook (1998)
- Environmental Assessment Source Book Update 22, Environmental Assessment of Mining Projects (1997)
- Environmental Assessment Source Book Update, Biodiversity and Environmental Assessment (Oct 1997)

Environmental Guidelines outlined in the World Bank Pollution Prevention and Abatement handbook (1998), specifically for Mining and Milling have been adopted as the main standards for current and future environmental compliance (see Appendix I).

Prior to the commencement of this EIA, extensive public consultation was conducted in a socio-economic study compiled by Professor G. Kalaba from the University of Lubumbashi. The Minerals Corporation of South Africa also prepared an initial sustainable development management plan for the Dikulushi Project following a site visit in November 2001.

The Nchelenge (Zambia) Port Facility Environmental Project Brief (EPB) was approved by the Environmental Council of Zambia (ECZ) in 2002 (subject to certain changes to future infrastructure). The ECZ decided that projected impacts in Zambia were not sufficient to warrant a full EIA.

1.6 EIA Administration and Structure

Anvil appointed African Mining Consultants (AMC) as project environmental consultants in October 2002. Mr Andrew Spivey, AMC's Senior Environmental Consultant, co-ordinated and project managed the Dikulushi EIA.

The EIA was undertaken in order to quantify environmental impacts and to design management plans and environmental protection based upon World Bank Guidelines and Industrial "best practice".

Baseline environmental information was collected and reviewed between November 2002 and January 2003. AMC assembled a team of specialists to collect baseline environmental data and assist with EIA preparation.

Detailed information on the project description and planned operations was obtained from Metallurgical Design and Management Ltd (MDM) of South Africa who were responsible for mine development including associated infrastructure design and construction.

The Dikulushi Project EIA was completed in April 2003.

2 PROJECT DESCRIPTION

2.1 History of the Dikulushi Copper-Silver Deposit

The Dikulushi deposit was first worked on in the early 20th Century with various studies conducted initially between 1911 and 1929 and then again in the 1950's. The French organisation - Bureau des Récherches Géologiques et Minières (BRGM) carried out delineation drilling at Dikulushi between 1972 and 1981, demonstrating to their satisfaction at the time, that a 'proven' reserve of 1,489,226 tonnes of ore grading 11.14% copper and 328 parts per million silver could be established. BGRM's recommendation to develop the deposit was not acted upon due to political uncertainty in the country in the 1980's.

Anvil conducted more extensive exploration activities, including drilling, in the second half of 1997. Anvil had signed a mining convention with the Government of Zaire on the 26th of February 1997. The concession area covered 12,945km^2. Anvil later renegotiated this convention with the government of the DRC and increased the area to 20,000km^2 comprising four exclusive exploration areas (ZER's) of approximately 5,000km^2 each.

Signet Engineering Pty Ltd., conducted a project pre-feasibility study for Anvil in early 1998, and much of the current mine design is based on this work. In July 2001, Metallurgical Design and Management Pty Ltd (MDM) were commissioned to prepare a definitive costing study for initial development of the project based on an open pit mine and heavy media separation (HMS) plant. MDM estimated the capital cost for this phase to be US$ 5.74 million. Following the successful securing of project finance, construction began in February 2002.

The current estimate of the mineral resources at Dikulushi is 1,940,000 tonnes of ore grading 8.59% copper and 266 grams per tonne silver using a 2% cut-off; or 1,350,000 tonnes grading 11.07% copper and 352 grams per tonne silver using a 4% cut-off. The orebody lies within a steep southeast dipping fault structure. The ore configuration makes it amenable to both open cast and underground mining methods. The orebody is open at depth below 200m, and if these resources prove to be economic, the mine life may be extended.

Site construction activities began in February 2002, and pre-development of the open pit commenced in July 2002. The mine produced its first copper/silver concentrate in September 2002 and concentrate production is currently just over 3,100 tonnes per month.

2.2 Project Location

The Dikulushi Copper-Silver deposit is located in the Haut-Katanga district, Katanga Province of the Democratic Republic of the Congo (DRC) see Figure 2.1.The mine site lies approximately 400 kilometres by road north-north-east of the city of Lubumbashi, the main commercial centre of the DRC Copperbelt. The site is approximately 50km north of the regional centre of Kilwa and 25km from the shore of Lake Mweru. The border with Zambia runs through Lake Mweru, some 30 kilometres southeast of the mine site. The area is accessed using a gravel road from Lubumbashi via Kasomeno, Kilwa and Kiankalomo. The journey from Lubumbashi takes approximately 14 – 20

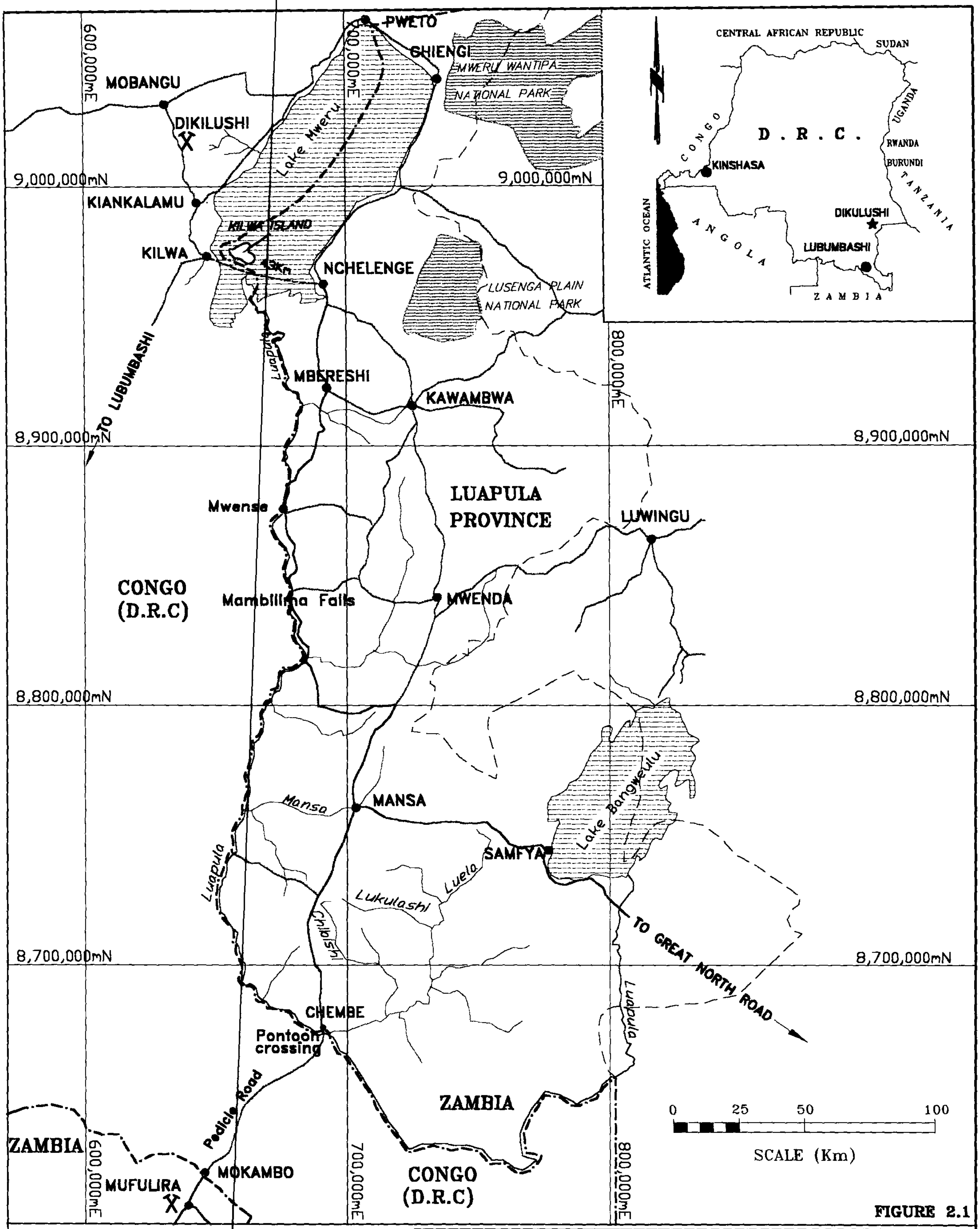


FIGURE 2.1

LEGEND

- TARRED ROAD
- UNSURFACED ROAD
- INTERNATIONAL BORDER
- PROPOSED BARGE ROUTE
- PROVINCIAL BOUNDARY
- X MINE
- ▤ LAKE
- RIVERS

AFRICAN MINING CONSULTANTS LTD
P.O BOX 20106, KITWE, ZAMBIA.

PROJECT TITLE: DIKULUSHI ENVIROMENTAL IMPACT ASSESSMENT

DIKULUSHI COPPER – SILVER DEPOSIT
NCHELENGE PORT FACILITY
PROJECT LOCATION PLAN

SCALE: 2,000,000

ORIGINATOR :		CLIENT: ANVIL MINING ZAMBIA LIMITED	DATE: DEC'01
DRAWN :	DKM	FILE NAME: C:\\DIKUL2.DWG	REV: 0

hours, although the road is usually impassable in the wet season from November to April. The other main access route is through Zambia via the Kilwa – Nchelenge Ferry crossing Lake Mweru. Nchelenge is 50km from Kilwa and the ferry crossing takes approximately 4 hours. Good tar roads exist from Nchelenge through Zambia to neighbouring Tanzania, Zimbabwe, Namibia and Botswana.

Kilwa, the nearest town, and Kiankalomo, the nearest large village, are situated 54 km and 37 km south of the deposit respectively. The closest permanent settlement is Dikulushi village located 4 km to the south-west of the mine. There was no pre-existing settlement at the mine site and therefore project construction did not require the resettlement of any indigenous people.

Almost no topographic survey data is available for the mine site. Relief around the mine site is gentle with slopes at ±3% to the east. The Dikulushi river, which flows only during the wet season, crosses the eastern extension of the final pit as shown on Figure 2.2.

2.3 Socio-Economic Aspects

The Dikulushi project is relatively small, self-contained, and reliant on the supply of imported equipment and materials via Nchelenge in Zambia. 130 skilled and semi-skilled staff are directly employed on contract by Anvil and housed at the mine site. The staff were recruited from regional mining centres and further afield, however the company has instigated training programmes aimed at enhancing local skill levels.

In order to promote sustainable economic development in the project area Anvil plans to retain an expert to prepare a sustainable development plan for Dikulushi. It is expected that the mining project will act as a springboard for development and economic diversification in the Dikulushi/Lake Mweru area and beyond.

In the short term, the project is likely to attract people to the area on expectations of enhanced job opportunities, however not all new arrivals will be able to be offered employment. This may, in the short term, strain local resources and infrastructure, and could result in some social friction.

2.4 Site Ecology

The Dikulushi deposit lies in Central Zambezian Miombo Woodland, an ecological type that covers much of central and northern Zambia, south-eastern DRC, western Malawi, Tanzania and parts of Burundi and north-eastern Angola.

This ecological type is characterised by broadleaf deciduous woodland and savannas interspersed with grassland, semi-aquatic vegetation and areas of evergreen groundwater forest.

Zambezian Flooded Grasslands occur in low lying areas around Lake Mweru and the Luapula River valley. These areas are relatively productive and, unlike the surrounding woodlands, which have nutrient deficient soils, are able to support wildlife in fairly high densities.

The area in the immediate vicinity of the Dikulushi operation is characterised by a mixture of Munga and Miombo woodland with riparian forest on the banks of the Dikulushi river. The Dikulushi river is ephemeral, and dries up completely towards the

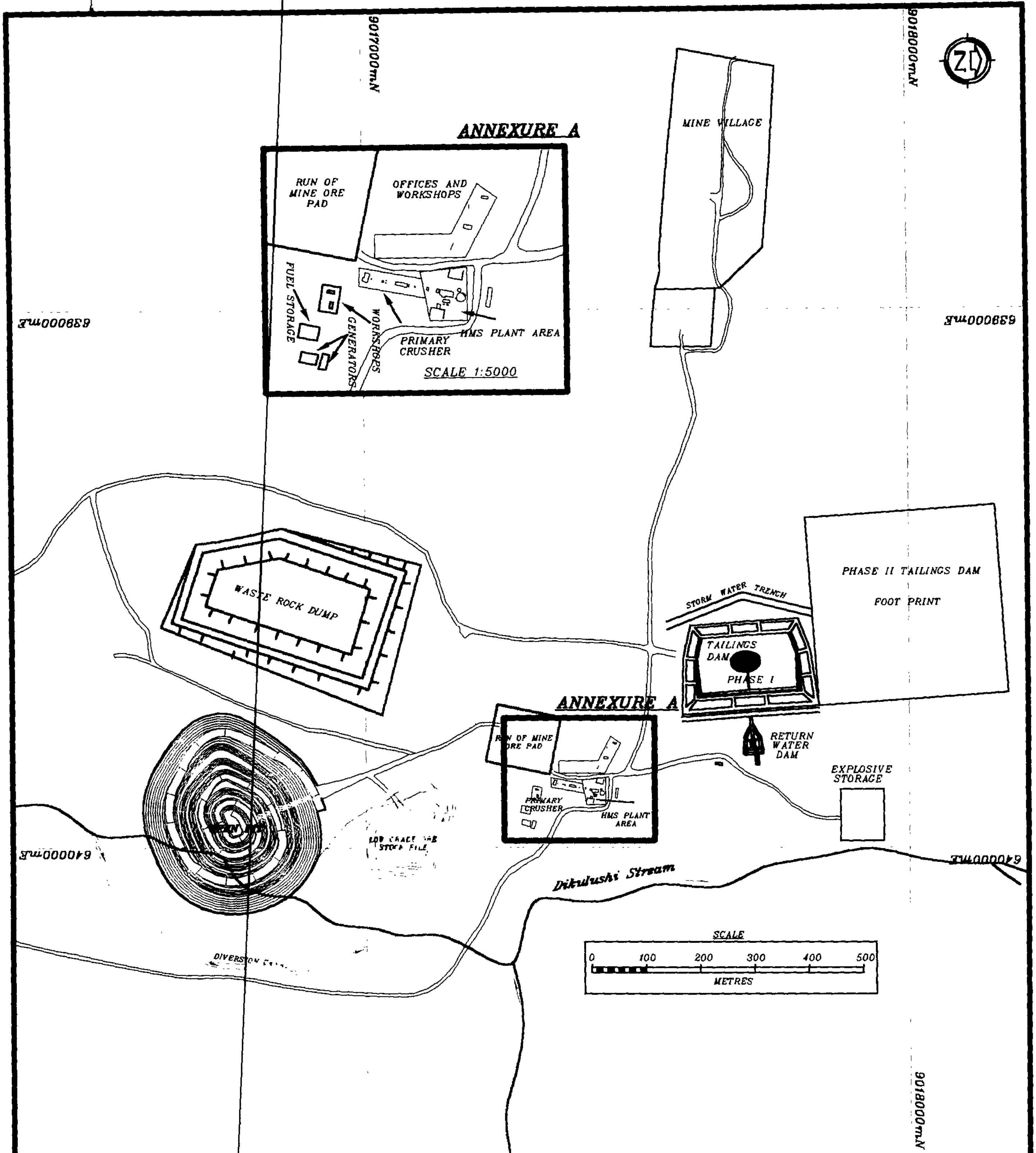


FIGURE 2.2

AFRICAN MINING CONSULTANTS LTD

P.O BOX 20106, KITWE, ZAMBIA

PROJECT TITLE: DIKULUSHI ENVIRONMENTAL IMPACT ASSESSMENT

DIKULUSHI MINE SITE PLAN

SCALE 1 : 10000

ORIGINATOR:	A.S.	CLIENT: ANVIL MINING NL	DATE:FEB 03
	K.M.	DWG NO: /../SITEPLAN.DWG	REV NO: 0

end of the dry season (May to October). There are no permanent wetlands in the immediate mine area.

No large mammals have been sighted in the project area for many years. Small mammals are common and there is an abundance of bird life.

2.5 Infrastructure and Site Access

Infrastructure in the project area is poor. There is no electricity supply or terrestrial telecommunications system. Access to the site from Lubumbashi is via an unsealed road that is usually only passable during the dry season. Because of the logistical difficulties in the DRC, Anvil found it appropriate to source all project equipment and supplies via Nchelenge in Zambia. At Nchelenge, material is loaded onto a 250 tonne barge owned and operated by Anvil and shipped to Kilwa (DRC) on the western shore of Lake Mweru. From Kilwa, equipment and supplies are transported 54 kms by unsealed road to the mine site.

Copper - silver concentrate is transported by road from the mine site to Kilwa and then by barge to Nchelenge for onward shipment by road to smelters in Namibia and South Africa.

2.6 Mine Development

Dikulushi open pit mine is being developed in two phases:-

Phase I: Year 1 - opencast mine to supply 250,000 tpa ore to a heavy media separation plant (HMS) that produces 38% copper in concentrate.

Phase II: Year 2 - HMS plant to be replaced by a 250,000 tpa ball mill and flotation concentrator that will produce a 60% copper concentrate. Tailings and low grade ore produced during Phase 1 will undergo re-treatment during Phase II.

A development strategy for the underground mine is currently being formulated by Anvil. This will become the third Phase of mine development. The expected life of the operation is presently 8 years. This may increase depending on the results of Anvil's ongoing local and regional exploration activities.

2.7 Mine Components, Processing Facilities

Figure 2.2 is a site plan showing the layout of the key on-site mine components for Phases 1 and 2 which include:-

- Open pit;
- Waste rock dump;
- Ore stockpiles;
- Dikulushi River Diversion Scheme in Year 2/3;
- Run-of-Mine Ore Crushing Plant (ROM);
- Phase I - Heavy Media Separation (HMS) Plant;
- Phase II - Mill and concentrator;
- Phase I Tailings dam;
- Workshops & fuel storage; and
- Mine infrastructure.

The Dikulushi mine site covers an area of approximately 50 hectares.

2.7.1 Open Pit

Con Roux Limited, a contract mining company has been employed by Anvil to carry out the Dikulushi opencast mining operations. Planned ore production is 250,000 tonnes per year for at least 4-5 years. The open pit is being mined conventionally with 5-metre high benches, and will be developed in 3 cutbacks/stages to produce the final pit shown in Figure 2.2. The planned ultimate depth of the pit is 120 metres. Anvil expects to continue mining below this depth by underground methods.

Borehole pumping tests performed by BRGM in the 1970's and observations made during the drilling program carried out by Anvil in 1997 indicate that the deposit may be associated with considerable groundwater and should be considered a wet deposit. Predicted groundwater inflow to the final pit is around 18,000 m^3/day. De-watering will be carried out from an in-pit sump as well as by pumping from 4 dewatering holes located outside the pit. This water will be used for domestic purposes and raw water feed to the process plant. Currently all process water is recycled via the tailings dam return water reservoir with zero discharge to surface waters. As the pit is deepened and water inflows increase, excess mine drainage water will be collected in settling ponds before it is discharged to the Dikulushi river.

Current pit slope design is based on Signet's 1998 pre-feasibility study. Anvil intends to verify the existing design by drilling a limited number of geotechnical drill holes during the first half of 2003. The suitability of the current pit design will be re-assessed using data collected from these holes and in pit geotechnical mapping.

Medium to high-grade ore from the open pit is trucked to the Run of Mine (ROM) stockpile. Low-grade ore mined prior to the Phase II plant upgrade will be placed on a low-grade stockpile to be treated at the end of the open pit mine life.

Storm water drains will be constructed around the open pit perimeter to prevent runoff from surrounding areas flowing into the pit.

2.7.2 Waste Rock Dump

The waste rock dump is located to the west and north~~west~~east of the open pit and is designed to accommodate 3.08 million bank cubic metres of material. The dump is being constructed in two lifts of 8 metres, with inter-berm slope angles of 12 degrees to facilitate rehabilitation and re-vegetation. A minimum distance of 100 metres is being maintained between the toe of the dump and the edge of the open pit. Rehabilitation of the dump will be ongoing as areas become available.

Storm water drains are to be constructed around the dumps and all run-off will be contained and diverted/pumped to a sedimentation pond before being discharged to the Dikulushi river.

Oxidation of sulphide minerals in the waste may result in acid rock drainage. Anvil's own Dikulushi Implementation Plan of April 2002 (Page 5) estimated that up to 20% of the waste could contain potential acid generating materials. Waste characterisation test work was not carried out prior to the project commencement and will be an urgent and early requirement of the Environmental Management Plan. Early recognition of a potential acid rock drainage (ARD) problem will enable adequate containment and mitigation measures to be put in place.

2.7.3 Ore Stockpiles

Low-grade stockpile

498,000 mt @ 1.8%

The low-grade ore stockpile is located to the east of the ROM pad and will contain up to ~~240,000~~ tonnes. This low-grade ore will be processed either during flotation or via heap leaching later in the mine's life.

ROM ore stockpile

The ROM ore stockpile is located adjacent to the HMS plant and will store approximately 20,000 tonnes at any one time, i.e. one month's ore supply.

Run-off from the ore stockpiles will be collected and directed to a sedimentation pond before clear water is released into the environment.

2.7.4 Dikulushi River Diversion Scheme

The Dikulushi river crosses the eastern portion of the final pit as shown in Figure 2.2. The river in the vicinity of the mine is ephemeral with zero flow recorded in the latter part of the dry season. In Year 2/3 the Dikulushi river will be impounded 100 metres upstream of the pit. Wet season flows from November to April will be directed into a small 750 metre long diversion canal which will pass 100 metres to the east of the pit and discharge back into the river to the east of the HMS plant. The diversion canal will operate throughout the remaining life of the pit and underground mine. At closure the pit will be allowed to flood. The diversion dam will be breached and the Dikulushi River will revert to its original water course.

2.7.5 Run-of-Mine Ore Crushing Plant

Run-of-mine ore is tipped into the ore bin, which is equipped with a vibrating grizzly feeder. Oversize material >76.5 mm passes through the primary jaw crusher and undersize material < 76.5 mm proceeds directly to the sizing screen. From the sizing screen oversize material > 16 mm passes through a secondary and tertiary crushing stage and undersize material < 16 mm is conveyed to the 350 tonne live crushed ore stockpile. The crushing plant processes ~~250,000~~ tpa at a rate of 62 tph.

450,000

2.7.6 Process Plant

Two metallurgical processes are to be used to treat Dikulushi sulphide ore. In Phase I a Heavy Media Separation (HMS) Plant produces 38% copper in concentrate. In Phase II the HMS plant is replaced by a conventional ball mill and flotation circuit, which will produce 60% copper in concentrate.

Phase I - Heavy Media Separation Plant

The configuration of the crushing circuit and HMS plant is shown in Figure 2.3a. HMS feed is pulped and de-slimed on a vibrating screen. De-slimed oversize material is mixed with heavy media ferrosilicon (FeSi) and pumped to a separation cyclone. De-slimed screen undersize gravitates to the effluent tank and is pumped to the tailings dam.

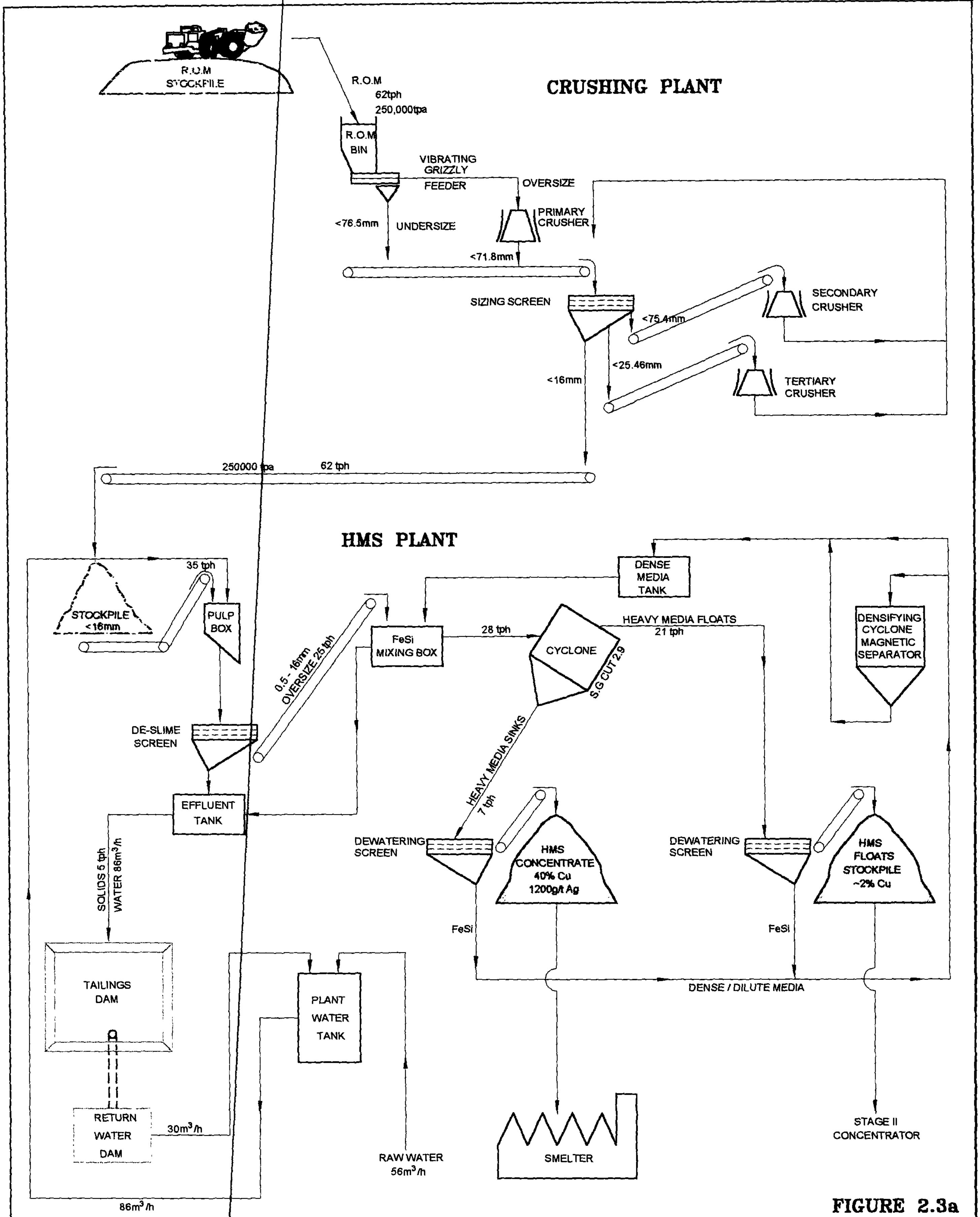


FIGURE 2.3a

AFRICAN MINING CONSULTANTS LTD
P.O BOX 20106, KITWE, ZAMBIA.

PROJECT TITLE: DIKULUSHI ENVIRONMENTAL IMPACT ASSESSMENT

PHASE I – HEAVY MEDIA SEPARATION PLANT
HMS PROCESS FLOW DIAGRAM

SCALE : NTS

ORIGINATOR : AQS	CLIENT: ANVIL MINING NL		DATE: MAR'03
DRAWN : FPM	FILE NAME: FLOWCHART1.DWG		REV: 0

From the separation cyclone the heavy media floats fraction gravitates over a vibrating screen onto the floats dewatering screen. The heavy media sinks fraction gravitates to a de-watering screen and sinks vibrating screen. Sinks material is conveyed to the concentrate stockpile (38% Cu & 900g/t Ag) awaiting shipment to the smelter. Floats material (~2% Cu) is conveyed to the floats stockpile for later reprocessing.

Approximately 2,000 tpm of tailings material (minus 0.5mm) is produced from the HMS plant. The tailings has a Cu content of 8-10%. This material is stored separately and will be reclaimed and reprocessed in the milling and flotation circuit during Phase II.

Phase II - Concentrator Mill and Flotation

The concentrator and flotation circuit process flow diagram is shown in Figure 2.3b.

Crushed ore from the mill feed stockpile, HMS plant floats and HMS plant tailings are fed into the ball mill. Mill discharge passes through a trommel screen and undersize is pumped to the mill cyclone. Cyclone overflow gravitates to the concentrator flotation section and cyclone underflow is returned to the mill feed.

Sulphide Flotation

Cyclone overflow is conditioned and then flows to the sulphide rougher cells. Rougher concentrate is pumped to the sulphide cleaner cells while rougher tailings are pumped to the oxide flotation circuit.

Cleaner concentrate is pumped to the sulphide re-cleaner cells and cleaner tailings are returned to the rougher feed. Re-cleaner concentrate is pumped to the concentrate thickener, while re-cleaner tailings gravitates to the cleaner cells feed.

Oxide Flotation

Sulphide rougher flotation tailings are fed to oxide flotation circuit conditioning tanks. Conditioned pulp gravitates to the oxide rougher cells. Rougher concentrate is pumped to the oxide cleaner cells and rougher tailings are pumped to the tailings dam.

Cleaner concentrate is pumped to the oxide re-cleaner cells. Cleaner tailings are pumped back to the rougher feed. Re-cleaner concentrate is pumped to the concentrate thickener while re-cleaner tailings gravitate to the cleaner cells feed.

Flotation reagents are stored in secure containers.

Analytical Laboratory

Grade control test work and chemical analysis is done in a laboratory supplied and maintained by SGS Limited.

Concentrate Thickening and De-watering

The settling of copper concentrate in the concentrate thickener is assisted by the addition of flocculant. Thickened concentrate is further de-watered in a filter press. Filtrate is returned to the thickener feed. The concentrate product (60% Cu) is stockpiled awaiting shipment to a smelter.

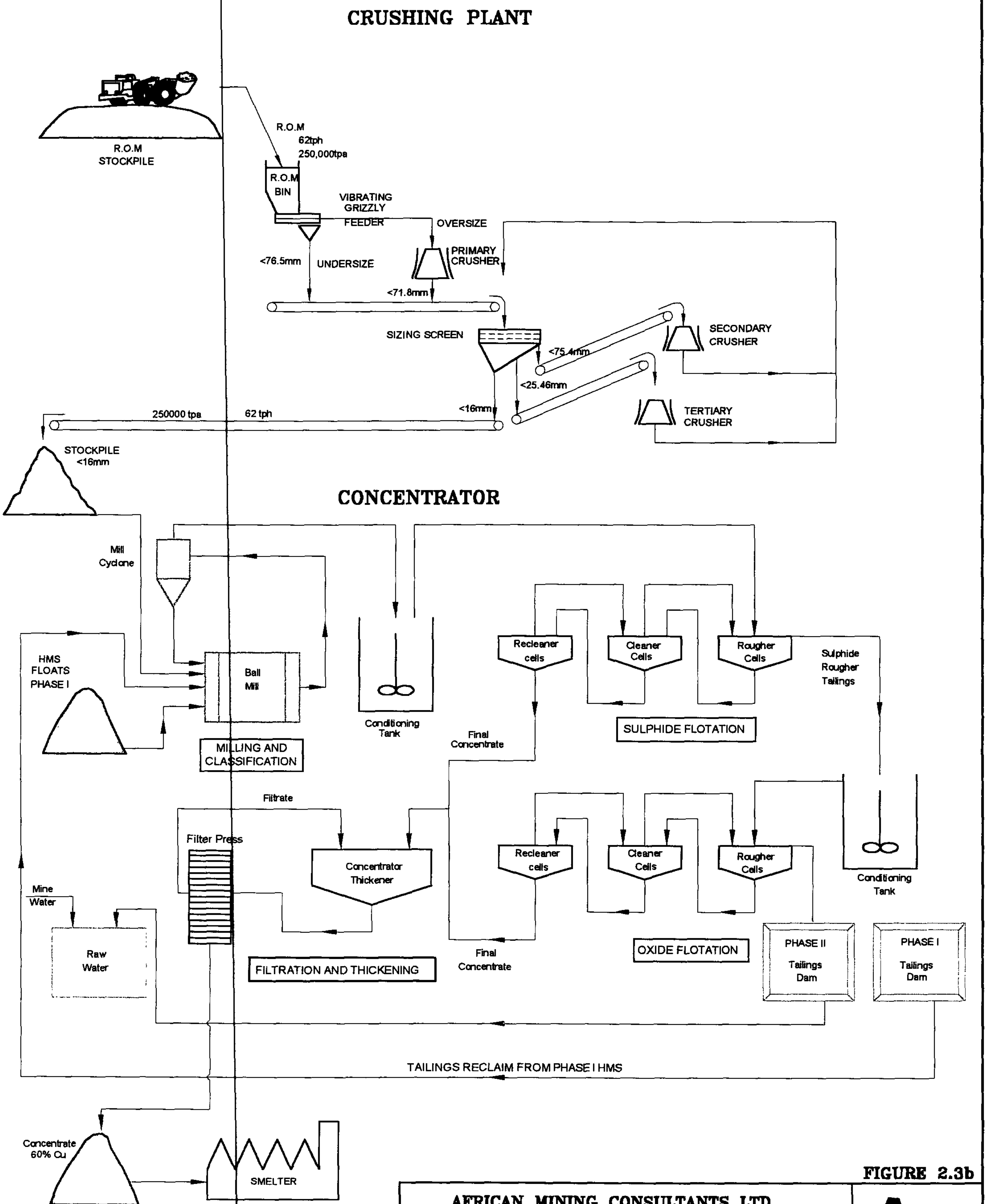


FIGURE 2.3b

AFRICAN MINING CONSULTANTS LTD
P.O BOX 20106, KITWE, ZAMBIA.

PROJECT TITLE: DIKULUSHI ENVIRONMENTAL IMPACT ASSESSMENT

PHASE II – CONCENTRATOR
PROCESS FLOW DIAGRAM

SCALE :

ORIGINATOR : MEF
DRAWN : DKM
CLIENT: ANVIL MINING NL
FILE NAME: flowchart2
DATE: DEC'02
REV: 0

2.7.7 Tailings Dam

Phase I Tailings Dam

The Dikulushi Phase I tailings dam is located some 200 metres northwest of the plant area as shown in Figure 2.2. Knight Piesold Consulting of South Africa designed the tailings dam.

The tailings dam is a typical side-hill impoundment covering an area of 1.8 ha. It will attain a maximum height of 3.8 metres. The dam is designed for the maximum 24 hour rainfall event of 210 mm and incorporates an earth fill starter wall, filter drains, toe drain, penstock, uphill storm water cut-off drains, perimeter catchment paddocks and return water dam (RWD) / silt trap. The relatively coarse HMS plant tailings (55% sand size and 44% silt size) are open ended into the tailings dam at a rate of 2,000 tpm from a perimeter tailings delivery pipeline. When necessary, flocculant is added to the tailings to assist settling of fines.

Supernatant water from the tailings dam is drained via a penstock into the RWD. During the dry season all tailings dam drainage water will be reclaimed and pumped from the RWD to the HMS plant raw water tank. During the wet season excess water is discharged from the RWD spillway into a drain leading to the Dikulushi river.

Phase I copper rich tailings (8-10% Cu) will be reclaimed in Phase II by hydro mining in the dry season only. Tailings will be re-pulped using water monitors and directed into the decant structure. Decant rings will be removed as the tailings elevation drops. The decant pipe will discharge into a pump box from where the tailings will be pumped to the mill.

Phase II Tailings Dam

Detailed design of the Phase II tailings dam will be completed by May 2003. The likely dam footprint is shown in Figure 2.2. It is envisaged that the Phase II tailings dam will be sited immediately to the north of the existing dam with one common wall. The Phase II concentrator will produce 20,000 tpm of tailings. Preliminary design work indicates that this dam will cover 12.25 ha and attain a height of 23.5 metres. Following the reclamation of Phase I tailings, the two tailings dams will be merged to form one impoundment. The Phase II dam will have sufficient storage capacity for the life of the mine.

2.7.8 Mine Workshops, Stores, Fuel & Oil Storage

Mine Workshops & Stores

Anvil and its contractor's workshops and stores have been constructed using 40 foot containers set 8 metres apart with ~~timber~~ steel frame roofs covered with corrugated iron roofing sheets. The workshop floors are constructed of reinforced concrete.

Fuel & Oil Storage

still planned

Fuel, oil and lubricants for mobile equipment, the process plant and mine village are supplied and delivered to site by Mobil-Exxon. The fuel depot at Nchelenge has a 5,000 litre petrol tank below ground and a 50,000 litre diesel tank above ground. Kilwa has a 5,000 litre petrol storage tank and a 35,000 litre diesel tank. There are a further 6 x ~~5,000~~ 35,000 litre above-ground diesel storage tanks at Dikulushi. Lubricating oil is stored in

200 litre drums in the workshops/stores area. The mine village generator has its own diesel storage tank, although this is no longer in use.

The mining contractor is responsible for the safe supply, storage and handling of all its fuel, oil and lubricants.

Mobil-Exxon, as part of their fuel supply contract with Anvil is responsible for the safe disposal of waste oils and lubricants from the operations. There is a 25,000 litre waste lubricant tank at the mine site. All waste lubricants will be cycled through an approved waste oil disposal facility in Zambia.

2.7.9 *Infrastructure*

Mine Village

The mine village is located approximately 1,200 metres WNW of the plant area. The accommodation is for single status Congolese and expatriate staff, and comprises barracks and small bungalows. Facilities include kitchen, mess, recreational club and open area for sports activities. Approximately 130 people are accommodated in the mine village. Sewage is disposed of in 4 septic tanks.

Domestic water is currently obtained from boreholes close to the open pit. Anvil intends to install 3 domestic water wells 500 metres west of the mine village to supply 10,000 litres/day of potable water. The water will be pumped to 2 x 5,000 litre storage tanks from where it will feed by gravity into the reticulation system.

Site Roads

Mine haul roads are constructed and maintained by the mining contractor. All other site roads have been constructed by Anvil using locally won lateritic materials.

Power Supply and Distribution

It is not feasible to connect to the DRC national power grid due to the remoteness of the mine site. Under normal operating conditions the process plant draws approximately 450 kW of power. Power is supplied by four 375 kVa generators and distributed by both underground cables and overhead lines.

Radio/Satellite Communications

Present off-site communications rely on a VHF radio link between the mine site, Lubumbashi, Kilwa and Nchelenge, and a VSAT satellite communications system for international communications.

2.8 Off-site Infrastructure Investments

Off-site investments in infrastructure include:-

- Upgrade of the Kilwa to Dikulushi un-sealed (54 km) road;
- Upgrade of the airstrip at Kilwa;
- Construction of the Kilwa Port facility (DRC); and
- Construction of the Nchelenge Port facility (Zambia).

2.8.1 Upgrade of the Dikulushi to Kilwa un-sealed road;

Anvil is upgrading the Dikulushi to Kilwa unsealed road to all weather status using locally won lateritic materials. Timber bridges are being replaced with Armco culverts and spillways. Regular road maintenance will be carried out by Anvil throughout the life of the mine.

2.8.2 Upgrade of the Kilwa Airstrip

also Nchelenge airstrip will be upgraded to facilitate medivac: 200 m clearing of bush @ each end, and a laterite base strip

Anvil intends to upgrade the existing airstrip at Kilwa to a minimum 900 metre class D runway. The airstrip will be upgraded with locally won laterite material. Fuel will be brought from the mine site to the airstrip in drums as and when necessary.

2.8.3 Kilwa Port Facility (DRC)

The Kilwa Port Facility is located at the village of Kilwa, on the western shore of Lake Mweru. Figure 2.4 is a general arrangement drawing of the port, which basically comprises a rock and earth-fill ramp, and fuel depot. Anvil has an office that is currently undergoing refurbishment, but no accommodation at Kilwa. The port has a new immigration and customs office which was constructed by Anvil.

The fuel depot has a 5,000 litre petrol tank below ground and a 35,000 litre diesel tank above ground to supply the transport contractors, the barges and Anvil's speedboat. The fuel depot is owned and operated by Anvil. The 50,000 litre diesel tank and the 5,000 litre petrol tank at Nchelenge will soon be moved from Nchelenge to Kilwa.

No hazardous materials (with the exception of fuel) are off-loaded or stored at Kilwa.

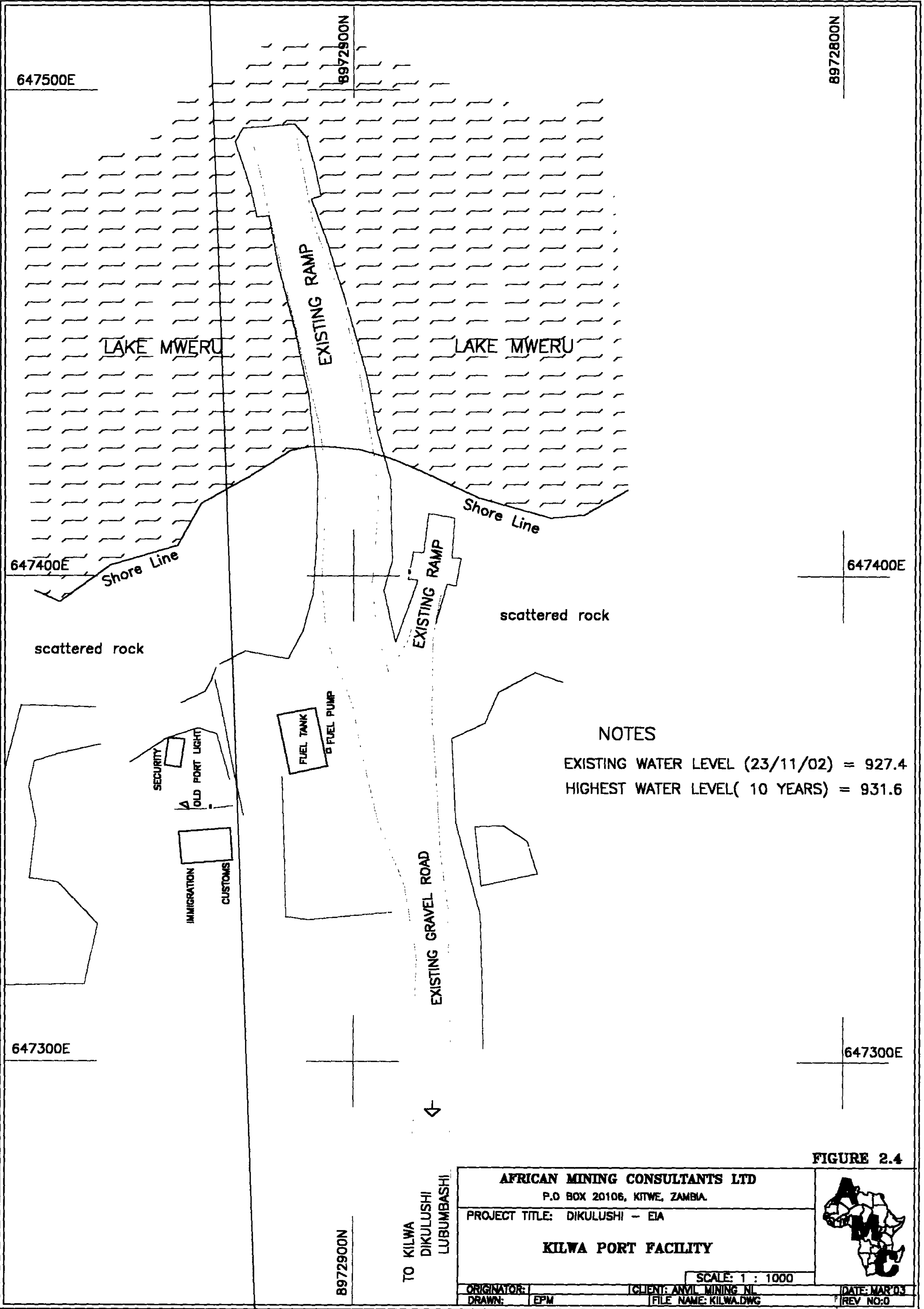
Anvil operates a small 25 tonne barge and a large 250 tonne barge on Lake Mweru. The 25 tonne barge was used to transport materials and equipment across Lake Mweru prior to the commissioning of the main 250 tonne barge on 14 June 2002. The smaller barge is now used as a support tender. The 250 tonne barge is based at Kilwa where the maintenance and refuelling of both barges is carried out.

Dikulushi currently produces 110 tonne/day of fine to medium gravel size concentrates. Four 35 tonne trucks make a daily crossing of Lake Mweru using the Nchelenge and Kilwa roll-on-roll-off port facilities. The trucks make the return journey loaded with concentrate for onward shipment to smelters in Namibia and South Africa.

The barge also carries materials and supplies from South Africa and Zambia to the mine site. The port facilities operate 6 days a week with either one or two crossings per day, mainly during daylight hours.

Starting in 2003 the HMS concentrate will be transported to Kilwa in 1.5 tonne bulker bags. These will be off-loaded directly onto the barge for bulk shipment to Nchelenge. At Nchelenge, the concentrate will be off loaded and stored in a covered, 500 tonne capacity concentrate storage shed before onward shipment to smelters. During the bulk shipment phase the barge will ship concentrate every second day because of the increased payload when using bulker bags.

Materials and supplies will be shipped on alternate days between shipments of concentrate. It is anticipated that by mid-2003, the barge will only need to operate during daylight hours.



NOTES

EXISTING WATER LEVEL (23/11/02) = 927.4

HIGHEST WATER LEVEL(10 YEARS) = 931.6

FIGURE 2.4

AFRICAN MINING CONSULTANTS LTD
P.O BOX 20106, KITWE, ZAMBIA.

PROJECT TITLE: DIKULUSHI – EIA

KILWA PORT FACILITY

SCALE: 1 : 1000

ORIGINATOR:
DRAWN: EPM
CLIENT: ANVIL MINING NL
FILE NAME: KILWA.DWG
DATE: MAR'03
REV NO:0

Once Phase II has been implemented, flotation concentrate will continue to be shipped in bulker bags. Due to the increased production rate in this Phase, the frequency of concentrate shipments from Kilwa to Nchelenge will increase.

2.8.4 Nchelenge Port Facility (Zambia)

The Nchelenge Port facility is located in Nchelenge Town on the eastern shore of Lake Mweru. A general arrangement drawing of the Nchelenge Port Facility can be found in Figure 2.5. The total area of the port is approximately 1.4 ha. The port comprises a concrete ramp and two permanent jetties, an office, Exxon-Mobil owned fuel storage facility, gravel driveway and truck parking area. A covered shed for the storage of concentrate is planned, although this may now be sited at another location away from populated areas of Nchelenge.

Domestic water for the facility is drawn from Lake Mweru. Sewage is disposed of in a septic tank.

The fuel depot has a 5,000 litre petrol tank below ground and a 50,000 litre diesel tank above ground to supply Anvil's fuel requirements in Zambia. These fuel storage tanks will be moved to Kilwa in the near future.

The concentrate storage shed will have a reinforced concrete floor, roof and sidewall. A reinforced concrete slab and bund wall will be constructed outside the shed to contain all concentrate material.

There are no workshop facilities at Nchelenge. Maintenance and re-fuelling of the barge is done at Kilwa in the DRC.

No hazardous materials (with the exception of fuel) are offloaded or stored at Nchelenge. All chemicals, fuel, oil and grease destined for Dikulushi remain on the trucks whilst in transit.

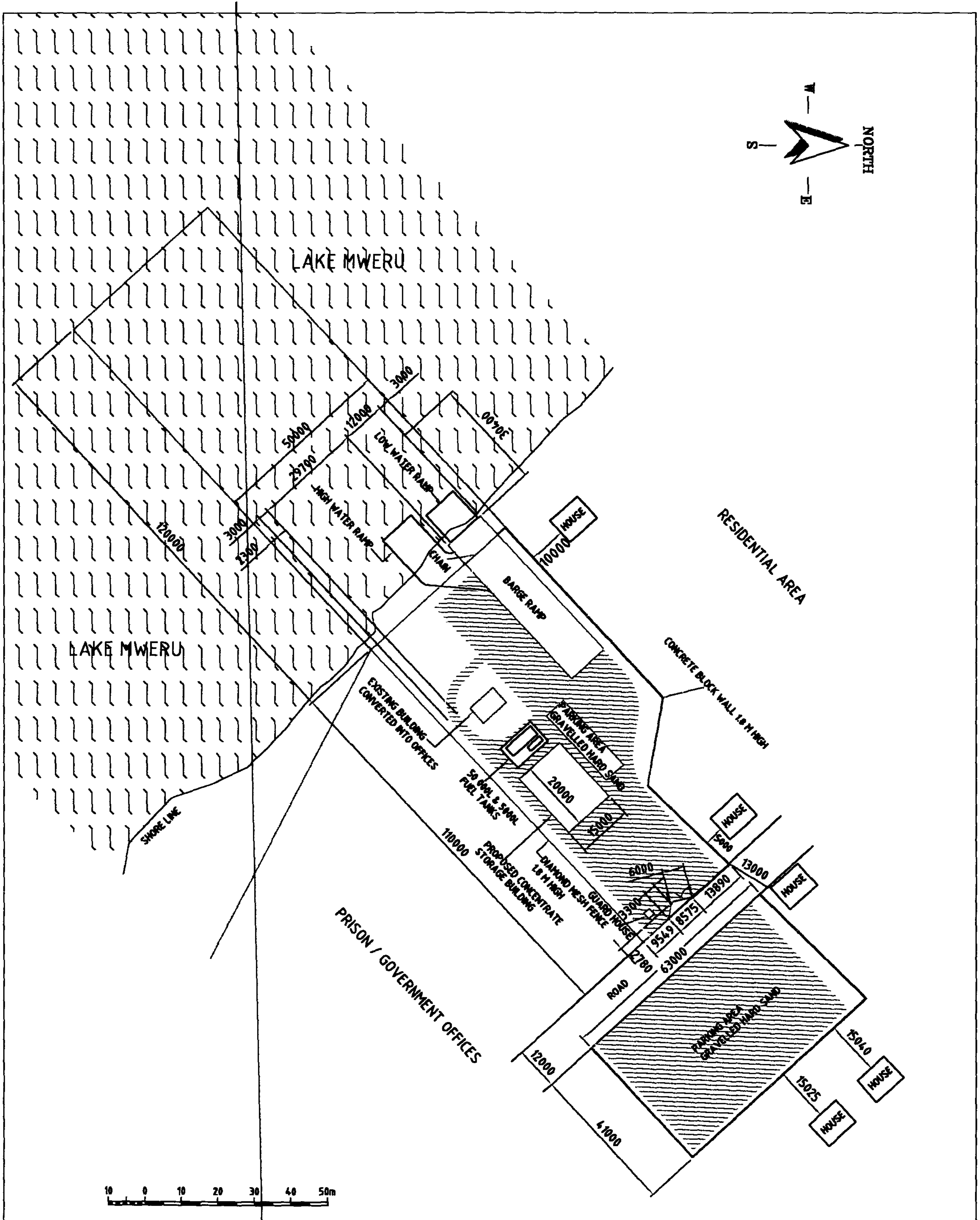


FIGURE 2.5

AFRICAN MINING CONSULTANTS LTD

P.O BOX 20106, KITWE, ZAMBIA.

PROJECT TITLE: DIKULUSHI – EIA

NCHELENGE PORT FACILITY

SCALE: AS SHOWN

ORIGINATOR:

DRAWN: EPM

CLIENT: ANVIL MINING NL

DATE: MAR'03

3 ENVIRONMENTAL BASELINE STUDY

3.1 Environmental Baseline Study Area

The environmental baseline study (EBS) area was previously defined in the Dikulushi Environmental Scoping Study (AMC, December 2001) as the Dikulushi mine site and the port facilities at Kilwa (DRC) and Nchelenge (Zambia). The study of physical, chemical and biological project impacts therefore focuses on these facilities, together with their access routes and materials handling infrastructure.

Project socio-economic impacts will affect a greater geographical area than the direct environmental impacts. The EBS area chosen for the socio-economic study therefore includes all communities impacted by the project.

3.2 Scope of Work

The Dikulushi Copper-Silver Project EBS included:-

- A desk study of technical information relating to the project;
- Visits to Government Departments, Non-Government Organisations and other relevant authorities in the DRC and Zambia.
- An investigation/assessment of environmental baseline conditions including:-
    - Climate
    - Air quality
    - Topography
    - Geology & Hydrogeology
    - Hydrology
    - Aquatic flora and fauna
    - Terrestrial flora and fauna
    - Land use and land classification
    - Noise and vibration
    - Infrastructure and communications
    - Socio-economic aspects

All aspects of the EBS were completed by the end of February 2003.

3.3 Climate

The nearest reliable, long-term meteorological station is located at Kawambwa, 60 km south-east of Nchelenge in Zambia. Discontinuous climatic data is also available from poorly kept records at Kilwa in the DRC.

Climatic data covering the period from 1970 to 2000 at Kawambwa acquired from the Zambian Meteorological Department and 27 years non-continuous rainfall data from Kilwa in the DRC was analysed to characterise climatic conditions in the study area.

The area is characterised by a tropical wet season - dry season climate. The altitude (1000-1050 metres amsl) moderates summer daytime maxima so that temperatures rarely exceed 40°C. Rainfall occurs between November and April and is largely controlled by the Inter -Tropical Convergence Zone (ITCZ).

Temporal and spatial variation in rainfall is extremely high on both a local and regional scale. Anvil intends to install a weather station at the mine site to collect more detailed data on local climatic conditions.

3.3.1 Rainfall and Humidity.

Rainfall data from Kilwa indicates that annual average rainfall is 1086 mm. Fluctuations in rainfall can be significant with rainfall of 790 mm recorded in the driest year and 1439 mm in the wettest.

Kawambwa lies at a similar altitude to the Dikulushi mine site. Meteorological data for the years 1970 to 2000 indicates mean annual rainfall to be 1322mm, with annual maxima and minima of 1664mm and 1004mm respectively. The maximum 24 hour rainfall event was 114 mm. It should be noted that the data differs significantly from the Kilwa records.

The average monthly rainfall recorded over the 30-year period for Kawambwa is presented in Figure 3.1. Recurrence intervals for 24-hour storms and high monthly rainfalls calculated from the same data are shown in Table 3.1 below.

Table 3.1 - Calculated Recurrence Intervals of monthly and 24-hour precipitation, based on 30 years daily rainfall data from Kawambwa.

Recurrence interval	24-hr precipitation	Monthly precipitation
50 years	130 mm	456 mm
25 years	110 mm	428 mm
5 years	77 mm	356 mm

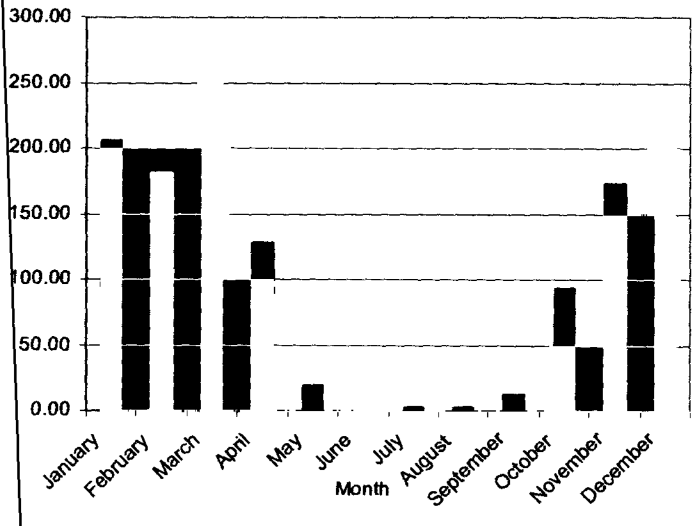


Figure 3.1 Monthly average rainfall, Kawambwa 1970 - 2000. (Meteorological Department, Zambia).

The one day Probable Maximum Precipitation (PMP) for the whole of Zambia has been calculated to be 390mm (Knight Piesold, 2002).

Humidity varies from a minimum of 23% in the dry season to a maximum of almost 100% in the wet season. Monthly average, maximum and minimum humidity is presented in Figure 3.2.

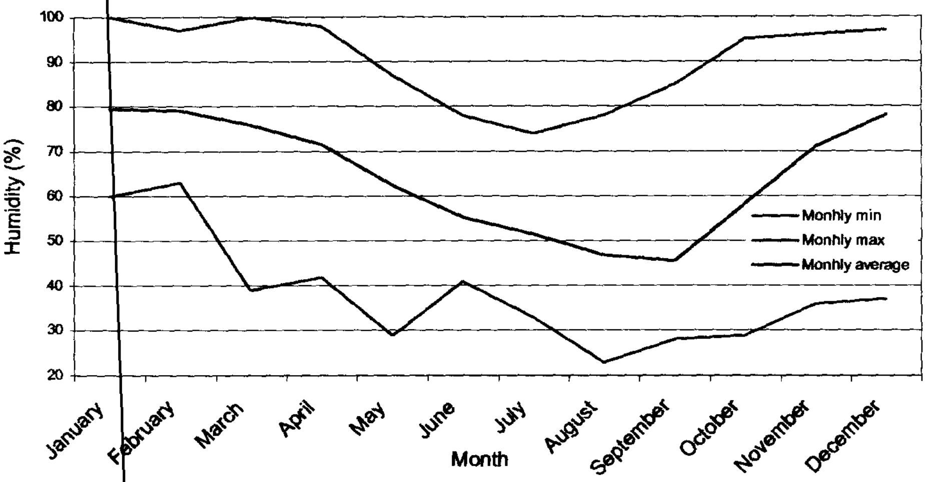


Figure 3.2 Relative humidity, Kawambwa 1970 – 2000 (Meteorological Department, Zambia)

3.3.2 Temperature and Sunshine.

Temperature data for Kawambwa indicates that the warmest period is immediately prior to the wet season. Monthly minimum and maximum temperatures vary between 5°C and 31°C in June, at the height of the dry season, whilst temperatures may only vary between 14°C and 32 °C in February, a typical wet season month. Maximum recorded temperature in Kawambwa is 39.6°C (September) and minimum recorded temperature 5.3°C (June). Temperature data is presented in Figure 3.3.

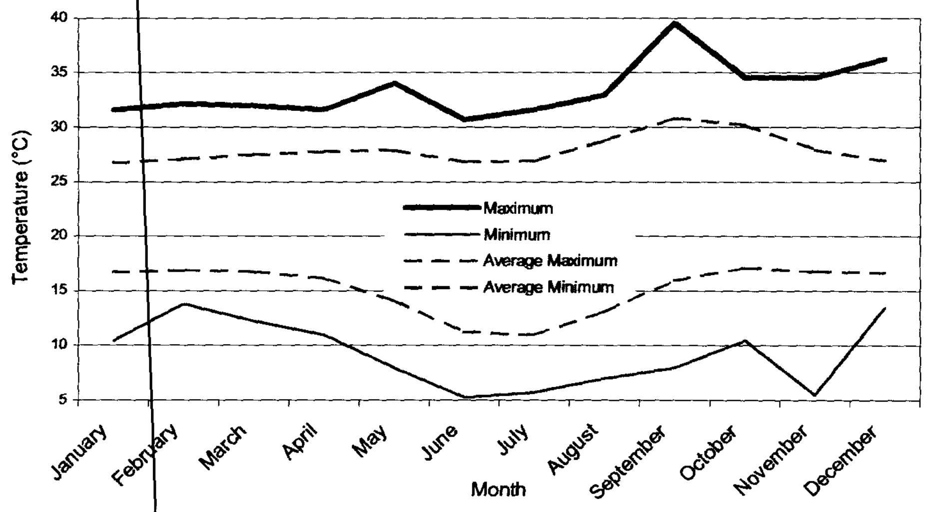


Figure 3.3 Monthly Minimum and Maximum Temperature, Kawambwa 1970 – 2000 (Meteorological Department, Zambia).

Mean annual sunshine (clear, sunny hours) in Kawambwa is 2500 hours per year.

3.3.3 Wind

Wind data for Kawambwa based on 5 years of daytime observations indicates that the prevailing dry season (July) wind direction is from the east-south east with mean and maximum wind speeds of 0.9 m/s^{-1} and 9.1m/s^{-1} respectively. The mean number of calm days in July is 2.8.

The prevailing wet season (January) wind direction is from the west-north west with mean and maximum wind speeds of 0.8 m/s^{-1} and 4.8 m/s^{-1} respectively. The mean number of calm days in January is 11.2.

3.4 Landscape and Topography.

Regional digital elevation models, and satellite imagery was reviewed and a site reconnaissance undertaken to define the topography and landscape in the study area.

The mine site lies on a flat to gently undulating plain between the Kundulungu Mountains in the west, and Lake Mweru in the east. Few waterways drain into Lake Mweru on the Congolese side of the lake. The Dikulushi river flows northwards through the mine site. Lake Mweru is fed by the Luapula river, which forms the international boundary between the DRC and Zambia to the south of the lake. Figure 3.4 shows the topography and hydrology of the Dikulushi – Kilwa Area.

3.4.1 Dikulushi

The local topography is gently undulating, sloping eastwards across the project site towards the Dikulushi river at a gradient of approximately 3%. The main topographical feature is the Dikulushi river valley, which trends in a north-easterly direction. The topography of the western side of the river within the mine area has already been altered by the development of the open pit and waste rock dumps.

3.4.2 Nchelenge

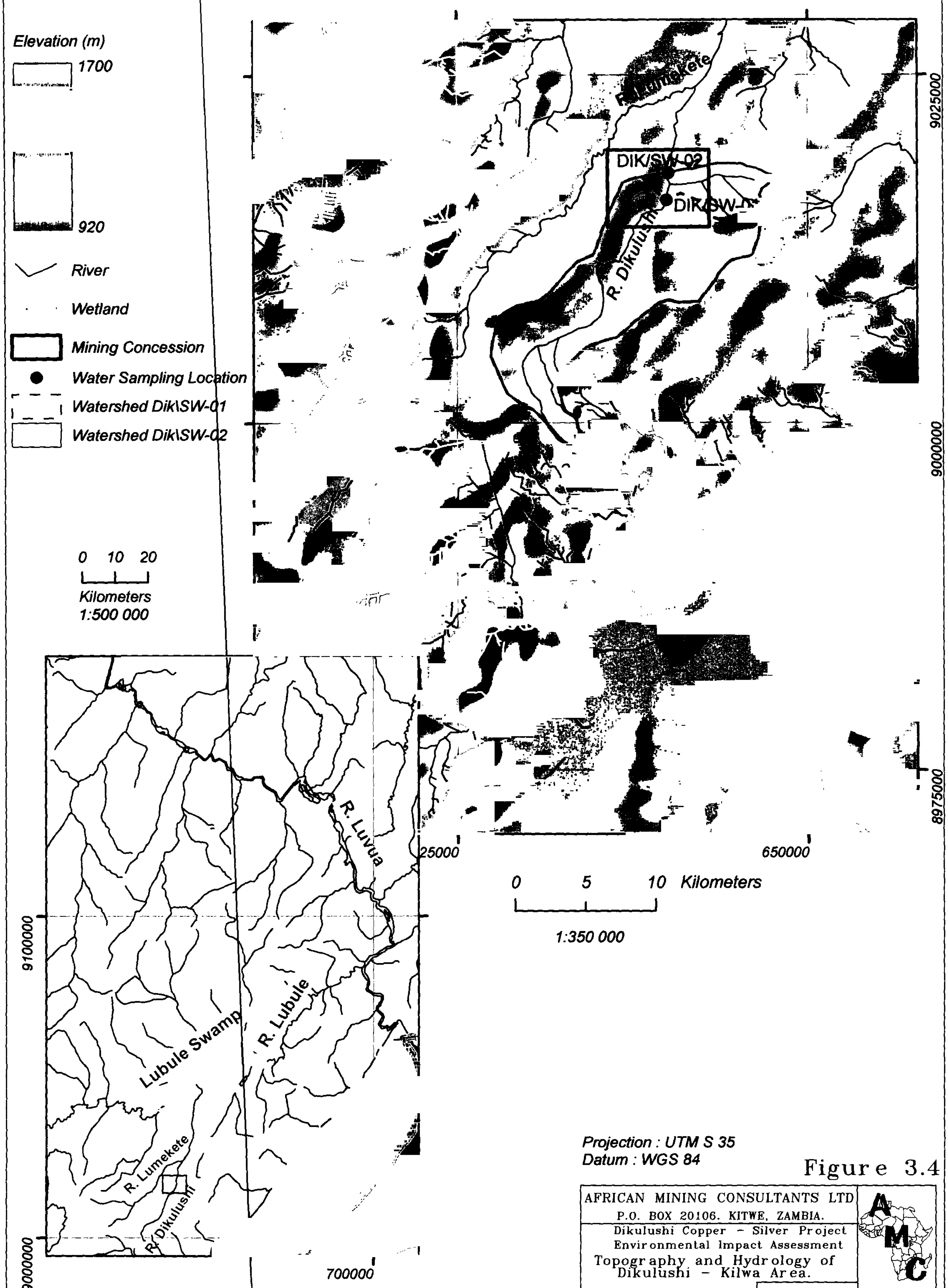
The town of Nchelenge lies at an altitude of 950 metres amsl. The landscape is dominated by Lake Mweru (475 km^2). The Zambian shores of the lake are characterised by ~~sandy~~ ~~muddy~~ beaches. The Luapula River forms a braided delta within a vast marshland dotted by low islands extending 15 km south of the town.

9K

Higher ground with slightly varying topography is found to the east of Nchelenge. This terrain is incised by small streams and rivers all draining westwards into Lake Mweru. The divide separating the Lake Mweru drainage basin and the Lake Bangwuelu basin lies 150 km east of Nchelenge. The highest point of the divide is 1600 metres amsl.

3.4.3 Kilwa

Kilwa is situated on the western shore of Lake Mweru, 7 km west of Kilwa Island. Sandstone cliffs to the north and ~~sandy~~ muddy beaches to the south dominate the shoreline. General topography is slightly undulating and slopes eastwards towards the lake.



Projection : UTM S 35
Datum : WGS 84

Figure 3.4

AFRICAN MINING CONSULTANTS LTD
P.O. BOX 20106. KITWE, ZAMBIA.

Dikulushi Copper - Silver Project
Environmental Impact Assessment
Topography and Hydrology of Dikulushi - Kilwa Area.

ORIGINATOR: EMF CLIENT: ANVIL Mining NL 2002-12-17
D'MAN: EMF DWG NO: topography.mx

3.5 Geology

The study area is located in the Late Proterozoic Kundelungu Aulacogen, a wedge shaped and north-east tapering fault-bounded trough, thought to be a failed rift or large sediment filled graben structure (see Figure 3.5). The Kundelungu Aulacogen is bounded by the Kibarian belt on the west and the Bangwelu block on the east, two Early to Mid-Proterozoic geologic domains.

Kundelungu Group sediments overlie older Roan and Mwashya formations. The Roan formations host copper and cobalt deposits in both the Zambian and the DRC Copperbelts. The lithostratigraphy of the Katanga System and the Kundelungu Group is presented in Table 3.

Table 3.2-Lithostratigraphy of the Katanga System in DRC (after Anvil, 2002).

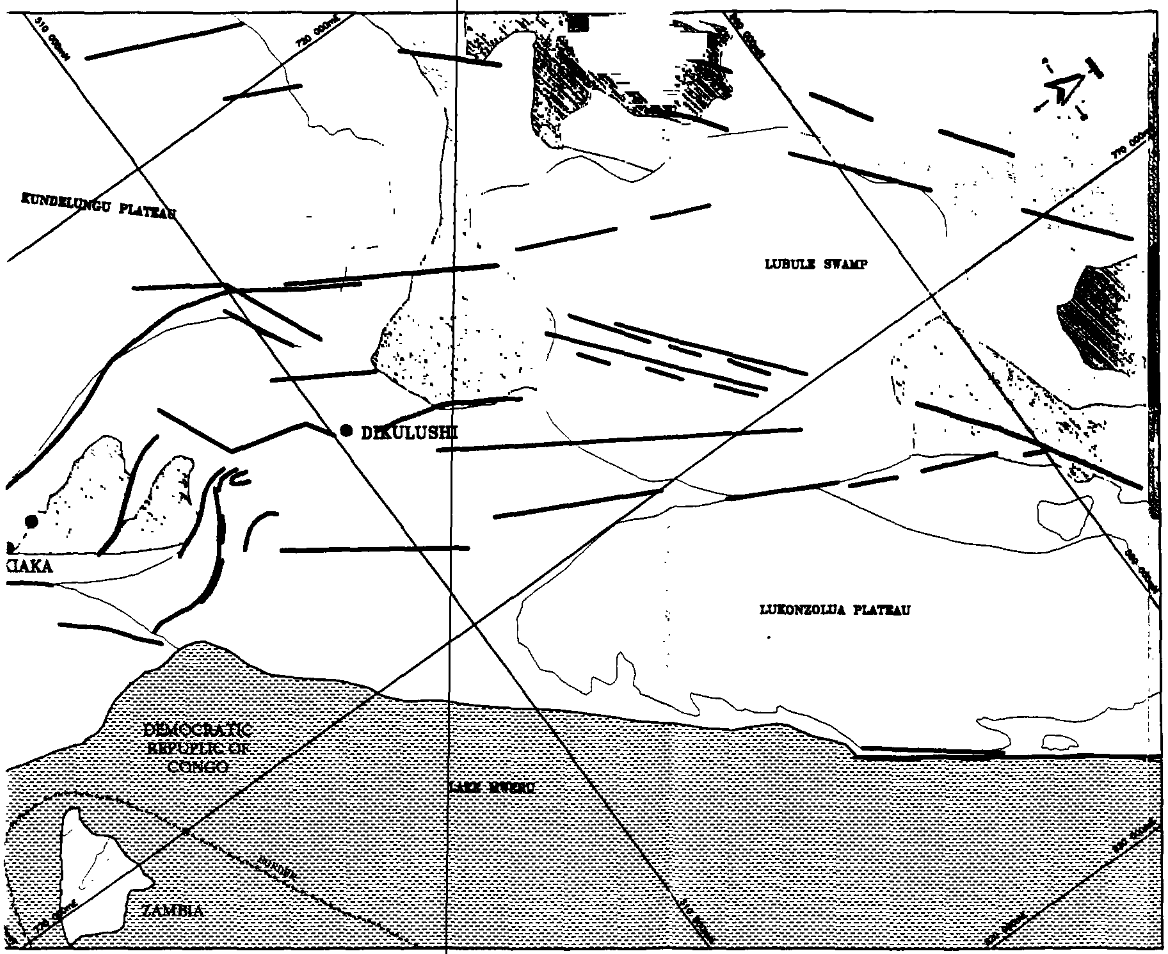
Era	Supergroup	Group	Formation	Lithology
Proterozoic *(~2500-570Ma)*	Katangan *(~945-620Ma)*	Upper Kundelungu	Mitobo	Arkoses with sandstones and shales
			Kiubo	Carbonated shales, sandy and argillaceous shales, sandstones.
			Kalule	Carbonated siltstones, sandy and argillaceous shales, pink limestones, diamictite - "Petit Conglomerate".
		Lower Kundelungu	Mowenzi	Arkosic sandstones with carbonated shales and siltstones
			Likasi	Carbonated shales and siltstones, dolomites, limestones, shales, diamictite – "Grand Conglomerate"
		Mine Series	Mwashya	
			Upper Roan	*(Mineralised formations of the Zambian and DRC Copperbelt.)*
			Lower Roan	

The Kundelungu sediments are generally shallow dipping and frequently traversed by faults. The western shoreline of Lake Mweru is bounded by an interpreted fault trace. Sub-parallel faults appear to control mineralisation at Dikulushi (Anvil, 2002).

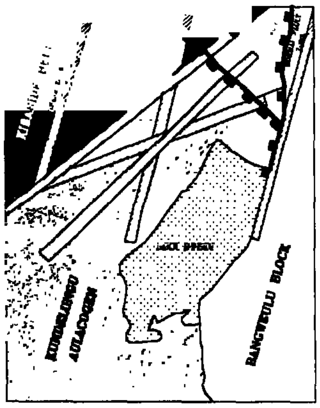
3.5.1 *Structure and Mineralisation.*

Three major fault trends have been identified at Dikulushi. An east-west trending fault controls the emplacement of mineralisation, while two later faults offset the orebody. Economic mineralisation extends for a strike length of 240m, and to a depth of at least 200m. The copper and silver mineralisation reaches a thickness of 25m within the major mineralised zone (Devmin, 2002).

Formation of the Dikulushi deposit is considered to result from a two-phase epigenetic hydrothermal metasomatic process. Copper mineralisation occurs as either massive veining or sediment pore space fill (MDM, 2001). Silver occurs in solid solution within copper minerals and its relative abundance correletes well to that of copper. Other minerals known to occur in small amounts in the deposit include Sphalerite (ZnS) and glaena (PbS).



STRUCTURAL SETTING



LEGEND

PHANEROZOIC	CENOZOIC				-ALLUVIUM AND LATERITE
	KAROO				-RED SANDSTONE -SHALES -TILLITES
PROTEROZOIC	KATANGAN	KUNDELUNGU	UPPER (KS)	KS2	-CALCAREOUS SANDY ARGILLACEOUS SHALES -CALCAREOUS SILTSTONE, SHALES, FELDSPATHIC SANDSTONES
				KS1	-CALCAREOUS SILTSTONES, SHALES, PINK OOLITHIC LIMESTONES -SHALES, PINK DOLOMITES -DIAMICTITE "PETIT CONGLOMERATE"
			LOWER		-CALCAREOUS ARKOSIC SILTSTONES, SHALES -DOLOMITES, AND LIMESTONES -BASIC VOLCANICS -DIAMICTITE "GRAND CONGLOMERATE"
		ROAN	MWASHYA		-DOLOMITIC SHALES -DOLOMITES, PYROCLASTITES
	[illegible]				-UNDIFFERENTIATED META-SEDIMENTS AND IGNEOUS ROCKS
	BANGWEULU				-UNDIFFERENTIATED META-SEDIMENTS AND IGNEOUS ROCKS

● KNOWN MINERAL OCCURRENCE
▬ FAULTS

ICAL MAP AND MINERAL OCCURRENCES. AFRICAN MUSEUM TAVERN 1997

FIGURE 3.5

AFRICAN MINING CONSULTANTS LTD
P.O BOX 20106, KITWE, ZAMBIA.

PROJECT TITLE: DIKULUSHI ENVIRONMENTAL IMPACT ASSESSMENT

GENERAL GEOLOGY OF DIKULUSHI AREA

SCALE 1 : 400000

ORIGINATOR:	A.S.	CLIENT: ANVIL MINING NL	DATE:FEB 03
	K.M.	DWG NO: /../LONSHIGEOLOGY.DWG	REV NO: 0

Copper minerals identified in the deposit are:

Chalcocite	Cu_2S	Dominant copper mineral at Dikulushi.
Chalcopyrite	$CuFeS_2$	Rare.
Malachite	$Cu_2CO_3(OH)_s$	In weathered rock.
Azurite	$Cu_3(CO3)_2(OH)_4$	
Chrysocolla	$Cu_2H_2(SiO_5)(OH)_4$	

The main mineralised zone occurs in the western part of the deposit. This zone branches into two mineralised lodes in the east. A third minor mineralised zone occurs within the hangingwall at the western end of the orebody. Table 3.3 shows the concentrations of elements in composite ore samples from the Dikulushi deposit (Mintek, 1998).

Table 3.3 - Element concentrations in ore samples from the Dikulushi deposit, Mintek 1998.

Element	Unit	Min.	Max.	Mean
AL	%	2.36	4.39	3.64
Ca	%	0.32	3.48	1.75
Cl	%	0.04	0.06	0.05
Cu	%	8.16	16.45	11.03
Cu ox	%	0.40	9.65	2.65
F	%	0.11	0.52	0.24
Fe	%	0.81	1.97	1.30
Mg	%	0.14	0.91	0.40
Mn	%	0.00	0.00	
Pb	%	0.02	0.63	0.23
S	%	0.09	5.00	2.69
S (--)	%	0.09	4.60	2.53
Si	%	26.30	31.60	29.28
Zn	%	0.08	0.65	0.27
Ag	ppm	138.00	562.00	290.67
As	ppm	9.00	240.00	82.33
Bi	ppm	6.00	9.00	10.40
Cd	ppm	0.00	16.00	5.33
Co	ppm	7.00	28.00	13.67
Cr	ppm	0.00	62.00	40.33
Hg	ppm	0.00	0.00	
Ni	ppm	9.00	40.00	26.00
Sb	ppm	0.00	14.00	5.67
Se	ppm	3.00	7.00	5.50
Te	ppm	0.00	0.00	

It should be noted that arsenic concentrations of up to 0.77% have been recorded in some assays (MDM, 2001), however, the highest As grade recorded in concentrate samples to date has been 0.28% with most assays in the range 0.04-0.1%. Most smelters do not consider penalties when arsenic values in concentrate are less than 1%.

3.6 Hydrogeology

Based on investigations by BRGM in 1979 and 1980, the following assumptions of hydro-geological conditions have been made:

- The dry season water table lies approximately 8m below surface This was confirmed by AMC staff in November 2002, when the water table was found at 5-7m depth, however it is not known at this stage whether this is perched water;
- Low yield first water strikes in exploration holes are at depths between 5 and 10m below surface;
- Yields increase dramatically below 50m depth;
- Cavities were reported in some boreholes with zero recovery over drilled distances of up to 3 metres;
- Artesian flow from some exploration drill holes was observed after rainfall indicating that conditions locally may be artesian;
- Groundwater flow across the site is from SW to NE on a gradient of 2%. It is likely that groundwater from the deposit contributes to base flow in the Dikulushi river;
- Pumping tests indicate that daily pumping requirements to de-water a 100m deep pit vary between 18,000 m^3 per day (1979 pumping test) and (7,200 m^3 per day (1980 pumping test).

When AMC personnel visited the mine site in November 2002, one borehole located on the NW pit perimeter was supplying water to the plant. The yield was estimated to be $100m^3$ per hour ($2,400m^3$ per day), a flow rate that barely meets the minimum water supply requirements of the HMS plant.

3.7 Soils

According to the classification system established by the US Department of Agriculture (USDA), the major soil orders in the region are Oxisols and Entisols. Oxisols are deep, well developed and extremely weathered soils. Entisols in the tropics are generally young and poorly developed soils rich in quartz sands or recent alluvial material. The fertility of Entisols varies according to the material making up the soil column. Entisols in recent alluviums are often very fertile while those developed in quartz sands are extremely nutrient deficient.

Soil classification was undertaken to assess soil resource and land capability at Dikulushi and Nchelenge as part of the Environmental Scoping Study in October 2001. Three soil profiles were studied at Dikulushi and three at Nchelenge. These soils were analysed for baseline element concentrations.

In addition to the soil classification exercise, seven soil samples were collected from around the Dikulushi mine site in November 2002. These were analysed for baseline element concentrations. Note that mining activities had commenced by this time and some soil pollution could already have occurred. In any event, previous exploration activities during the 1970's and 1980's are likely to have spread copper mineralisation over a wide area.

Soil geochemical analysis results are presented in Table 3.4.

Table 3.4 - Soil Geochemical Analysis Results (November 2002)

Sampling Point	Sample No.	Total Metals							
		Al μg/g	Ca μg/g	Cr μg/g	Cu μg/g	Fe μg/g	Mg μg/g	Mn μg/g	Pb μg/g
SOS-1	DIK/SOS-10 (0 -10cm)	3100	1600	24	18	3200	499	90	12
SOS-2	DIK/SOS-11 (0 - 10cm)	2300	299	15	10	5500	797	249	12
SOS-3	DIK/SOS-12 (0 -10cm)	2800	2500	17	20	7100	998	289	10
SOS-4	DIK/SOS-13 (0 - 10cm)	2200	199	25	16	3700	397	199	<10
SOS-5	DIK/SOS-14 (0 -10cm)	3300	1900	30	48	3500	398	189	15
SOS-6	DIK/SOS-15 (0 - 10cm)	2900	797	30	10	3300	299	100	<10
SOS-7	DIK/SOS-15 (0 - 10cm)	3700	595	30	18	5200	893	228	<10

3.7.1 Dikulushi

Three soil pits were selected for the EBS as being representative of the different geology and vegetation in the immediate mine area.

Vertisols were identified in Soil Pit No.1 (SP-01). These heavy, clayey soils were generally located in depressions (dambos and munga woodland) and are sensitive to disturbance by external pressure, but quickly revert to their original state after the removal of the disturbance.

Upland Ultisols were identified in Soil Pit No.2 (SP-02). These soils are characterised as being permeable, strongly leached, lacking soil nutrients and likely to display high acidity and aluminium toxicity. Trafficability is better than that of Vertisols. The Ultisols in this area are easily eroded by rainwater when the thin layer of topsoil is disturbed or removed.

Recent fluvial soils (Entisols) were identified in Pit 3 (SP-03). These are generally more fertile soils and are found along the Dikulushi river.

Vegetation, soil and cultivation are strongly linked at Dikulushi. Cassava cultivation is found on upland soils in slash and burn clearings within the Miombo woodland. Cassava is relatively tolerant to aluminium toxicity and nutrient deficient soils. Maize cultivation is carried out alongside the Dikulushi River on the Entisols whilst evidence of cultivation on the heavier clay soils (Vertisols) is rare.

3.7.2 Nchelenge

During the site visit in December 2001 three soil pits were dug and classified. These soils were analysed for baseline element concentrations.

Regosols and Entisols, were found in two pits on higher ground. Beach sand found on the lake shore is a typical Fluvisol. The Regosols are older lake sediments that are no longer reworked by wave action, and are now covered with grasses or crops.

The beach sand is not suitable for cultivation due to instability and constant reworking by wave action. The fertility of older lake sediments is dependant on parent material, degree of formation, soil water availability and water logging. Oxisols do not occur at the site but are likely to occupy much of the upland areas away from the lake.

The beach sands and older lake sediments are extremely permeable and infiltration capacity is therefore high. Degraded, older lake sediments are prone to erosion by surface runoff. These soils occur commonly at the site and are frequently covered by grass. In such cases they show few signs of degradation. Disturbed soils are likely to become unstable and are easily removed by rainwater and storm events.

3.8 Hydrology

3.8.1 Surface Water Drainage

The Dikulushi River traverses the eastern side of the deposit and flows northwards into the Lumekete River, Lubule River, through Lubule Swamp and subsequently into the Luvua River, fed by Lake Mweru, which eventually drains into the Congo River system. The watershed of the Dikulushi River at the mine site is approximately 160 km^2. Much of the surface water drainage in the region arises from woodland and agricultural areas. Figure 3.4 shows the topography, rivers and major wetlands of the area.

3.8.2 Surface Water Sampling

Two representative water-monitoring sites were chosen to evaluate the baseline surface water quality and river/stream flow rates in the immediate project area. The locations of the monitoring sites are shown on Table 3.5 and Figure 3.6.

Table 3.5 - Surface Water Monitoring Sites - Co-ordinates and Description of Physical Location.

Monitoring Site	Site GPS UTM Co-ordinates		Physical Location
	Easting	Northing	
DIK/SW-01	639936	9016011	Dikulushi River, upstream of the Dikulushi open pit and plant area.
DIK/SW-02	640066	9017943	Dikulushi River downstream of the Dikulushi open pit and plant area.
KIL/SW-03	647376	8972293	Kilwa Port Facility
NCH/SW-04	689852	8966450	Nchelenge Port Facility

Two additional sampling sites were selected to evaluate the surface water quality of Lake Mweru in the vicinity of the Kilwa and Nchelenge port facilities. UTM co-ordinates of monitoring sites and physical locations are described in Table 3.5.

Rationale for monitoring site selection: -

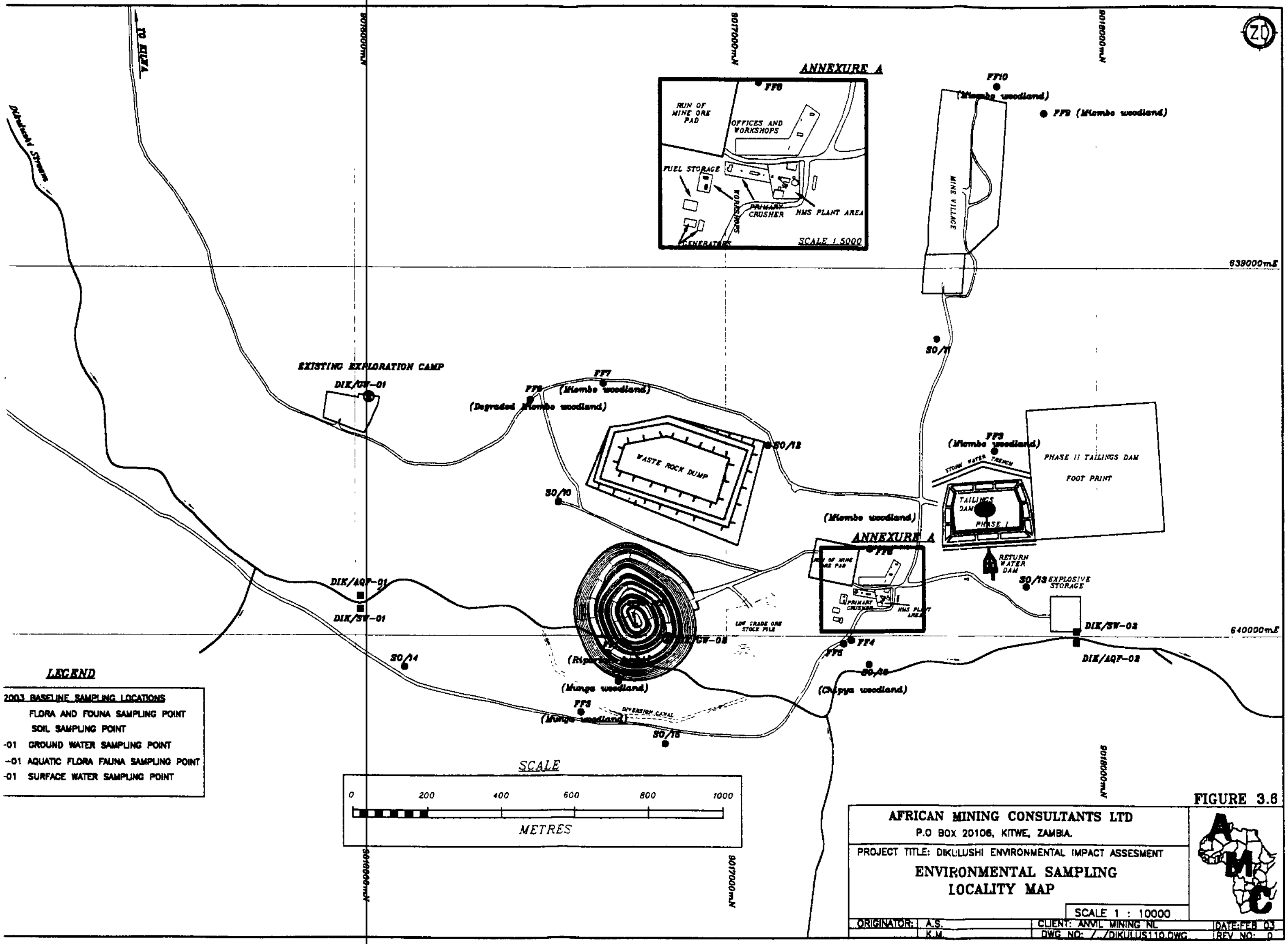


FIGURE 3.6

AFRICAN MINING CONSULTANTS LTD
P.O BOX 20106, KITWE, ZAMBIA.

PROJECT TITLE: DIKULUSHI ENVIRONMENTAL IMPACT ASSESMENT

ENVIRONMENTAL SAMPLING
LOCALITY MAP

SCALE 1 : 10000

ORIGINATOR:	A.S.	CLIENT: ANVIL MINING NL	DATE:FEB 03
	K.M.	DWG NO: /../DIKULUS110.DWG	REV NO: 0

- Monitoring Site - DIK/SW-01
  Sited upstream of the Dikulushi copper/silver deposit and open pit to assess the general water quality of the Dikulushi river before it is affected by the mine.
- Monitoring Site - DIK/SW-02
  Sited downstream of the Dikulushi copper/silver deposit and open pit to assess the effect of mining and processing activities on the general water quality of the Dikulushi River.
- Monitoring Site - Kil/SW-03
  Sited close to the Kilwa port facility in order to evaluate and monitor Lake Mweru water quality.
- Monitoring Site - Nch/SW-04
  Sited close to the Nchelenge port facility to evaluate and monitor Lake Mweru water quality.

3.8.3 Sampling Frequency

A single set of samples was taken to determine initial surface water quality. Full suite chemical, physical and bacteriological analyses were performed on these samples.

At the time of the visit in November 2002, there was no significant flow observed in the Dikulushi River. Stream flow rates will be monitored when flow rates become significant (above 5 litres/second).

3.8.4 Analytical Parameters

The results of surface water sampling and analysis will help provide a basis for the design of the mine's environmental monitoring programme.

During AMC's one-off water sampling exercise, the physical, chemical and bacteriological parameters tested for included:-

pH,
Conductivity
Total Dissolved Solids (TDS)
Total Suspended Solids (TSS)
Sulphates
Fluoride
Chloride
Nitrogen
Phosphate
Cyanide
Calcium
Colour
Total Coliform
Faecal Coliform

Total and dissolved metals tested for included:-

Aluminium
Arsenic
Boron
Barium
Beryllium
Cadmium
Cobalt
Chromium
Copper
Iron
Mercury
Magnesium
Manganese
Molybdenum
Nickel
Lead
Selenium
Vanadium
Zinc
Uranium

3.8.5 Field Water Quality Measurements

At each sampling point, field water quality parameters were measured using a Horiba U-10 Water Quality Checker. The parameters measured include pH, conductivity, turbidity, dissolved oxygen, temperature and salinity. The Horiba Water Quality Checker was calibrated at the start and end of each day using standard Horiba calibration solutions.

3.8.6 Sampling Personnel and Procedures

N.G. Armitage and E.M. Fackel (AMC) conducted all surface water sampling. All sampling was carried out in accordance with internationally accepted procedures for the collection of surface water samples for physical, chemical bacteriological and metal analysis. The surface water sampling protocol and results of surface water analysis and field water quality measurements are described in Appendix II.

3.8.7 Results from the Dikulushi River

The November 2002 results for the Dikulushi River indicate that the overall water quality of the river is good, with all the parameters tested falling within the ranges outlined in the World Health Organisation Drinking Water Quality Standards. The results also indicated that pH, TSS, sulphate, calcium, magnesium and manganese levels in the river are higher upstream than at the downstream location. TDS and conductivity values are significantly higher upstream with TDS and conductivity values of 505 mg/l and 680 µS/cm respectively at the upstream sampling point compared to 335 mg/l and 384 µS/cm downstream.

The relative proximity of the mine garden to the upstream sampling location could be a factor in the higher values, with fertiliser (although no phosphates and nitrates were traced) and disturbed topsoil more likely to enter the river here. Monitoring results for the above parameters are summarised in Table 3.6.

Table 3.6 Dikulushi River Quality - Significant Parameters (November 2002)

Sampling Point	pH	Conductivity µS/cm	TDS mg/l	TSS mg/l	Sulphate mg/l	Ca mg/l	Mg mg/l	Mn mg/l	Faecal Coliform (100 ml)
Dik/SW/01	7.9	680	505	55	65	80	38	0.1	Nil
Dik/SW/02	7.4	384	335	40	50	42	21	<0.1	nil

Analytical results from water samples taken in November 2002 (EIA Baseline) and October 2001 (Environmental Scoping Study) show some significant differences. Electrical conductivity, and total and faecal coliform concentrations in the river were significantly higher in October 2001 than in November 2002. No bacterial coliform was recorded in 2002 compared to a faecal coliform concentration of 26/100ml at the upstream location and 292/100ml at the downstream location in October 2001. Conductivity in October 2001 was recorded as 820 µS/cm at the upstream sampling point compared to 680 µS/cm recorded at the same point in November 2002. The variations in results between November 2002 and October 2001 are attributed to changes in surface runoff, which can significantly affect the quality of small streams. Monitoring results for October 2001 are summarised in Table 3.7.

Table 3.7- Dikulushi River Quality - Selected Parameters (October 2001)

Sampling Point	pH	Conductivity µS/cm	TDS mg/l	TSS mg/l	Sulphate mg/l	Ca mg/l	Mg mg/l	Mn mg/l	Faecal Coliform (100 ml)
Dik/SW/01	7.6	820	505	10	40	86	58	0.3	26
Dik/SW/02	7.9	830	510	50	5	78	62	0.8	292

3.8.8 Results at Lake Mweru (Nchelenge and Kilwa Port Facilities)

The 2001 scoping study results indicated a high incidence of faecal coliform; otherwise the lake was deemed to be relatively unpolluted, despite observed activities such as bathing, washing of clothes and fishing. The 2001 water sample was taken before operations commenced at Nchelenge.

Selected analytical results from the November 2002 sampling programme are shown in Table 3.8. The results indicate that the Lake in the vicinity of both the Kilwa and Nchelenge port facilities remains relatively unpolluted at both locations, even though operations had commenced. Faecal coliform was recorded as nil at both locations. The differences are attributed to differing local conditions such as wind and wave action that may have been moving potential pollutants into and away from the sample area.

Table 3.8- Selected Lake Mweru Water Quality Analysis Results (November 2002)

Sampling Point	pH	Conductivity µS/cm	TDS mg/l	TSS mg/l	SO_4^{2-} mg/l	Faecal Coliform (100 ml)	T.Al mg/l	Cl^- mg	T.Ca mg/l	T.Mg mg/l
KIL/SW/03	8.1	98	87	35	10	Nil	2	6	7	4
NCH/SW/04	7.6	92	72	45	45	Nil	<0.2	8	8	5

The differences between the Kilwa and Nchelenge port facilities are statistically insignificant with many parameters having similar values. The Kilwa port facility does have slightly higher pH, conductivity, TDS, total coliform and total aluminium values, whilst Nchelenge has slightly higher TSS, sulphate, chlorine, total calcium and total magnesium.

3.9 Stream Sediment Sampling and Analysis

Messrs N.G. Armitage and E.M. Fackel (AMC) carried out all sediment sampling, in accordance with internationally accepted procedures for the collection of stream/river sediment samples. The sampling protocol is described in Appendix II.

Stream sediment samples were submitted to A. H. Knight Analytical Services for geochemical analysis of sediment solids, and dissolved metal analysis on sediment pore water.

Sediment samples were collected at the surface water monitoring sites SW-01 and SW-02 on the 28th of November 2002. The full results of geochemical (sediment solids) and dissolved metals (pore water) analysis are presented in Appendix III. Sediment geochemical results of significance are summarised in Table 3.9.

Geochemical results from the November 2002 analysis indicate aluminium, magnesium, iron, and manganese to be higher at the upstream location (DIK/SS/01) than at the downstream location (DIK/SS/02). However values for copper were significantly higher downstream than upstream, most probably due to the presence of the Dikulushi deposit located between the two sampling points.

Table 3.9 - Significant geochemical results from sediment sampling (November 2002)

Sample No.	Sampling Date	Total Metals					
		Al µg/g	Mg µg/g	Cr µg/g	Cu µg/g	Fe µg/g	Mn µg/g
DIK/SS/01	28/11/02	2800	3400	46	22	6800	89
DIK/SS/02	28/11/02	1600	896	57	149	4000	60

Results from the environmental scoping study (October 2001) indicate that magnesium, manganese, aluminium, chromium, copper and iron were higher at the downstream sampling location (Dik/SS/01) than at the upstream location, which had higher mercury and arsenic values. Results of significance are presented in Table 3.10.

Table 3.10 - Significant geochemical results from sediment sampling (October 2001)

Sample No.	Sampling Date	Total Metals									
		Hg µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Al µg/g	As µg/g	Ba µg/g	Cr µg/g	Cu µg/g	Fe µg/g
DIK/SS-1	24/10/01	5	900	20	10	800	6	200	17	9	1200
DIK/SS-2	24/10/01	2	1500	146	8	2500	2	200	51	30	4300

3.10 Groundwater Sampling and Analysis

Messrs N.G. Armitage and E.M. Fackel (AMC) carried out all ground water sampling in accordance with internationally accepted procedures for the collection of ground water samples. The ground water sampling protocol is described in Appendix II. Ground water samples were submitted to A. H. Knight Analytical Services for analysis.

Table 3.11 - Groundwater Sampling Sites Co-ordinates and Description of Physical Location.

Sampling Location	UTM E	UTM N	Description
DIK/GW-01	639351	9016032	Bore hole used for potable water at the security camp 1km South-west of the pit
DIK/GW-02	639896	9017445	Borehole on the N. wall of the open pit used for potable water at the main camp.
DIK/GW-03	637948	9014028	Central Well at Dikulushi Village

Two representative groundwater sampling sites were selected to evaluate the quality of groundwater in the study area. A further ground water sampling point was established at Dikulushi village to check drinking water quality. A description of the groundwater sampling points is presented in Table 3.11.

3.10.1 Ground Water Quality

One groundwater sample was taken during the 2001 Environmental Scoping Study. The groundwater sample was taken from a borehole 60m southeast of DIK/GW-01, in what was then the Anvil exploration camp. The analysis of the sample indicated that arsenic, barium, chromium, iron and manganese, all exceeded Zambian drinking water quality standards (based on WHO parameters), although the high presence of iron was attributed to corrosion of the borehole casing.

Results from the samples taken in November 2002 indicated that groundwater quality at Dikulushi Village (DIK/GW/03) was within the Zambian (WHO) drinking water quality standards. Results for DIK/GW/02 indicated TDS to marginally exceed the minimum drinking water quality standard. Otherwise all parameters complied with the drinking water standards. Some of the parameter values such as TDS and Mg at Dik/GW/02 are probably influenced by the close proximity of the Dikulushi deposit. Comparisons of Groundwater Analysis Results are shown in Table 3.12.

Table 3.12- Comparison of Groundwater Analysis Results (October 2001 and November 2002)

Sampling Point	pH	TDS Mg/l	TSS mg/l	SO_4^{2-} mg/l	As mg/l	Ba mg/l	Cr mg/l	Fe mg/l	Mg mg/l
DIK/GW/01 - (Oct 2001)	7.7	220	50	<5	0.12	2	0.3	17	8
DIK/GW/02 - (Nov 2002)	7.1	535	20	45	<0.01	<0.1	<0.1	<0.1	45
DIK/GW/03 - (Nov 2002)	7.1	103	20	65	<0.01	<0.1	<0.1	<0.1	5

3.11 Terrestrial Flora

3.11.1 Survey Methods

Circular areas, thirty (30) metres in diameter were randomly selected for sampling, based on homogeneity of vegetation. Vegetation composition, location and proposed mining activities were the main factors considered in the selection of the sampling points. The areas sampled included:

(a) within the limits of the final open pit, covered by Riparian and Acacia types of vegetation;

(b) the vegetation around the waste rock dump, surrounded by mixed Miombo and Chipya subtypes;

(c) the vegetation around the Tailings dam; and

(d) the vegetation around the camp outside the perimeter fence, which is predominantly Miombo with two or three dominant species.

The method adopted for the vegetation survey produced information that could be used to produce a generalised description of the vegetation of the area. The locations of vegetative types are described in Table 3.13 and illustrated in Figure 3.6.

The study involved the identification of woody species; determining the frequency of dominant and co-dominant trees in each sample plot; measuring diameters of all woody species over two (2) cm in diameter to determine regeneration potential; and collection of plant specimens for the forest herbarium.

Mr Lishomwa Mulongwe, a senior forestry research officer from the Forestry Research Department of the Ministry of Agriculture (Kitwe, Zambia) conducted the vegetation survey.

Table 3.13 - Sampling Plot Locations and Vegetative types

Plot Number	Vegetation Type	UTM Reading
FF1	Riparian (evergreen) forest	640047 (E) 9016681 (N)
FF2	Munga (*Acacia*) woodland	640124 (E) 9016709 (N)
FF3	Munga (*Acacia*) woodland	640208 (E) 9016607 (N)
FF4	Chipya (*Combretum-Terminalia*) woodland	640012 (E) 9017336 (N)
FF5	Chipya (*Combretum-Terminalia*) woodland	640021 (E) 9017315 (N)
FF6	Degraded miombo (Fires scarred *B. spiciformis*)	639360 (E) 9016468 (N)
FF7	Miombo (*Brachystegia longifolia*) woodland	639315 (E) 9016671 (N)
FF8	Miombo (*Brachystegia longifolia*) woodland	639763 (E) 9017386 (N)
FF9	Miombo (*J. globiflora-B. bussei*) woodland	638579 (E) 9017861 (N)
FF10	Miombo (*B.spiciformis- J.globiflora*) woodland	638506 (E) 9017736 (N)
FF11		639497 (E) 9017727 (N)

3.11.2 Vegetation Description

The vegetation in and around the mine area is mainly Chipya/Munga and Miombo woodland. Riparian vegetation is only found along the riverbank where it is not stratified in any distinctive forms, although canopy species can easily be distinguished above the tangle of small trees and climbers. Chipya/Munga woodland covers the area intended for expansion of the open pit and is characterised by single strata woodland with tall grasses, annual herbs and fire resistant shrubs like *Dichrostachys cinerea.* The Miombo woodland type of vegetation occurs in three forms, Terminalia, mixed Miombo and predominantly Miombo.

A few people live close to the mine area. These people were mainly small-scale farmers before the establishment of mining operations. Annual burning of the land takes place during the dry season. This is indicated by fire scars on most trees, the presence of dead trees, climbers and the predominance of tall grasses and short-lived herbaceous plants where burnt trees once stood. The absence of the regeneration of woody species in such areas may be a consequence of high intensity fires during the dry season.

The woody vegetation is largely devoid of any epiphytic vegetation such as tree orchids. The only species found on trees are straggler figs and ferns growing in small pockets of debris lodged in tree forks. The parasitic genera ***Loranthus*** was observed on a few trees.

The flora of the area appears to be rich, and the vegetation survey was extensive enough to collect and record most of the species present. The main vegetation types are described below.

3.11.3 Evergreen Forest - Riparian

Riparian forest occurs along the Dikulushi river and the smaller stream close to the crushing/concentrate plant. Small pockets of evergreen forest were also found in drainage depressions where soils are deep and moisture content high. No exhaustive survey of vegetation along watercourses and drainage lines was conducted.

Riparian tree species like *Clausena anisata*, *Khaya nyasica* and *Diospyros batocana* are very common. While the palm *Raphia fanifiria*, the thorny tree *Mimosa grabraa* and various species of *Rhus*, intertwined with climbers of mainly the genera *Dioscorea* and *Smilax* form a thicket-like understorey.

With the exception of *Clausena* and *Raphia* species there was a general absence of regeneration along the river.

3.11.4 Open Woodland with Tall Grass (Chipya/Munga)

Open woodland is characterised by the presence of grass and genera associated with Chipya/Munga woodlands including *Acacia*, *Combretum* and *Terminalia* and emergent species like *Albizia adianthifolia*. These areas are associated with annual high intensity fires during the dry season, and scattered within these seasonal fire holes are *Acacia polycantha, A.sieberana*, and *A.nigrescens*. Fire scars are prominent on surviving trees as well as dead and fallen trees. Giant grasses of the genera *Loudetia* and *Hyparrhenia* and a proliferation of herbaceous vegetation during the rainy season are also a common feature of these fire-affected areas.

Degraded Miombo with similar characteristics but having additional species such as *Pericopsis angolensis*, *Dichrostachys cinerea*, *Diplorynchus condylocarpon*, *Grewia*, *Pseudolacnostylis maprouneifolia*, *Peltophorum africanum*, *Strychnos cocculoides*, *Annona senegalensis*, *Combretum*, *Lannea Monotes katangensis*, *Albizia versicolor* and *A*, *adianthifolia* is prominent along roads near the waste rock dump. An abundant tangle of *Smilax kraussiana* and *Aframomum biauriculatum* was evidence for past fire occurrences.

Regeneration in this woodland type is restricted to *Sterculia*, *Pterocarpus* and *Lannea,* species well represented in the understorey.

3.11.5 Open Woodland with Short Sparse Grass (Miombo)

This is typical Miombo characterised by *Julbernardia globiflora*, *J. paniculata*, *Brachystegia* species and *Isoberlinia angolensis*. Apart from the camp area and roads, this was the least disturbed woodland in the area. The woodland can be divided into the following three subtypes:

1. Good quality almost pure *Julbernardia globiflora - Brachystegia bussei* stands.
2. *Julbernardia paniculata - Brachystegia spiciformis - Isoberlinia angolensis* stands.
3. *Julbernardia globiflora - Brachystegia speciformis* stands

The understorey is made up of mostly *Pterocarpus angolensis, Erythrina abyssinica, E.excelsa, Annona senegalensis, Uapaca kirkiana, U.benguelensis, Combretum molle, Diplorychus condylocarpon,* and *Piliostigma thonningii.* These occur either as small trees or regeneration.

3.11.6 *Termitaria*

A good number of termite mounds are scattered across the mine area hosting the following large tree species: *Azanza gackeana, Dombeya rotundifolia, Boscia angustifolia, Combretum molle, Ziziphus mucronata, Erythrina abyssinica, E. excelsa, Sterculia quinqiloba* and *Diospyros mespiliformis.*

Smaller trees and shrubs observed include *Lannea discolor, Markhamia obtusifolia, Steganotaenia araliacea, Euclea schimperi, Byrsocarpus orientalis, Grewia flavescens,* and *Rytigynia umbellulata.*

3.11.7 *Grassland*

Common grasses in the area are *Hyparrhenia, Loudetia, Andropogon* and *Setaria* species. In places affected by annual fires, the grass can form a thick vegetation cover up to two metres high. In wetter areas species of *Cyperus* are found often associated with reeds and bulrush.

Woody species associated with the grasses are genera such as *Acacia, Combretum, Monotes, Piliostigma* and *Peltophorum.* These woody species usually occur as small trees at various stages of regeneration, often with basal sprouts burnt off by the annual dry season fires.

3.11.8 *Frequency Distributions of the Dominant Tree Species*

Frequency distributions of dominant tree species were done over the circular sample plots, therefore this information is indicative only. The number of dominant and sub-dominant tree species found in Miombo and Munga/Chipya woodlands in the general mining license area are included in Appendix 5.

3.11.9 *Diameter Distribution*

Diameter distributions are important for determining stages of growth for woodlands, regeneration and timber extraction potential. The bar graph presented in Figure 3.7 indicates that most species encountered were in the smaller diameter classes. This may be due to various factors including fire and historical land use activities by local people in the area.

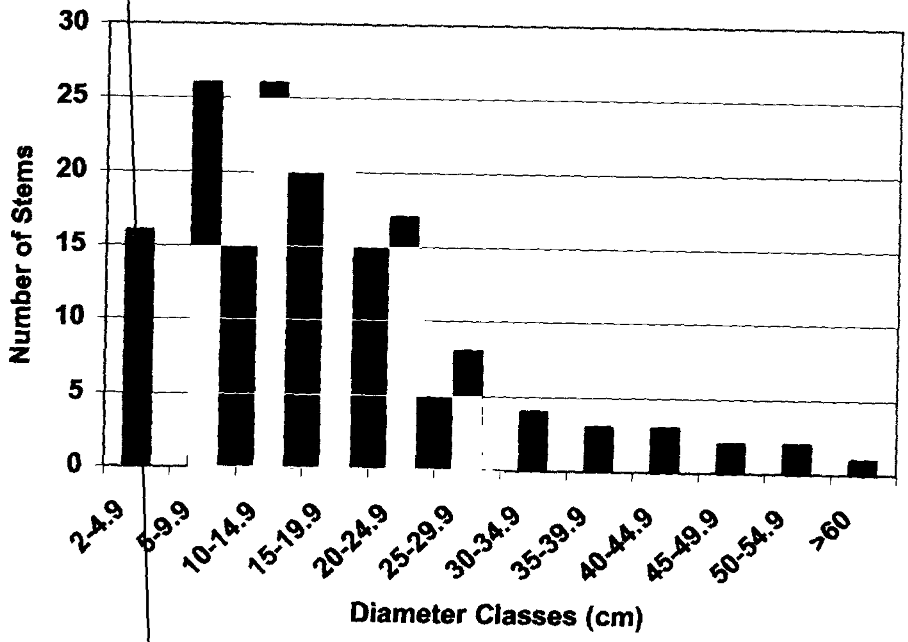


Figure 3.7 General diameter bar chart based on tree diameters measured for all plots sampled during the vegetation survey.

3.11.10 Vegetation Growth Patterns

The vegetation is generally intact, although current mining activities have created disturbances in the form of roads, camps, dumpsites and the open pit. In addition, soil compaction, localised water erosion, vegetation suppression, waste (liquid and solid) disposal, and exhaust fumes in various forms and quantities may contribute to the alteration of the physical and chemical environment.

Major alterations to the canopy structure are not expected in areas not impacted by direct mining activities. As uncontrolled fires are prevalent in the area, the mining company is encouraging fire suppression and preventive initiatives in the woodland area surrounding the mine. The benefits include: (a) improved vegetation cover, (b) reduced risk of fire damage to mining plant and machinery; and (c) improved visibility/lower air pollution during the dry season.

In the disturbed areas where vegetation has been markedly altered by human factors, deliberate re-vegetation will improve the working environment. This could include planting of pioneer species such as: *Acacia polycantha, A.sieberana, Albizia adianthifolia, Peltophorum africanum,* and *Dichrostachys cinerea*. A small tree seedling nursery with a capacity of 10,000 plants is to be established and managed as part of the vegetable garden. The seedlings can be transplanted during the rainy season.

3.12 Terrestrial Fauna

3.12.1 Wildlife Survey

The type of wildlife, location and frequency of occurrence in the project area was assessed by interviewing local people. The following questions were asked: -

- What animals were once present in the area?
- What animals are found in the area today?
- What in their opinion has caused the changes in animal population structures?

In addition, the Lusaka branch of the International Union for the Conservation of Nature (IUCN) was contacted to obtain a copy of the threatened species 'Red List' for Katanga Province. Although Dikulushi is well forested, the fauna survey exhibited a conspicuous absence of wildlife, with the exception of birds, which were both plentiful and of varied species. The wildlife present in the project area is listed in Table 3.14.

Table 3.14 - List of Wildlife Reported to be Present in the Dikulushi Area

Mammals	Reptiles	Birds
Bush Baby Duiker Vervet Monkey	Black Mamba Python Viper Tree Frogs Lizards	Night Jar Sun birds Wild doves Rollers Woodpeckers

3.12.2 Wildlife Habitats and Anthropological Factors

According to the local people the area once had abundant wildlife. Elephant, baboon, vervet monkey, duiker, puku and impala were once a common sight in the woodland and dambo areas between Kilwa and Dikulushi. Poaching and cultivation of dambos has decimated wildlife populations or forced them out of the area.

The woodland supports a variety of birds; Rollers and woodpeckers were sighted frequently. Abundant wild fruit species including Uapaca (masuku), and Ficus are an obvious source of bird food.

3.13 Aquatic Flora and Fauna

3.13.1 Aquatic Resources

The main watercourse crossing the project area is the Dikulushi river. Two monitoring sites were selected to evaluate aquatic resources in the project area, see Table 3.15 for monitoring site location and description. These locations corresponded with the surface water monitoring sites SW-01 and SW-02.

Table 3.15 - Aquatic Flora and Fauna Monitoring Sites.

Aquatic Site No.	UTM GPS Coordinates	Location Description
Dik/AQF-01	E 639936 N 9016011	Dikulushi River, upstream of the Dikulushi open pit and the plant area.
Dik/AQF-02	E 640066 N 9017943	Dikulushi River Downstream of the Dikulushi open pit and the plant area.

A review of the socio-economic study conducted by Dr. G. Kalaba 2001, which investigated the local fishing industry in and around Lake Mweru, was also undertaken.

3.13.2 Methodology

The following methods were used to collect data on aquatic flora and fauna:-

(a) *Interviews with local inhabitants*

Interviews were conducted on site with local inhabitants

(b) Riverine and aquatic flora survey

Most of the riverine and aquatic flora was identified at site but plants not immediately identifiable were catalogued, pressed and taken back to Kitwe for later examination.

(c) Review of Dr. Kalaba's study

The United States Environmental Protection Agency (USEPA) protocol for the rapid bio-assessment of streams and wadeable rivers was used to assess the aquatic environment at both monitoring sites.

The above approach provided a comprehensive description of the aquatic conditions and riverine / aquatic flora and fauna found in the area.

3.13.3 Fish Species

Dr. Kalaba identified numerous fish species in Lake Mweru after consulting secondary information from 1974, refer to Table 3.16 for details.

3.13.4 Fishing Activities (trapping and netting)

No fishing is conducted in the Dikulushi River, presumably due to its ephemeral nature, and the proximity of Lake Mweru, which contains a relative abundance of fish.

At Lake Mweru most fishing is done using nets. Fishing regulations are not respected or enforced, in particular during the closed period from January to March. As a result there has been a drop in fish catches relative to the intensity of fishing activity, and certain species e.g. *Labeo altivels* (Mpumbu) and *Labeo barbus* (Mpifu) have disappeared or become rare.

According to the 1999 Pweto Territorial Report, the quantities of fresh fish produced from the Lake have tripled in recent years. Consumer demand for fresh fish is increasing, while the demand for salted and smoked fish has decreased. A comparison between marketed fish in 1974 and 1999 is provided in Table 3.17.

Table 3.16 Fish Species in Lake Mweru Source: Mulomba Mwanzambala, 1974

No.	Scientific Name	Kibemba Name	Remarks
1.	*Mormyrus longirostris*	Kafutwe (Ndomondomo)	
2.	*Mormyrop*	Mulobe	
3.	*Gnathonemus*	Kise	
4.	*Petrocephalus*	Kifutu	
5.	*Hydrocyon*	Manda	
6.	*Sarcolaces odoe*	Mubombo	Now rare
7.	*Distichotus faciolatus*	Lukusu	
8.	*Labeo barbus*	Mpifu	Now rare
9.	*Labeo altivels*	Mpumbu	Now disappeared
10.	*Chysichtys*	Monde	
11.	*Auchenoglanis*	Mbwa-Lupembe	
12.	*Clarias silure*	Muta (Kabambale)	
13.	*Eutropius*	Libanga	
14.	*Tilapia melanopleura*	Pale	
15.	*Tilapia macrochir*	Kituku	
16.	*Tilapia sparmanni*	Katenge	
17.	*Serranachromis*	Makobo	
18.	*Alestes*	Kyaka	
19.	*Tylochromes*	Maela	
20.	*Synondothis*	Bongwe	

Table 3.17 - Marketed Fish 1999 vs 1974 (Kg).

Commodity	1999	1974
Fresh	338,879	121,879
Salted	87,569	94,492
Smoked	18,835	272,592
Small fry	8,059	Figures not available

Current fishing industry practices at the Lake are almost certainly not sustainable in the medium to longer term.

3.13.5 USEPA Rapid Bio-assessment Protocols - Dikulushi River

N.G. Armitage completed a biological habitat assessment of the Dikulushi River at surface water sampling point SW/01 and SW/02 in November 2002. The United States Environmental Protection Agency (USEPA) Rapid Bio-assessment Protocol (RBP) was used to assess the aquatic environment at each of the surface water sampling sites. The Habitat Assessment Score is based on a scale from 1 to 200 with lower scores indicating a high level of human impact on the water course. Habitat Assessment Scores are described in Table 3.18.

Table 3.18 – Description of Habitat Assessment Score.

Habitat Assessment Score	Habitat Description (level of human impact)
0 - 50	Poor Habitat (habitat which is severely impaired by human activity)
51 - 100	Marginal Habitat (habitat which is impaired by human activity)
101 - 150	Sub Optimum Habitat (habitat not significantly impaired by human activity)
151 - 200	Optimum Habitat (habitat relatively or completely unaffected by human activity)

The completed field data collection sheets are included in Appendix V. The results of the bio-assessment exercise are summarised in Table 3.19.

Table 3.19 - USEPA Rapid Bio assessment of Aquatic Flora and Fauna.

Aquatic Site	Location	Habitat Score (Max 200)	Aquatic Habitat Description
DIK/SW-01	Dikulushi River, Upstream of the Deposit	158	Optimal habitat for aquatic flora and fauna. (Little impact from human activity).
DIK/SW-02	Dikulushi River, downstream of the Deposit	186	Optimal habitat for aquatic flora and fauna. (Almost no impact from human activity).

The results of the USEPA Rapid Bio-assessment exercise indicate that habitat quality of the Dikulushi River is optimal, with little current human impact at the locations evaluated using this methodology.

3.14 Air Quality

There is no existing air quality data for the Dikulushi area because of its remoteness and the absence of industry and infrastructure. Field observations indicate that the general air quality of the area is good, although, there is a seasonal variation as well as localised and temporary deterioration in air quality.

Grassland and forest fires, charcoal burning and traditional slash and burn agriculture during the dry season generate smoke and dust. This air pollution sometimes hangs over the area and forms a distinctive haze. The haze layer is mainly visible from the air and is worst during the coolest months (June and July) when temperature inversions tend to trap the smoke near ground level. The haze frequently persists until the arrival of the rains in November. Local and temporary air quality deterioration is also associated with domestic (village) fires.

At the mine site, dust and air pollution is generated from open pit operations such as blasting, drilling and transportation of ore and waste. Plant operations also contribute to dust generation, especially the crushing and screening sections of the plant. Wind borne dust emanates at certain times from the ROM ore stockpile, waste rock dump and tailings dam. Minor contributors to air pollution are the diesel generator and mine vehicles.

The amount of airborne dust depends on seasonal variations such as dryness and wind. Dust has been observed to be more of a problem during the dryer months. The extent of this problem is not yet fully understood, however Anvil intends to identify the type of dust and air pollution generated at site and to monitor respirable dust at strategic working areas as part of their health and safety management plan.

3.15 Noise and Vibration

There is no historical noise data for the Kilwa area or Dikulushi mine site. Due to the remote location of the deposit and absence of infrastructure and industry other than the mine, the highest noise levels generated are associated with the elements i.e. wind, rain and thunderstorms. The presence of a significant number of trees and the capacity of the rolling landscape to absorb sound pressure from these sources means that noise levels are extremely low. Daytime noise levels based on the $L_{A90.T}$ Index are estimated to be between 30 and 40 decibels (dB).

It is estimated that noise levels in local villages such as Dikulushi Village situated some 4.5 kilometres from the Dikulushi deposit may reach 55 dB during periods of social activity but the average daytime background noise level is likely to be closer to 45 - 50 dB. Due to the absence of electricity in the rural setting, evening noise peaks tend to drop off as darkness falls and inhabitants prepare for sleep. Night time background noise levels are likely to be between 30 and 35 dB.

The mine site is the largest producer of noise and vibration in the area. There is currently no quantifiable information on noise or vibration at the mine site. The plant operations and diesel generators are the main sources of background noise. These increase during machine start-up, etc. The largest noise levels are noted during blasting operations at the open pit, which occur on average once per week.

Blasting is also the major source of vibration although plant operations (crushing etc) and large vehicle movements constitute secondary sources of vibration. Due to the location of local villages and the nature of the rolling wooded landscape most noise and vibration (apart from blasting) does not reach local settlements.

3.16 Land Use and Land Capability

Regional land classification based on United States Department of Agriculture (USDA) standards indicates medium to low potential for sustainable development. Oxisols are extremely nutrient deficient soils and have poor water retention abilities, though they are easily worked for agricultural use. Prior to project development, the mine site was not used for industry, agriculture or habitation.

Cassava, the most common crop, through slash and burn practices is cultivated near settlements and towns. There is no large-scale commercial farming in the study area.

Animal husbandry is limited to the keeping of goats and poultry. The Tsetse fly was not observed in the study area.

Upland sandy and deeply weathered soils have low soil fertility and support cultivation of (mainly) cassava. Farming of these upland areas is extensive although fields are abandoned after a few years, due to declining yields, for newly cleared and burnt land.

Old abandoned cassava fields are a common feature of the area. Abandoned fields revert to shrub vegetation and later woodland. There is no cassava cultivation in the immediate vicinity of the deposit. The only cultivation close to the mine site, before project implementation, were small maize plots along the Dikulushi River.

Soils in depressions, dambo's and wetlands are generally difficult to manage and cultivate due to their physical properties and temporary or permanent water logging.

Alluvial soils along watercourses support cultivation of vegetables and maize. Although they are of limited geographical extent, their relatively high soil fertility and easy access to water makes these soils an important natural resource.

3.16.1 Land Classification

Satellite imagery has been used to identify and outline the distribution of five forms of land cover found in the Dikulushi area. Based on satellite data interpretation and field observations, land cover in the area can generally be described as predominantly woodland dissected by streams and rivers with some riparian forest and dambos.

Rural settlements dominate along access roads and tracks and along the shores of Lake Mweru. There are no industrial or urban zones within the project area. A land classification map has been produced from analyses and interpretation of the satellite imagery.

A LANDSAT-7 Enhanced Thematic Mapper scene of the project area was supplied by Anvil. The scene is 180km by 180km and is of good quality with no cloud cover. The image was acquired on the 4th of May 2002 and contains five spectral bands in the visible and infrared spectra. It has a resolution of 30 metres for all channels. The land classification is based on multi-spectral analysis and supervised classification using training sites and maximum likelihood classification. SPOT panchromatic data with 10-metre resolution was used to assist feature identification and to support the classification procedure.

Table 3.20 - Land classes definition and characteristics.

Land Class	Definition	Image Characteristics.
Woodland	Often typical Miombo woodland. Well distributed.	Reflectance in the near infrared spectral band with more signal from soil than in dense vegetation. Large and uniform features.
Dambo / Wetland	More or less vegetated water-logged area.	Low reflectance in all spectral bands. Commonly forming drainage networks or "swamp" features.
Built-up / degraded land	Land used for housing and crop production. Generally rural villages along access routes and the shore of Lake Mweru.	High reflection in all bands. Forming patchy features.
Dense vegetation/ Forest	Dense vegetation often along watercourses and sometimes on wetland.	Very strong signal in the near-infrared spectrum. As strips along watercourses and as "islands" in wetlands.
Water	Open water	High absorption in all bands.
Cropland / Pasture / Grassland	Open non-forested land. Vegetated by grass or crops.	Strong reflectance from mineral soil and some reflectance in the near-infrared spectrum.

Six land cover classes were selected from observations made on the ground. These are water; dense vegetation/forest; woodland; dambo/wetland; cropland/pasture/grassland; and built-up/degraded land. Land class, definition and image characteristics are described in Table 3.20

The total area classified is 3,050 km^2. Figure 3.8 shows the distribution of land classes and proportional land cover. Land class distribution is shown in Table 3.21.

Table 3.21 - Land class distribution

Land Class	Percent of classified area.
Woodland	34%
Dambo / wetland / open water	14%
Built-up / degraded land	2%
Dense vegetation / Forest	35%
Cropland / Pasture / Grassland	15%

Built-up or degraded land occurs where land use is most intense although some of the land in this category can be naturally occurring features such as sand-spits and beaches. Built-up land occurs mainly along the shores of Lake Mweru and along roads and watercourses. There is a strong spatial relationship between cropland and built-up land and it is likely that some un-vegetated (recently planted or fallow) cropland is recorded in this category.

Dense vegetation / Forest occurs along watercourses where human exploitation is minimal and soil conditions favourable. This vegetation type found away from the main drainage network is present as very dense woodland or very dense vegetation in swamps.

It is important to note that the crop rotation of cassava, in particular, leaves a large part of all cultivated land fallow.

3.17 Socio-Economic Study

3.17.1 Introduction

Professor G. Kalaba, an anthropologist/sociologist from the University of Lubumbashi, conducted a Social Baseline Study between 11th September and 2nd October 2001. This section of the report relies heavily on Dr Kalaba's work supplemented by additional information collected at Nchelenge by Dr Mutilo Silengo (AMC) and Mr. N Armitage (AMC).

3.17.2 Approach Methodology

Dr. Kalaba used a semi-structured interview technique to interview key stakeholders within the project area and the surrounding Kilwa district. The research program adopted the following approach;

1. Review of literature
2. Interviews with key informants
3. Direct observations to validate data and information

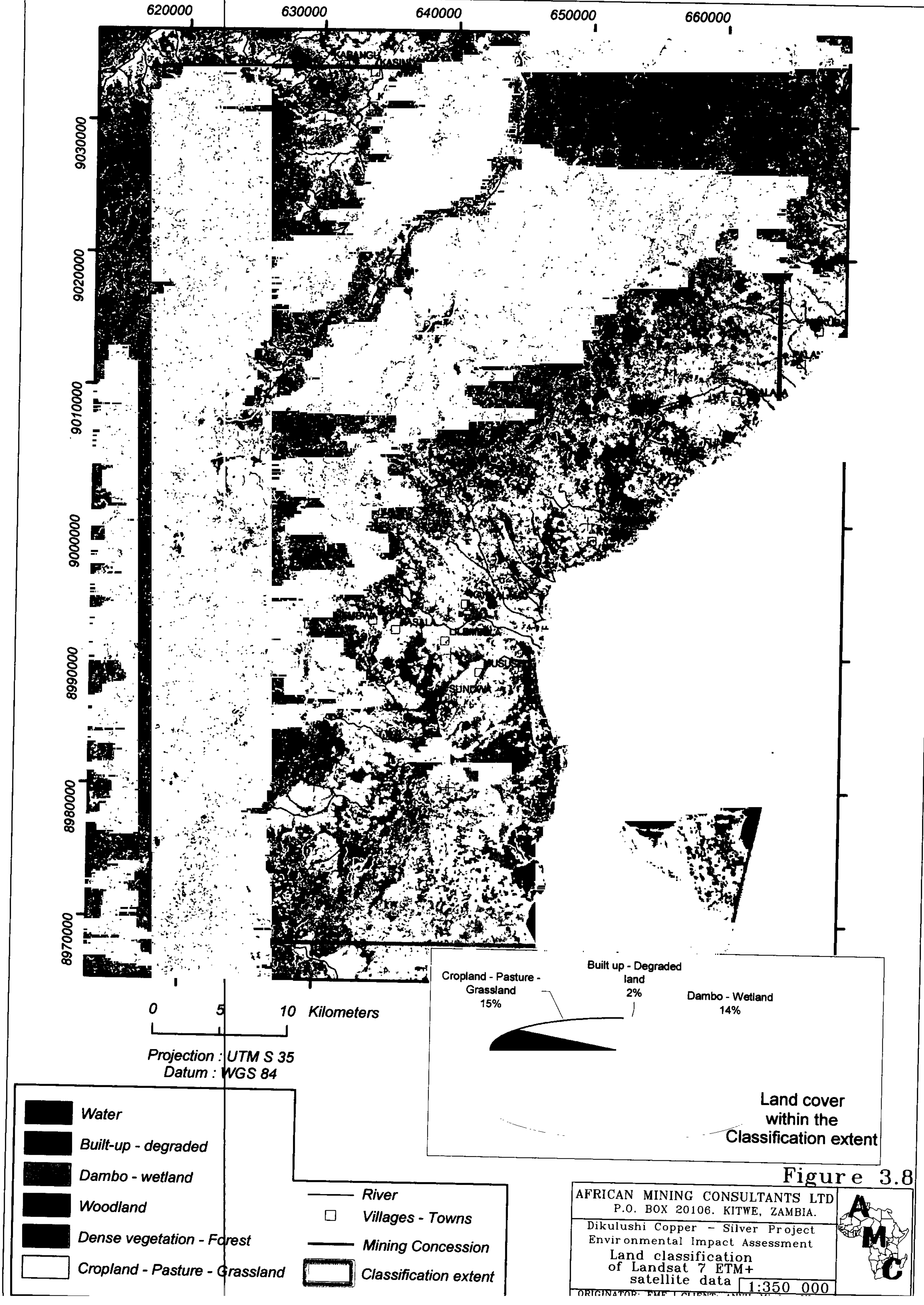


Figure 3.8

AFRICAN MINING CONSULTANTS LTD
P.O. BOX 20106. KITWE, ZAMBIA.

Dikulushi Copper – Silver Project
Environmental Impact Assessment

Land classification
of Landsat 7 ETM+
satellite data

1:350 000

The scope of Dr Kalaba's report included a survey of the local community (culture, religion, structure, political profile, project awareness and diet) as well as local infrastructure and the presence of Non Governmental Organisation's (NGO's).

Secondary information was consulted in order to map villages and social/cultural locations. Mr. Armitage conducted a brief urban-social investigation at Nchelenge in January 2003.

3.17.3 Country Overview

Since 1994, the Democratic Republic of Congo (formerly Zaire) has been racked by ethnic and civil war, caused in part by a massive influx of refugees from Rwanda and Burundi. In May 1997 President Mobuto Sese Seko (Head of State from 1965 after a military coup ousted Patrice Lumumba) was toppled by rebel leader Laurent Kabila.

The Kabila administration was subsequently challenged by a Rwanda and Uganda backed rebellion in August 1998. Troops from Zimbabwe, Angola, Namibia, Chad, and Sudan intervened to support the Kinshasa regime. A cease-fire between the warring factions was signed on 10 July 1999, however, sporadic fighting has continued.

Laurent Kabila was assassinated on 16th January 2001 and ten days later his son, Joseph Kabila, was named head of state. Despite taking a radically different approach to his father, the new President has been unsuccessful in completely ending the war. As of March 2003, Joseph Kabila remains Head of State and the Government.

Democratic elections were last held in the DRC on the 29th of July 1984, although a transition to representative government is currently planned. A Supreme Court heads the judicial branch and the legal system is based upon Belgian civil law and Congolese tribal law. Ongoing talks are hoping to establish a new constitution after a referendum on the last draft constitution (1998) was not ratified.

The economy of the DRC is made up of agriculture (65%), industry (16%,) and services (19%) (CIA, fact book 1991). Major industries include mining (diamonds, copper, cobalt and zinc), mineral processing, consumer products (including textiles, footwear, cigarettes, processed foods and beverages) and cement. The main exports are diamonds, copper, coffee, cobalt and crude oil.

The economy of the DRC has been severely negatively impacted by the civil war. Since 1998, the DRC has experienced heavy erosion of Government revenue, escalation of external debt and an exodus of foreign business. The war has intensified the scale of such basic problems as an uncertain legal framework, corruption, raging inflation and lack of openness in government economic policy and financial operations.

Efforts by the IMF and World Bank to introduce policies to secure economic stability have recently been implemented with enthusiastic backing from the current President. The new Mining Code introduced with the support of the World Bank in 2002 is an example of such a policy. The code aims to clearly define the relationship between an investor and the Government.

The population of the DRC is 53,624,718 (2001), GDP is approximately US$120 per capita, literacy levels are 77.3%, life expectancy is 49.3 years, major languages are French, Swahili Lingala, Kingwana, Kikongo and Tshiluba. The main religions are

Roman Catholic (50%), Protestant (20%), Kimbaguist (10%), Muslim (10%) and traditional (10%).

3.17.4 *Provincial Government and Administration*

The DRC is made up of ten provinces: Bandundu, Bas-Congo, Equateur, Kasai-Occidental, Kasai-Oriental, Katanga, Maniema, Nord-Kivu, Orientale and Sud-Kivu. The provinces are broken up into districts, which are then divided into territories, sub–territories, sectors, groupings and finally villages (according to Law No 6 of 1982).

The provincial capital of the Katanga Province is Lubumbashi, 400km southwest of Dikulushi. Pweto is the capital of the Pweto territory, which includes the Mpweto district of which Kilwa is the main centre. The official administrative structure follows provincial divisions outlined above, with official representation apparent from sector level up to territory level (headed by a Territory Administrator) and then on to district, provincial and national levels. From the sector level downwards, more traditional tribal governing systems operate.

Katanga province (formerly Shaba until 1997) is endowed with a huge amount of mineral potential including large copper, cobalt and uranium resources. In line with the rest of the DRC, however, its economy has been steadily degraded by the instability caused by civil war.

3.17.5 *Traditional Government and Administration*

Chief Kiona Nzini heads the Kiona Nzini sector, within which lies Dikulushi. The chief has overall responsibility for all administrative and customary roles including the local courts and police. He is assisted by a council of notables (Village Keepers) from 56 villages belonging to his sector, 28 from each of two groupings, Kiona Nzini and Kasongo - Mwana. These notables form the second tier of authority.

The third tier of authority is made up of landowners. In the Kasongo-Mwana grouping for example, there are three landowners: Kashinda, Kyaka and Ngwena. The last level of authority falls to individual village headmen. They have no courts, police or council of notables. Their authority is based on traditional values and they are regarded in high esteem. Local Authority Structure described in Figure 3.9.

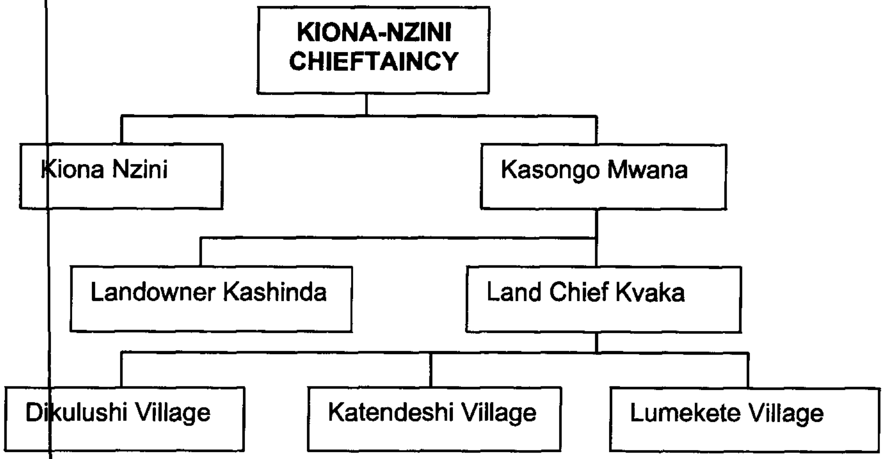


Figure 3.9 Local Authority Structure

3.17.6 Local Population

The population of the Katanga Province is around 4.4 million (2001) of which a large proportion live in or around the main provincial centre, Lubumbashi. Current population growth rate is estimated to be almost 4%. Statistics taken for the country as a whole indicate that some 48% of the population is made up of children aged between 0 and 14 years. The Mpweto sub-territory has an estimated population of 286,882 with a population density of 13 persons per km^2.

Within this sub-territory, an estimated 27,600 people were found in Kiona-Nzini sector spread over 7,573 km^2. This is the lowest population density in the territory with 3.64 inhabitants per km^2. The population of the Kasongo-Mwana Grouping (Dikulushi Grouping) was an estimated 13,570 people.

3.17.7 Social Fabric and Structure

The Dikulushi community under Chief Lubele is made up of 66 people of the Bazela ethnic group. They are organised in small groups of 11 families, averaging 6 persons per family. Dikulushi is part of the Kasongo Mwana grouping in the Kiona-Nzini sector. The Bazela originated from the settlement of the Baluba Shakandi immigrants in the East of Lualaba, with some groups coming from Maniema. The Baluba Shakandi form the main tribe in the area of which many tribes are descendant. The main language in the area is Kizela, a Luba dialect influenced by Kilomotwa.

The Bazela are bordered to the west by Baluba Shanhadi, to the north by Basonde and to the south by tribes related to the Aruund. Mixing of the Baluba Shanhadi and the Aruund is not uncommon.

3.17.8 Ethnic-Tribal Groupings

Katanga Province has a diverse mix of ethnic or tribal groupings with their corresponding languages. The main languages spoken in the province are French, Swahili, Bemba, Lingala, Kingwana, Kikongo and Kizela. The principal ethnic group in the study area is (as noted above) the Bazela who occupy the area of Kiona-Nzini and other nearby areas around Lake Mweru including Lwanza, Kazimuziri, Lukonzolwa, Mukuba and Nzuiba. The Bazela are hard-working agriculturists, fishermen and traders.

3.17.9 Religious Practices and Beliefs

The main religion in the area is Christianity, broken up into various denominations such as Roman Catholics (representing three-quarters of the population), Methodists, Pentecostals, Garenganze, Jehovah's Witnesses, Seventh Day Adventists, New Apostolic, the Reformed Church, etc. Amongst the population there still remains a small section with animist beliefs attached to the cult Mbidi Kiluwe (a belief based on spirits).

As in most rural African cultures Christianity goes hand in hand with local beliefs. Many local beliefs relate to cosmology, and there are a set of explanations about the universe: the sky, the sun, the moon, the stars, rainbows, lightning and earthquakes. The explanation of these natural phenomena in Bazela culture are defined by earthly associations, i.e. the belief that the sky is a big bowl of stone which covers the entire earth, or by the belief in spirits. For example, the fear of evil spirits makes the Bazela people worship those protective spirits of the land.

The rural calendar of festivals is very much dominated by the different seasonal phenomena such as the full moon and the start of the rains. These events often constitute a religious holiday in the area.

3.17.10 Local Diet and Family Structure

In a typical Congolese family, two parents will usually support at least three children as well as one or two relatives/dependants per household, bringing the total average household number to 6. The household is normally broken up into rooms depending on sex and family standing, one room for the parents one room for the female members and dependants, one room for the male dependents and sometimes a living room and kitchen in larger homes.

Cassava is the staple diet in the study area, although maize, flour and rice are also eaten by the more wealthy. These foods are supplemented by salted, smoked or fresh fish with, occasionally, some smoked or dried meat and sweet potatoes.

The main beverages consumed besides water include home made alcohol called *Lutuku*, an opaque beer *Kibuku*, *Munkoyo* and *Malovu* or palm wine, which are brewed in relatively hygienic conditions.

3.17.11 Livelihoods

Almost all the people in the study area rely on fishing or subsistence agriculture to survive. The rural calendar is dominated by farming activities as shown in Table 3.22.

The average maize yield is 700 kg/ha and that for groundnuts is 800 kg/ha. Secondary crops include beans, sweet potato, paddy rice and voandzu (*voandzeia subterranean* Mbambara groundnuts), which give good yields.

In various parts of the territory there are small plantations of tobacco, bananas, palm trees, and other vegetables, particularly in the vicinity of shanties. The production of food crops generally covers the needs of the population. The high cost of transport constitutes a major constraint for the economy of Pweto territory.

Table 3.22 - Rural Calendars in the Project Area (Agricultural Cycle)

Month	Farming Activities
January - March (Wet Season)	Cultivation of Cassava, maize, rice, and groundnuts Choice of ground for the next cultivation. Second sowing of maize (January). Harvesting and drying, as well as maintenance.
April - July (Cool, Dry Season)	Maintenance and section-fire. Control of reservation of seeds, beginning of marketing of agricultural products.
August - September (Cool, Dry Season)	Preparation of new fields.
October - December (Hot, Wet Season)	Sowing of maize cassava and rice. Propagation by cutting with intercalary sowing: groundnuts, beans and voandzu (Mbambara groundnuts).

3.17.12 Livestock

Apart from Group Litho Moboti (GLM) – Kundelungu (Nsonga and Kasongo Mwana groupings), cattle are not found in the villages of the Kiona-Nzini sector. Most households keep a few small livestock for consumption and as traditional capital. Many households possess some chickens, ducks and goats.

3.17.13 Agricultural Development Potential

The territory of Pweto possesses excellent agricultural potential, especially the Kilwa plains. There is abundant fertile land surrounding riverbanks and valleys, which is only sporadically exploited by the local people.

Two major agricultural projects have been implemented in the general area, one at Mpande for the cultivation of palm trees and the other a rice growing project at Sensele. The first has been only partially successful because of the vagaries of rainfall, however, the rice project has been very successful. The Diocese of Kilwa cultivates more than twenty fields of rice for its own consumption. Further development of this potential will depend on future governmental policy and support.

3.17.14 Other Industries

Few other economic activities are carried on. There is some small-scale manufacturing with members of the Pweto territory being involved in building, carpentry, joinery, tailoring and sculpting. Many of these craftsmen are semi-retired workers from larger commercial centres. Building and basket making is also conducted on the lakeshore.

There is a small-scale tourism sector within the Pweto territory although tourism potential is hardly tapped. There are some hotels and restaurants for local tourists at Kilwa, 55 km from Dikulushi. The local Catholic Church provides accommodation and housing for foreign tourists and nationals. The 1999 Annual Territory Report mentions Kabyatu Hotel in Kilwa, which has 14 rooms.

Fish processing (bagging, smoking or salting) is normally undertaken by the fishermen themselves, awaiting transfer to the traders in the area.

The mining sector is relatively undeveloped although there are some artisinal workings. Sorekat Ltd, in Kasambo in sector Mwenge, exploited one gold deposit but operations ceased due to low grades. Salt works are present at Kakwale (Kasama), Kalala (Kizabi), Kilongo, Kibale, Somba (Mwenge) and Kinganza (Kiona-Nzini). Three copper deposits have been worked artisinally in the past, including two to the north-west of Kilwa (Kyaka and Dikulushi) and one to the east of Pweto (Kapulo).

Prospecting continues in the area with the deposits at Kapulo and Kyaka now being heavily researched by Anvil.

3.17.15 Incomes

No recent data is available on local incomes. GDP per capita in the DRC is estimated as US$120 per annum. Studies from 1973 indicate that the average rural agriculturalist earned the equivalent of $299 per year and a fisherman earned the equivalent of $274 per year.

3.17.16 Imports and Exports

Imports to the area include manufactured products such as lamp oil, soap, cooking oil, bicycles, second-hand clothes, wheat flour, sugar, cases of soft drinks and other products. Major exports include cassava, maize, rice, fresh, salted and smoked fish.

3.17.17 Medical Services

There is one state owned hospital at Kilwa and 24 state rural clinics. Of these 15 are found in the community of Mweru, 6 in Pweto, 1 in Kilwa, 1 in Mwenge and 1 in Kiona-Nzini (Report 1999:24-25).

The Protestant Garenganze Evangelical Mission operates two hospitals, one at Chamfubu and the other at Lwanza.

The Franciscan Sisters of Mary (F.M.M) manage one dispensary at Pweto, two maternity clinics at Lukonzolwa and another dispensary at Dubie. Lepers are treated at Chamfubu, Lukonzolwa, Dubie and Lwanza.

A common problem with all local medical facilities is the lack of sufficient medicines and general pharmaceutical products.

3.17.18 Health Statistics

The epidemiological report of the Health Zone of Kilwa for the first seven months of 2001 places malaria as the number one illness with a monthly average of 978 cases; Diarrhoea, including dysentery average 393 cases monthly; anaemia 263 cases and sexually transmitted infections 290 cases on average per month. Other illnesses are present with less significant occurrence. There has been some progress compared to the report of 1974 where measles was the most common infantile illness (Mulomba, 1974:24). There is no information on HIV / AIDS prevalence in the area.

Medicines sans Frontieres (MSF) limit their support to the referral hospital at Kilwa and to 10 of the 28 health centres.

There are no dental or registered private paramedical services. There is no ambulance or emergency medical evacuation service. However MSF have one vehicle, which is sometimes used as an ambulance.

3.17.19 Education Facilities

There is no registered school at Dikulushi village, however two elementary kinder-garten schools have been established by the local community.

There are 12 elementary schools at the Christian missions, 10 of which belong to the Catholic Church and 2 to Protestation missions. The nearest to Dikulushi are at Kabangu, Lukona and Kasongo-Mwana.

There are four high schools in the general vicinity: at Kasolo, Dubie, Kasongo-Mwana and Kabangu (intermediate level/elementary high school). Three of these four schools are Catholic schools.

The dropout rate at the elementary level is 69% for boys and 90% for girls. For those who complete elementary school, only 21% proceed to high school.

A fishery school exists at Kilwa, which hardly operates because the army currently occupies its premises.

3.17.20 Sport and Recreation

Soccer is the main sport in the Pweto territory with soccer pitches in abundance. Recreational activities revolve around sport, consumption of alcohol, as well as organised events such as boxing, theatre, and dances.

3.17.21 Non-Governmental Organisations

These include:

- **Médicins Sans Frontières (MSF)** who assist with health issues and the disabled in the territory. Their activities include vaccination campaigns against poliomyelitis for children between 0-5 years etc.
- **Le Bureau Diocésain pour le Développement** (Diocese Office of Development) under the Catholic Church through which wells for abstraction of drinking water were dug throughout Kilwa-Kasenge Diocese by MIVA an Austrian organisation.
- **La Caritas et le Programme Alimentaire Mondial** (Caritas and World Food Programme), which look after the war displaced at Kilwa.
- **Le Groupe des Volontaires de Kilwa** (Volunteers of Kilwa) this group implements public interest micro-projects under the leadership of Chief Paul Kabulo wa Ilunga. Among its projects is a shelter for visitors at Kilwa hospital and the digging of drainage trenches in Kilwa.
- **World Vision**, which is reported to have had difficulty establishing itself in the area.

3.18 Local Response to the Dikulushi Mine Project

3.18.1 Fears and Expectations for Project

A survey carried out among the population of Dikulushi and its immediate vicinity found that some of the local population had the following fears:

- There will be no repair of the Dikulushi - Lubumbashi road;
- More expatriates will be employed at the expense of local people;
- There will be no effective government control (taxes) on the export of ore; and
- Zambians will profit more than the local people.

The survey found that some people expected the project to help the local community by: -

- Bringing an end to unemployment;
- Opening a clinic and a drug store in the vicinity of the mining site and by equipping the General Hospital at Kilwa with an ambulance;
- Rehabilitating bridges on Kilwa-Lubumbashi road;
- Building a supply shop for essential goods;
- Mechanising agriculture and fishing;
- Proving electricity to the territory;
- Increasing local workers skill base and providing school equipment;
- Organising cooperatives for fishermen and farmers and providing recreation;
- Recruiting 40% of locals of Kiona-Nzini chieftaincy (25% from Kasongo-Mwana and 15% from Kiona-Nzini) and the remaining 60% from the other groupings of the territory; and
- Offering bicycles to local chiefs and building cement houses.

Clearly, many of the fears are unfounded or have no real bearing on the project, and some expectations are unduly optimistic. They do give an insight however into the widely different ways that a project such as this can be regarded.

3.19 Infrastructure and Communications

3.19.1 Transport

Two constructed gravel roads constitute the main road network in Pweto territory, the Kapema - Mutotomoya road (303km) and the Kabulembe - Mitwaba Border road (162km). Kilwa is found along the Kapema - Mututomoya road 137km south of Pweto.

Only one practical route exists between Lubumbashi (provincial capital) and Kilwa. This road is passable only during the dry season. The distance by road from Kilwa to Lubumbashi is approximately 350 km.

3.19.2 Local Roads

Local roads and paths join sectors and villages one to the other;

- Kabangu-Kiankalamu road (51 km), joins the sector of Kiona-Nzini with the one of Mweru at the junction of the Kilwa-Pweto main road;
- Mutabi-Mwenge road (84 km) joins the sector of Kiona-Nzini with Mwenege. The lack of a ferryboat on Luvwa at Mwenge makes this road not fit for traffic;
- Kilwa-Dikulushi (about 55 km)
- Kasongo Mwana-Kabangu-Dikulushi

3.19.3 General Road Conditions

Roads in the area are typically in a state of disrepair. Various organisations and individuals particularly the Reverend Sister Theodore of Dubie occasionally carry out voluntary road maintenance.

The vast majority of people in the area move around on foot and there are no taxi, bus or cargo services in Kilwa or Dikulushi. There are airstrips located at Kilwa, Dubie, Pweto and Lwanza.

3.19.4 Communications

Microwave radio provides communication links for the missionaries in the area such as the Catholic Mission of Kilwa and its subsidiaries at Dubie, Lukonzolwa etc., the Protestant Missionaries (Methodist Church of Kilwa) and the public administration office. A radio communications system has been set up by Anvil using VHF broadcasters and receivers to link Kilwa, Dikulushi and Nchelenge. The Dikulushi Mine site is equipped with a satellite telephone.

There is no local radio broadcasting service in the area although attempts to set up a rural radio station have been made in the past. Postal communication is facilitated by the post office at Kilwa, with the majority of incoming mail comprising newspapers, publications and parcels. Outgoing mail is significantly less in bulk and quantity than incoming mail.

3.19.5 Other Infrastructure

The only source of electricity in the region is the hydro electric plant at Konde Falls, which provides a limited amount of Pweto territory with electricity. Electricity does not extend to the Mpweto sub territory which includes Kilwa and the project area. Locally, power is provided by small generators and solar panels (at the missions) and diesel generators (at Dikulushi Mine).

Water reticulation systems are non-existent in the area; potable water is derived form wells, boreholes and rivers and is typically of unchecked quality.

A main police base housing 100 officers is located at Kabangu, some 25km from Dikulushi.

4 POTENTIAL ENVIRONMENTAL & SOCIAL IMPACTS

4.1 Approach Methodology

The identification and assessment of Environmental Impacts is based on World Bank Operational Policy OP 4.01 Section (e). In order to predict and identify the project's likely current and future negative and positive impacts the following was undertaken:-

- Review of Mine design studies by Mintek, MDM and Knight Piesold Consulting;
- Interviews with Dikulushi mine management and operators;
- Site visits to inspect mine area and observe mining operations; and
- A review of historical socio-cultural-economic and environmental data in the project area.

An environmental impact matrix was constructed to quantify the impacts in terms of whether a particular impact is negative or positive, cumulative or instant, short-term or long-term, permanent or temporary. Major potential environmental and social impacts are discussed in detail in Chapter 4 from Section 4.3 onwards.

Due to the fact that mining operations have already commenced, some impacts have been quantified using historical data as well as data collected during site visits in 2002/03.

Mitigation measures that should be implemented to minimise project impacts are included at the end of each section. These mitigation measures provide the basis for the development of the Dikulushi Environmental and Social Management Plan (ESMP) in Chapter 6.

4.2 Environmental and Social Impact Matrix

The environmental and social impact matrix (ESIM) is divided into the following 11 sections based on the major mine components as outlined in Chapter 2 - Project Description.

- Open Pit and Underground Development;
- River Diversion Scheme;
- Processing;
- Ore Stockpiles;
- Tailings Disposal;
- Waste Rock Dumps;
- Mine Workshops, Fuel and Oil Storage Facilities;
- Infrastructure and Communications;
- Barge and Port Facilities;
- Road and Airstrip Upgrade; and
- Social-Cultural and Economic Components.

Each section in the ESIM is then evaluated in relation to the data included in the baseline study in order to identify and evaluate potential environmental and social impacts. The baseline study addressed the following bio-physical and social topics: -

- Climate;
- Air quality;
- Topography;
- Geology;
- Hydrogeology;
- Hydrology;
- Aquatic flora and fauna;
- Terrestrial flora and fauna;
- Land use;
- Noise and vibration;
- Infrastructure and communications; and
- Socio-economic conditions.

The impact on the environment of each mine component is then assessed over the 3 stages of mine life (construction, operation and closure) and in the event of an accidental release to the environment. Impacts are quantified as a deviation from observed/monitored baseline conditions.

A description of each impact is included in the matrix. The ESIM characterises project impacts according to the following criteria: -

- Overall negative or positive nature of impact;
- Probability of the impact occurrence;
- Instant or cumulative nature of impact;
- Scale of impact i.e. local, regional or national;
- Significance of impact, i.e., the deviation from baseline conditions;
- Duration of the impact; i.e. until return to baseline conditions,

Environmental aspects/issues and potential impacts associated with each mine component are characterised based on a qualitative assessment and quantitative evaluation, where appropriate data is available. Table 4.1 explains the criterion used to characterise potential impacts. The ESIM is presented in Appendix VII.

Table 4.1 Rating of Environmental Impacts in Environmental & Social Impact Matrix

Impact Criterion	Term	Description
Likelihood of Impact occurring	Has Occurred	
	Low	
	Moderate	
	High	
Nature of Impact	Negative	Overall negative deviation from baseline conditions.
	Positive	Overall positive deviation from baseline conditions.
Temporal Nature	Instant	Instant deviation from baseline conditions.
	Cumulative	Deviation from baseline conditions increases over time.
Geographic Extent	Local	Impact confined to project area. Dikulushi-Kilwa-Nchelenge.
	Regional	Will affect areas outside project area, including Katanga Province.
	National	Affects the Democratic Republic of Congo.
Significance	Low	Overall significance of impact to environment and people.
	Moderate	
	High	
	Very High	
Duration	Short Term	Shorter than project life.
	Medium Term	Continuous throughout project life.
	Long Term	Continues beyond project life.
	Permanent	Permanent impact.

4.3 Flora and Fauna

4.3.1 Destruction and Alteration of Woodland and Riparian Forest

At the end of mine life natural vegetation will have been completely removed from an area of approximately 110 hectares (footprint of operations) where the open pit, tailings dam and waste rock dumps will have been constructed.

Approximately 300 hectares of woodland will be altered in and around the mine village, workshops and other installations due to disturbances arising from roads, camps, dumpsites and mining operations. In addition, soil compaction, localised water erosion, vegetation suppression, waste (liquid and solid) disposal, and exhaust fumes in various forms and quantities will also contribute to the alteration of the physical and chemical environment affecting flora and fauna.

Most of the vegetation affected by mine development is woodland. Riparian forest and aquatic flora and fauna along the Dikulushi River will be removed completely along a 700 metres stretch when the river is diverted to the east of the open pit in Phase II of mine development.

However, the area where flora and fauna is severely impacted is small in relation to the vast unexploited woodlands in the Katanga region. The impact is local and is not likely to affect the ecology of the region.

Principal concerns relate to the possible presence of endemic species prior to mine development as well as translocation of contaminants from waste rock, the plant area and the tailings disposal facility.

Any endemic species is likely to have been specific to 'copper clearing' vegetation. The presence of endemic species was not fully investigated or documented prior to mine development.

Translocation of contaminants from sulphide rich material through surface water and groundwater and windblown dust can affect vegetation beyond the mine boundary, impede re-vegetation during progressive mine rehabilitation and adversely affect future land use.

4.3.2 Re-vegetation

Re-vegetation will take place progressively from mine closure or as single mine components are phased out (e.g. disused parts of the waste rock dump and tailings dam). Re-vegetation will however be affected by changes to the physical and chemical environment caused by mine operations. These changes will remain for a relatively long period of time.

Natural re-vegetation of the open pit area will commence following the cessation of open pit mining. Re-vegetation will be restricted by the gradient of the pit walls and presence of rocky ground, and will most probably arise in the form of grasses and small bushes. Re-vegetation is likely to occur naturally in the open pit area until decommissioning when the pit will be allowed to flood. The flooded pit will provide a new habitat for aquatic flora and fauna, although the water could contain elevated metal concentrations that may restrict the development and diversity of aquatic life.

The river diversion channel will provide a further new habitat for aquatic flora and fauna to develop during mine operations, although this habitat is likely to be significantly disturbed during decommissioning when river flow will revert to the original stream channel passing through the open pit.

4.3.3 Waste Rock Dump and Tailings Dams

Re-vegetation of the waste rock dump, tailings dam and other installations will be done progressively as these installations are phased out, or at decommissioning. The nature of this re-vegetation will be restricted by the lack of organic matter, and possibly affected by acid rock drainage (ARD). In this case, vegetation could take many years to become re-established.

4.3.4 Mitigating Measures

In order to mitigate the impact on flora and fauna habitats caused by mine development, flora removal should be restricted to areas such as the open pit and mine dumps where stripping of the natural vegetation is unavoidable. Where it is practicable topsoil should be stripped and stored for future use in re-vegetation work. Commercial timber should be sold and non-commercial timber felled and made available to the inhabitants of Dikulushi village.

Impacts on the physical and chemical environment by mine operations can be minimised by controlling run-off from mine installations and where appropriate using dust suppression systems in the plant.

The duration of impacts on flora and fauna can be reduced by the ongoing re-vegetation and rehabilitation of affected areas. Anvil will develop a detailed

Decommissioning and Closure Plan for the open pit, tailings dam, waste dump and plant area following the completion of ARD studies.

4.4 Surface Water

Impacts on surface water quality during operations will arise from contaminated surface runoff, accidental spills and mine drainage water entering the Dikulushi river.

Contamination of surface water could arise from erosion of the tailings dam, stockpiles, waste-rock dumps and other mine components containing elevated concentrations of metals or other pollutants including process reagents.

Fuel and lubricant handling spills at the mine site may enter watercourses and could impact surface water quality.

Sediment load is likely to increase in the Dikulushi River when surface runoff erodes disturbed soils and excavated material.

These impacts on surface water quality are likely to occur throughout the life of the mine. Contamination of surface water may continue after mine closure. Long-term impacts on surface water are subject to the degree of exposure of degradable mine components such as the dumps and the tailings dam.

A significant environmental impact would occur if there was an accidental release of diesel from a fuel storage facility or if there was a breach in the tailings dam wall.

A diesel spill would affect water quality, impacting both flora and fauna. Diesel and lubricant contamination can remain for long periods of time and seep into watercourses if not reclaimed and disposed of in an appropriate manner.

A tailings breach would result in a severe impact to surface water causing siltation and contamination of the Dikulushi River.

4.4.1 Dikulushi River Diversion Scheme

Destruction of a 700m stretch of the Dikulushi River to make way for the Stage III open pit extension will have a significant environmental impact. Construction of the diversion channel will take place during the dry season to minimise/reduce the impact on stream flow rates.

The flow regime of the Dikulushi River will alter after construction of the diversion channel due to a change from a meandering natural stream to a relatively straight man-made channel. The impact of this on the immediate upstream and downstream sections of the river is not known, but any impact is unlikely to be significant.

Breaching of the stream diversion embankment at the end of mine life will allow water to flow into and flood the open pit. The water that may flow out of the pit into the Dikulushi River is unlikely to affect the long-term water quality of the river.

During flooding of the open pit, the Dikulushi River will experience a significant decrease in flow possibly leaving the downstream channel and the diversion canal largely dry in the immediate project area.

Due to evaporation from the flooded open pit, the pit water level (seasonally) may not be sufficient to adequately transfer flow across the pit, thereby affecting the downstream flow rate permanently. This would not be the case if the diversion channel continues to be used after mine closure.

The significance of the impacts of the Dikulushi River Diversion Scheme on the Dikulushi River are rated as moderate as the Dikulushi River is relatively small and there is no domestic or agricultural water usage within 7 km downstream of the deposit.

4.4.2 Lake Mweru

Impacts on Lake Mweru at the Kilwa and Nchelenge port facilities may have occurred during construction work, however there is no evidence to date that this is a concern. Possible impacts include disturbed sediments and accidental fuel and lubricant releases.

During operation, potential impacts include disturbance of sediment due to propeller action especially in December when the lake level is at its lowest. Spillage of diesel and oil during refuelling and servicing of the barge could impact lake water quality.

Concentrate may spill into Lake Mweru during loading and unloading of the barge. In the case of a major accident up to 160 tons of concentrate could be spilled into the lake. The concentrate would, over time, release metals into the lake water. Such an impact is considered minor, since it would be an isolated event and occur in a very large volume of water. Cumulative small spills of concentrate from the trucks or barge into the lake near the shoreline may locally impact water quality, flora and fauna and domestic water use. This contamination would be localised but could occur throughout the life of operations, however, evidence to date would again indicate that this is not a major concern.

4.4.3 Mitigating Measures

Controlling direct runoff from contaminated surfaces into watercourses will reduce the impact of mine operations on surface water. The construction of perimeter drains and sedimentation ponds, adequately dimensioned, monitored and maintained will reduce/minimise the impact of contaminated runoff on the receiving environment.

4.5 Groundwater

4.5.1 Mine Dewatering

Mine de-watering will lower the water table in the mine area and possibly increase oxidation of sulphide minerals in and around the deposit.

Following the cessation of mining operations and mine dewatering the water table will rebound to near baseline levels, flooding the underground mine and open pit. The groundwater inflow to the mine may be polluted by the presence of metals and other pollutants associated with the deposit. This may restrict future water use and negatively impact aquatic flora and fauna.

Groundwater availability and quality at Dikulushi village is not likely to be affected by mining operations because the village is 3.5km from the mine site.

4.5.2 Mine Tailings, Ore Stockpile and Waste Rock Dump

Groundwater quality may be affected by seepage of contaminated water from the tailings dam, ore stockpile and waste rock dump. Groundwater contamination is most likely to be Acid Rock Drainage (ARD) related and in the form of metals and other potentially toxic elements found in the deposit. Seepage of contaminated water may occur throughout the life of the mine and continue post closure. These impacts are unlikely to be transmitted to groundwater users outside the mine due to the 3.5 km distance to the nearest abstraction point (Dikulushi Village). Contamination would however affect groundwater users at the mine site since potable water is drawn from boreholes located at the mine.

The degree and probability of groundwater contamination will to a great extent depend on the chemical composition of the mine tailings, waste rock and ore stockpiles and their potential for ARD.

4.5.3 Mitigating Measures

Geochemical characterisation of the mine tailings and waste rock will determine ARD potential and the requirement of remedial measures to control, collect and treat seepage from mine dumps. If the results of the proposed ARD test work on tailings and waste rock (refer to Dikulushi Environmental Management Plan) indicate the tailings and/or waste rock solids to have a net acid producing potential (NAPP) the following mitigation measures will be considered by Anvil;

- Perimeter seepage interception drains;
- Re-cycling of seepage to the plant and/or treatment prior to discharge; and
- Ongoing monitoring of dump seepage and groundwater quality in the vicinity of the mine, tailings dam and waste rock dumps.

4.6 Landscape and Visual Character

The open pit, waste rock dump, process plant and tailings dam are the most evident visual impacts at the mine site.

The visual impact of open pit and waste rock dump development will increase until the end of Phase II when the open pit reserves are exhausted and underground mining commences. During Phase III a relatively small tonnage of underground development waste will be produced.

The open pit will be a prominent aspect at the mine site covering an area of 10 hectares but will be visible only from within the mine site or from the air. After decommissioning, the pit is likely to form a small lake with steep, partially vegetated sides.

The waste rock dump will have a footprint of approximately 10 hectares and attain an ultimate height of 16 metres (2 lifts of 8 metres). The surrounding woodland will to some extent screen the visual impact of the dump. As re-vegetation occurs the visual impact will lessen.

The tailings dam will have a footprint of approximately 20 hectares and attain a maximum height of 23.5 metres.

4.6.1 Mitigating Measures

The impact of mine operations on the landscape and the visual character of the area could be reduced by ensuring that operations and mine components are screened from the surrounding population by vegetation and by ensuring mine components do not exceed a height above the tree canopy. Re-vegetation of structures such as dumps and tailings dams will be carried out as these components or parts of them are decommissioned. Re-vegetation of the tailings dam walls will be done progressively as the dam is raised while the upper surface of the dam will be re-vegetated at closure.

4.7 Noise and Vibration

4.7.1 Dikulushi Mine Site

The main sources of noise and vibration are mining equipment, blast hole drilling, diesel generators, crushing circuit, HMS plant (Phase I) and concentrator mill (Phases II & III).

These installations and operational activities will be running 24 hours per day and will mostly affect operators and others working close by. Workers are at risk of hearing impairment.

Open pit blasting will produce significant noise and vibration levels but only for very short durations.

Dikulushi village and other more distant settlements are not likely to be affected by noise from the mine site because there is 3.5 km of woodland between the mine and Dikulushi village which will absorb much of the noise.
The main source of surface vibration in the plant area is the crushing plant and specifically the primary crusher. The plant is located some 700 metres from the mine village and is likely to contribute to village background noise levels. However, noise levels should not be a nuisance to village residents.

4.7.2 Port Facilities

The barge and trucks operating at both port facilities generate noise and vibration above baseline levels. Noise levels may be a slight nuisance to people living in Kilwa and Nchelenge and may also disturb aquatic animals and birds. However, port operations are daytime only and not continuous.

4.7.3 Mitigating Measures

Anvil will implement a maintenance and prevention programme for all mine equipment and machinery to minimise noise levels. Ear protection will be provided to all employees working in areas of the open pit and plant site where noise levels regularly exceed 85dB. Regular hearing tests will be conducted on workers at risk and noise levels will be monitored in all strategic areas.

Noise levels at the Kilwa and Nchelenge port facilities will be monitored. A complaints record will be kept by Anvil and, if necessary, used to develop strategies to further minimise noise levels.

4.8 Air Quality

4.8.1 Mine Site

Dust will mainly be generated from heavy mine equipment operating on haul roads and waste dumps, the crushing plant and tailings dam. Open pit blasting will also generate dust but for short durations only. Air emissions from power generators and vehicles may affect air quality locally.

Air quality deteriorates during the dry season when fine particles are easily dispersed by wind. Dust from the crusher circuit and tailings dam could adversely affect employee health, soil resources and vegetation. Dispersal of dust is likely to continue post closure until vegetation has established itself on the waste rock dump, tailings dam and plant area.

Respirable dust will be generated at the crushing plant and may affect employee health if left unmanaged.

Minor local air pollution will arise from diesel generators and mine vehicles.

4.8.2 Mitigating Measures

Anvil will use dust suppression techniques such as scrubbers (crusher) and water sprayers (haul roads) to control/minimise dust generation. All employees working in dusty environments will be issued with dust masks. Respirable and total dust levels will be monitored in strategic areas.

4.9 Soil Resources

4.9.1 Mine Site

Removal of vegetation during construction of the waste rock dump, tailings dam and plant site has resulted in some soil erosion. However, the main impact on the soil resource is likely to be the result of translocation of contaminants from the ROM pad, waste rock dump and tailings dam into the soil via surface runoff, seepage and wind blow. This may adversely affect future use of soil resources. The degree and duration of impact on soil resources will depend on the geochemical characteristics of waste rock and tailings material.

4.9.2 Mitigating Measures

Proposed mitigating measures to protect surface water quality and air quality will also protect soil resources.

4.10 Accidental Releases

4.10.1 Mine Site

A breach in the tailings dam wall or return water dam will result in the release of silt and contaminated water into the Dikulushi river. Silt deposition will obstruct stream flow and the tailings composition will alter stream sediment geo-chemistry. A deterioration of river water quality will affect downstream water use and flora and fauna along the river. Similar impacts would occur in the event of dam wall overtopping.

A failure of the tailings delivery pipeline will result in tailings spill and contamination of soil and surface water and damage to vegetation.

A major spill of diesel will release organic contaminants resulting in soil contamination and possible surface and groundwater pollution.

4.10.2 Mitigating Measures

Knight Piesold Consultants designed the tailings dam against a 1:100 year storm. The tailings dam will be operated as per the Knight Piesold safe operating manual to minimise/reduce the risk of dam failure. Anvil will conduct regular monitoring of the tailings dam wall, decant and freeboard, and carry out daily inspection of the tailings delivery pipeline.

Anvil will develop an Emergency Response Plan (ERP) that will be implemented in the event of an accidental release of tailings or diesel. Management will be informed and immediate action will be taken to stop the release. Local inhabitants will be made aware of the spill and any dangers it may pose to them. Anvil will clean up any spill and conduct an investigation into the causes of the release. The findings of the investigation will be used by Anvil to develop strategies and measures, which will be implemented to ensure that a similar accident does not recur.

4.11 Hazardous and Non-Hazardous Waste Generation

4.11.1 Mine Site

Used oil and grease from mine workshops may contaminate surface water and soils if spilled or allowed to enter the mine drainage system.

Washing of mining equipment may result in the release of lubricants into the environment.

Scrap metal will be generated over the life of the mine.

Inadequate storage and/or handling of reagents and chemicals used in the concentrator (Phase II) may result in the contamination of surface soils and water.

4.11.2 Mitigating Measures

Oil traps will be installed in drains at the mine workshops to prevent oil entering the site drainage system and environment. Oil traps will be regularly maintained. The surpernatant will be stored in drums in a secure area awaiting collection by Exxon Mobil. Oil sludge will be disposed of at an approved site.

Used oil from light and heavy equipment servicing will be stored in drums in a secure bunded area with impervious flooring and roof awaiting collection by Exxon Mobil for recycling/final disposal.

All mining equipment will be washed in designated areas with impervious floors and collection drains equipped with oil traps.

Concentrator reagents and chemicals will be stored under cover in a secure area with impervious floor.

Scrap metal will be kept separate from hazardous waste and stored in a dedicated area awaiting sale and collection by scrap metal dealers.

Non-hazardous waste such as containers, drums, timber, metal sheets etc. will be sold to the local community.

Anvil will develop and implement a hazardous and non-hazardous Waste Management Plan. The plan will identify different categories of hazardous and non-hazardous waste and describe handling, storage and disposal procedures for the various types of waste. Emphasis will placed on waste reduction, reuse or recycling to reduce the impact of waste disposal on the environment.

4.12 Cultural Heritage

Development of the mine (open pit, rock dump, plant area and other installations) could disturb sites of archaeological or cultural significance.

Post closure, the Dikulushi mine may come to be regarded as part of the DRC national heritage and the cultural value attached to it increased, making the mine itself a site of cultural heritage.

4.12.1 Mitigating Measures

Sites of archaeological or cultural significance should be investigated, mapped and documented. Any finds should be preserved by marking or, if necessary, responsibly relocating and recording of artefacts.

No evidence was found to indicate the presence of any sites of archaeological or cultural significance at the mine site during the baseline study. However, no extensive archaeological/cultural study was conducted prior to the commencement of mining operations.

4.13 Socio-Economics

4.13.1 Economic Impacts

Project investment will introduce multiplier effects in the regional and local economy. The project will promote the business of local suppliers and contractors providing goods and services to the mine.

The direct economic impact of the project in Dikulushi will be the additional employment earnings generated in the local community. These earnings will improve the local economy by facilitating the purchase of additional good and services.

4.13.2 Social Impacts

The social impacts of the project are:-

a) Social Infrastructure

The construction and rehabilitation of social infrastructure such as clinics for the direct welfare of employees is an important positive impact for the local community.

b) Influx of outside population

The project is likely to attract people from surrounding areas seeking employment. This will put the local population in direct competition with outsiders, a concern already expressed by local residents. Depending on ability and the availability of jobs, local residents should be given preferential consideration when hiring.

c) Local Culture and Customs

The mining project will have an impact on the local customs and culture of the local communities, as employees are likely to be drawn from outside the region and the country. All employees should be sensitive to the cultures, customs and values of local people. This should be reinforced through company policy and education, especially to non-Congolese employees.

d) Potential Increase in HIV/AIDS Infections

The project is likely to induce a large number of job seekers from outside the community. This influx of population in the area has the potential of increasing the chances of the spread of HIV/AIDS infections. The Company should put in place a policy based on education and prevention, which will be communicated to all employees and their families. In practice community, church and education groups should support this initiative

e) Infrastructure and Communications

A significant positive impact can be expected from road improvements undertaken by Anvil between Kilwa and Dikulushi, and from barge traffic across Lake Mweru. Road rehabilitation will result in increased mobility for people living in the region as well as the movement of people and goods between Zambia and the DRC.

The mine site is equipped with a VHF radio link to Kilwa and Nchelenge and a satellite communication system including telephone and Internet. This facility benefits both the mine and the local community. At mine closure this positive impact is likely to be discontinued.

4.14 Analysis of Alternatives

Mine site construction began in May 2002. The mine was commissioned in September 2002 and the first copper/silver concentrate was produced at the end of that month. Analysis of the environmental aspects of the alternative pre-mine development options including the 'no development option', are not addressed because the mine was already operating before commencement of this EIA study. Anvil took the view that there were no insurmountable environmental issues for the Phase I production stage, and that it was justified in seizing the window of opportunity to push ahead with initial development of the project as soon as it recognised the significance of the political changes in the country in early 2001.

An analysis of the alternatives relating to future mine development, decommissioning of the Dikulushi River Diversion and extension to the existing tailings disposal facility is discussed below.

4.14.1 Opencast and Underground Mine Development

Further development of the open pit would cease if there were an early change over to underground mining. A change to underground mining would result in positive environmental impacts including:-

- Less surface disturbance (habitat destruction and river diversion);
- Minimal surface overburden/waste rock dump requirement; and
- Reduced nuisance from noise and dust;

The high capital cost of developing an underground mine compared to continuing open cast operations would compromise the project's economic viability and therefore is not a realistic option at this stage in project development.

4.14.2 Diversion of the Dikulushi River

At mine closure two options are available to mine management with regard to the Dikulushi River Diversion Scheme. These options are:-

1. The Dikulushi River Diversion channel is retained as a permanent feature: or
2. The upstream diversion dam is breached allowing the Dikulushi River to flow into the open pit.

Option 1 will ensure continued flow of the Dikulushi River (during periods of normal flow) and will avoid the risk of river pollution caused by the mixing of river and pit water.

Option 2 may result in a deterioration of river water downstream of the open pit caused by the ingress of polluted pit water. A disruption to the river's flow regime may also occur due to its low flow and ephemeral nature. It is possible that the water level in the flooded open pit may not be high enough to discharge into the downstream Dikulushi river channel.

The selection of either option will ultimately depend on future hydrological and hydrogeological studies to determine post closure pit water quality and quantity, and its possible use as a perennial water resource for irrigation agriculture and domestic water supply. The closed pit could also provide a potential habitat for aquatic flora and fauna.

4.14.3 Tailings Disposal

It is currently envisaged that the Phase I tailings dam will be extended northwards to provide tailings storage capacity for the remaining life of the mine (Phases II & III). Knight Piesold Consulting will complete the detailed design of the new dam extension in May 2003. This design report will consider alternative sites. Tailings ARD potential should be included in the dam design study so that any ARD impacts can be mitigated.

4.14.4 Concentrate Export

Dikulushi copper/silver concentrate is currently transported by road to the Ongopolo smelter in Namibia and the O'oKiep Smelter in South Africa. Smelting and refining of the concentrate at Mufulira mine in Zambia was considered as an alternative to the Ongopolo smelter because of its relative proximity to Dikulushi and therefore its lower transport cost and reduced impact on the environment and road infrastructure. However, Zambian concentrate import taxes at the time and higher smelting costs at Mufulira mine exceeded the additional transport cost of moving the concentrate to Ongopolo. The decision to initially use the Ongopolo smelter was therefore based on financial considerations.

5. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

This Section provides a specific, measurable, attainable, reliable, and time bound plan to manage the environmental and social impacts of the project. The approach is based on World Bank guidelines, Anvil company policy and industry best practice. The plans take into consideration the impacts and mitigating measures outlined in Chapter 4 - Potential Environmental and Social Impacts and breaks up the management criteria into the following sub sections:

- Environmental Management Plans
- Environmental Monitoring
- Non Compliance Procedures
- Emergency Management Plan
- Social Management Plan
- Decommissioning and Closure Plans
- Environmental Protection Costs

The management plans will be initiated with immediate effect and regularly updated to reflect new mine developments and changes to the existing plan. Annual Environmental and Social Reports will be produced by Anvil. External independent auditing of the ESMP will start in 2005 and continue throughout the project once every 2 years in order to evaluate implementation and assess compliance with management actions.

Dikulushi mine operations commenced in 2002. Therefore this management plan is designed to evaluate current project impacts and environmental compliance and integrates environmental protection and sustainable development into the running of the project. A table of management actions is included in Appendix VIII.

4.15 Environmental Management Plans

4.15.1 Surface Water Management

Test work will be conducted to determine the geo-chemical characteristics of Dikulushi waste rock, ore stockpile and HMS/concentrator tailings and evaluate their potential for Acid Rock Drainage (ARD) generation. If any of the materials have net acid producing potential (NAPP) a detailed environmental study will be undertaken to assess the likelihood and severity of any surface water pollution and the mitigating measures to be implemented.

To control/prevent potentially contaminated water from entering surface water courses additional drains will be constructed around mine dumps and plant components as shown in Figure 5.1. All drainage systems will discharge into a sedimentation pond or series of cascading sedimentation ponds. The sedimentation ponds will be designed with sufficient volume to allow settling to occur before water is discharged into the Dikulushi River. Resulting discharge will be monitored and treated if necessary as

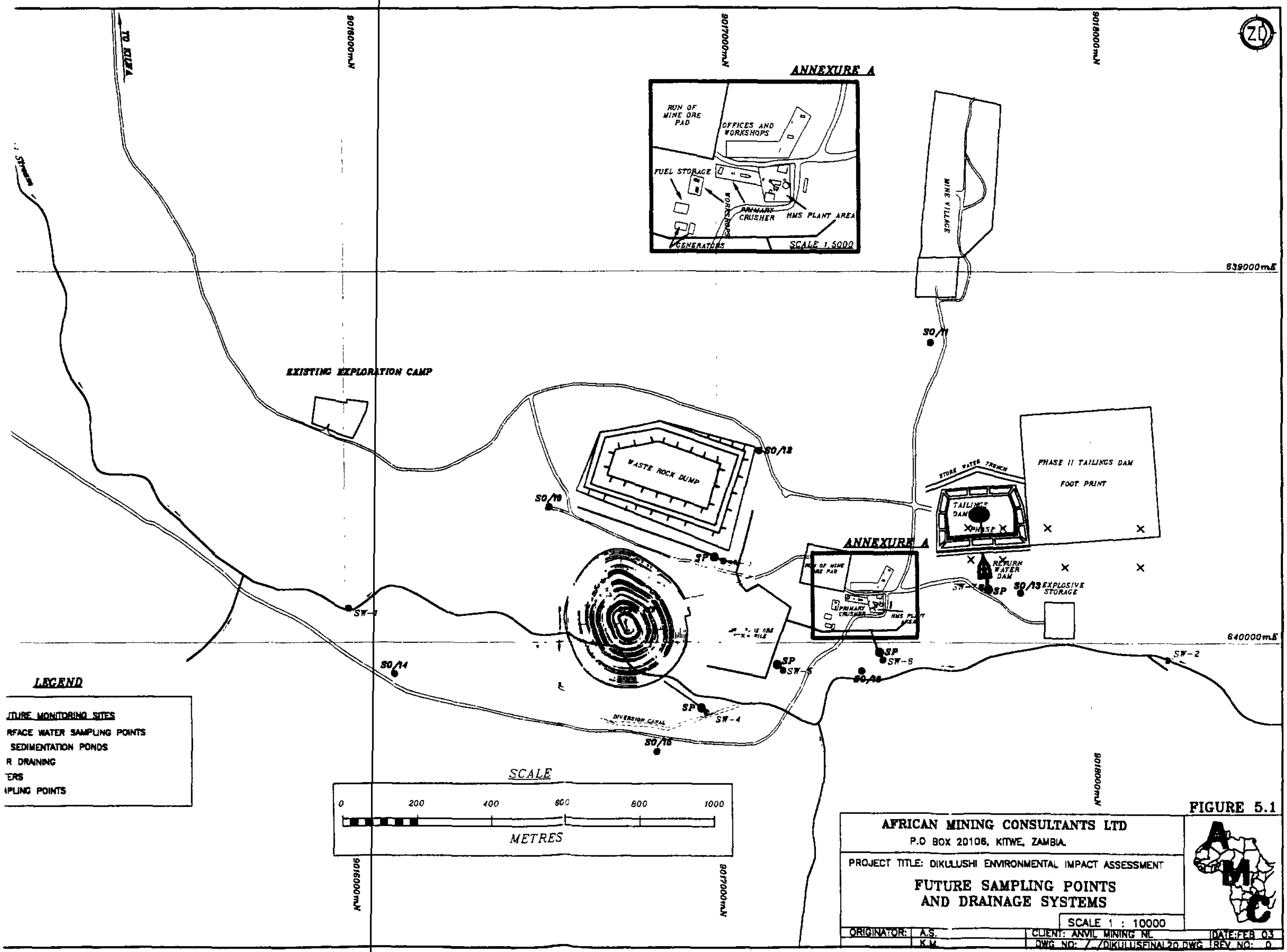


FIGURE 5.1

AFRICAN MINING CONSULTANTS LTD
P.O BOX 20106, KITWE, ZAMBIA.

PROJECT TITLE: DIKULUSHI ENVIRONMENTAL IMPACT ASSESSMENT

FUTURE SAMPLING POINTS
AND DRAINAGE SYSTEMS

SCALE 1 : 10000

ORIGINATOR:	A.S.	CLIENT: ANVIL MINING NL	DATE:FEB 03
	K.M.	DWG NO: /../DIKULUSFINAL20.DWG	REV NO: 0

outlined in the non-compliance procedures. All drains and sedimentation ponds will be regularly inspected and maintained to ensure that they are operating efficiently and are clear of solids.

Implementation of the above management actions is the responsibility of the mine Health, Safety & Environment (HSE) Department.

4.15.2 Waste Rock Dump

Surface run-off will be controlled by the construction of bund walls and perimeter drains around the waste rock dump. Stable dump walls will be constructed in two lifts of 8 metres height with a 15 metre wide berm and overall slope angle of 1:3.

Groundwater quality downstream of the waste rock dump will be monitored on a monthly basis to evaluate possible contamination resulting from seepage through the base of the dump. Groundwater monitoring will be done from one or more boreholes equipped with piezometers (refer to Figure 5.1). Groundwater sampling will be conducted according to the sampling procedures outlined in Appendix II.

Any seepage issuing from the toe of the dump will be monitored together with surface runoff (refer to environmental monitoring plan - Section 5.2).

Groundwater will be analysed at the mine analytical laboratory for pH, total dissolved solids, sulphates and total copper.

Visual assessment of dust levels will be conducted weekly. Trees around the periphery of the dump will be protected to reduce wind blow and dust generation.

Re-vegetation of the dump will be done progressively using the methods specified in the flora and fauna management plan.

Responsibility for dump management rests with the HSE manager and mine manager.

4.15.3 Tailings Dam

The tailings dam management plan aims to ensure that potential impacts from the tailings dam to surface water, ground water and air are controlled/minimised.

Physical inspections of the tailings dam will be carried out weekly. Results of these inspections will be recorded in a logbook to be kept at the mine offices. The inspection will include but is not limited to:-

- Evidence of slumping, cracking and/or seepage from the dam wall;
- Operation and integrity of the decant and return water dam;
- Condition of the tailings delivery pipeline;
- Recording of dam wall freeboard; and
- Measurement of phreatic surfaces in the dam wall using installed piezometers;

Groundwater quality downstream of the tailings dam will be monitored on a monthly basis to evaluate possible contamination resulting from seepage through the base of the dam. Groundwater monitoring will be done from one or more boreholes equipped with piezometers (refer to Figure 5.1). Groundwater sampling will be conducted according to the sampling procedures outlined in Appendix II.

Groundwater will be analysed at the mine analytical laboratory for pH, TDS, sulphate and total copper.

Surface water flow from the tailings dam to the return water dam will be monitored during discharge as outlined in the surface water monitoring programme. An additional perimeter drain and sedimentation pond will be constructed around the Phase II tailings dam and discharge from this settlement pond will be regularly monitored.

Visual assessment of dust levels at the dam will be conducted weekly. Trees around the periphery of the dump will be protected to reduce wind blow and dust generation.

Concurrent re-vegetation of closed areas of the tailings dam will be undertaken using the methods specified in the flora and fauna management plan. Progressive re-vegetation of the dam will be done as the dam wall is raised.

Wall stability, freeboard, phreatic surface, ground water seepage analytical results, and comments on dust will be documented and a quarterly report submitted to the Mine manager detailing areas of concern and recommending possible remedial action.

An external competent person will inspect the tailings dam every 2 years and produce a detailed report. This report will review design, operation, development, stability and rehabilitation issues and assess implementation of the EMP.

In the event of groundwater contamination Anvil will conduct a detailed study/ investigation including groundwater flow modelling to determine the degree and likely extent of contamination, and develop measures to mitigate the impact.

In the event of significant dust generation due to wind blow, Anvil will implement appropriate measures to reduce/minimise dust levels. These measures will include accelerated re-vegetation of the dam wall, construction of windbreaks, and maximising the wetted surface of the beach during the dry season.

Tailings dam stability is the responsibility of the mine manager. Dust and groundwater monitoring will be the responsibility of the HSE manager.

4.15.4 Solid and Liquid Waste Management Plan

Anvil will develop a hazardous and non-hazardous Waste Management Plan to ensure that solid and liquid waste arising from the mine and off site investments is identified, collected, stored and finally disposed of in an environmentally responsible manner.

The key aspects of the Waste Management Plan will be:-

- Identification of the various types of hazardous and non-hazardous waste;
- Development of actions to reduce, reuse or recycle waste;
- Establishment of dedicated storage areas and storage conditions for different types of waste;
- Installation of oil traps in drains at mine workshops, equipment refuelling and washing bays. Development of a preventative maintenance programme to ensure efficient operation of oil traps;
- Used engine oil and oil trap supernatant and sludge, will be collected and stored in drums in a secure area awaiting collection by Exxon Mobil for final disposal under the fuel supply contract; and
- Identification of biodegradable waste for use in site rehabilitation.

The HSE manager is responsible for overall waste management at the mine and off site investments.

4.15.5 Flora and Fauna Management Plan

The Flora and Fauna Management Plan focuses on minimising the negative visual impact caused by mine development, and on bio-diversity conservation. The plan involves flora and fauna protection and progressive re-vegetation.

Areas to be stripped of vegetation in future mine development will be surveyed prior to construction. Commercial timber will be felled and sold. The local community will be allowed to collect non-commercial timber for use as construction material and fuel.

Topsoil in future development areas (extension to tailings dam) will, in so far as it is practicable to do so, be stored for future rehabilitation. This may not however be practicable due to the very thin layer of topsoil overlying the heavily leached tropical acrisols and lixisols present in the immediate mine area.

In line with its corporate environmental policy, Anvil will discourage deforestation in and around the mine site. This policy will be promoted via community awareness programmes and be enforced by mine security.

A section of the mine garden will be used as a nursery to grow seedlings of indigenous pioneer species such as *Acacia polycantha, A. sieberana, Albizia adianthifolia, Peltophorum africanum,* and *Dichrostachys cinere.* The seedlings raised will be used in re-vegetation of the mine dumps and plant area.

During decommissioning a layer of bio-degradable waste and seedlings will be applied to areas of the tailings dam, waste rock and ROM pad not already rehabilitated, to promote post closure re-vegetation.

The HSE manager is responsible for implementation of the Fora and Fauna Management Plan.

4.15.6 Safety Management Plan

Anvil will introduce international occupational health and safety (OHS) standards at the mine site to protect workers and the public from potential hazards.

Inadvertent Access to Hazardous Areas

To prevent inadvertent access by the public, warning signs will be erected in hazardous areas in English, French and Kizela (local dialect). These areas include the open pit, waste rock dump, tailings dam and plant area.

Mine Effluent Streams

Warning signs will be erected at the tailings dam, return water dam and effluent streams to prevent the public from utilising mine effluent for domestic purposes.

Hazardous Materials

Fire fighting equipment will be installed in all diesel refuelling areas and oil storage areas. All fire fighting equipment will be regularly inspected and maintained.

Oil and lubricants will be stored in secure bunded areas on impervious floors.

Reagents and chemicals used in the HMS Plant and concentrator will be stored in a secure covered area on an impervious concrete floor. Only designated personnel will have access to this area and protective clothing will be worn at all times.

The explosives magazine is managed and operated by Africa Explosives Limited (AEL). AEL conforms to international standards for transport, storage and handling of explosives.

Provision and Maintenance of Safety Equipment

All employees will be issued with adequate safety equipment, including eye, ear and respiratory protection in areas of high noise and/or dust. Supervisors will ensure that operators wear the required protection. Daily checks of personal safety equipment will be conducted. Safety equipment such as fire extinguishers and appliances will be inspected and tested quarterly. All hazardous machinery will be fitted with guards to protect operators. Rotating machinery will have emergency stop buttons.

Training

All employees will attend regular OHS classes where they will undergo training on basic first aid, emergency procedures, emergency equipment, protective clothing and accessories. Operators working in hazardous areas will receive specific OHS training on the hazards, precautions and procedures for operating machinery and the safe handling, storage and use of hazardous materials. Material Safety Data Sheets will be obtained/developed for all hazardous materials on site indicating handling procedures, potential hazards, risks and emergency action to be taken in the event of an accident.

Building Maintenance

Building inspections will be conducted annually and a regular maintenance programme implemented to ensure buildings are safe for employees to occupy. The maintenance programme will focus on the physical integrity of buildings, electrical wiring, piping, and sanitary facilities to ensure that all are safe and in good working condition.

4.15.7 Transport Management Plan

This will be implemented to minimise pollution arising from transport and to ensure road safety:

Mine Road Traffic

Site access roads, Dikulushi mine roads and the Dikulushi-Kilwa road will be regularly maintained and speed restrictions enforced for the safety of road users and the public. Drivers of light vehicles and operators of heavy equipment will be regularly tested to ensure they are competent to operate the mobile equipment in their charge. All mine vehicles will be maintained in a road worthy condition. Anvil will issue the company's road safety rules to all contractors working at the mine, and will monitor adherence.

Barge And Port Facilities

Barge and port facilities at Kilwa and Nchelenge will be regularly maintained. Anvil will ensure that safety regulations are adhered to and pollution is prevented/minimised. To achieve this Anvil will:-

- Conduct daily inspections of fuel storage facilities and carry out all necessary maintenance;
- Routinely inspect and check working order of all fire fighting equipment on board the barge and in the port facilities;
- Trucks will be inspected before disembarking to check for leaks of fuel or oil, and these leaks will be repaired before the trucks leave the port facility;
- Barge and speedboat operators will be instructed to look out for evidence of any fuel or oil spills on the lake surface and will report this to the mine manager and Port master.
- Monitoring of surface water quality at the port docking facilities will be done monthly with the emphasis on possible diesel and/or oil spillage.

4.15.8 Underground Environmental Management Plan

An Environmental Management Plan for the future Dikulushi underground mine will be developed by Anvil prior to the commencement of mining (possibly in Year 4 of operations).

4.16 General Environmental Monitoring

Regular monitoring of surface water, domestic water usage, groundwater, soil, noise, local climatic conditions and air quality will be undertaken by Anvil. The monitoring programme will enable the mine HSE department to quantify the extent and degree of impact of mine operations on the surrounding environment and assess compliance with relevant environmental standards.

4.16.1 Surface Water Monitoring

Monitoring of mine discharge to the environment will be done to assess compliance with DRC Statutory Regulations and/or international standards.

The surface water monitoring programme is based on the World Bank Pollution Prevention and Abatement Handbook (1998) guidelines. Proposed monitoring sites and monitoring frequencies are:-

- All Sedimentation Ponds (weekly when discharging); and
- Dikulushi River upstream and downstream of operations (weekly)

The monitoring sites are shown in Figure 5.1 and sampling procedures are described in Appendix II.

The parameters conductivity and pH will be monitored weekly in the Dikulushi River using a water quality probe. TDS, TSS, total sulphate and total copper will be analysed for monthly in the mine analytical laboratory. Full suite analysis (refer to baseline

Section 3.8.4) will be conducted every 6 months. Any additional parameters of concern identified will be added to the monthly monitoring programme.

Sampling of the sedimentation ponds will commence when discharge occurs and continue weekly until discharge ceases. pH, TDS, TSS, conductivity and total copper will be analysed for in the mine analytical laboratory. Full suite analysis of sedimentation pond water will be conducted every 6 months and any additional parameters of concern identified will be included in the discharge sampling analysis.

10% duplicate samples will be sent to an independent certified laboratory for Quality Assurance / Control (QA/QC) analysis every 6 months.

Compliance will be based on World Bank Guidelines (Pollution, Prevention and Abatement Handbook, Mining and Milling, 1998) pending promulgation of the DRC environmental regulations.

4.16.2 Surface Water Flow

Drainage channels around the open pit, waste rock dump, tailings dam, ore stockpiles and plant area will be inspected monthly during the wet season to ensure the drains are free of debris and flow into the sedimentation ponds is unimpeded. This action will prevent overflowing drains and resulting contamination of the surrounding environment.

The flow rate of the Dikulushi River will be monitored weekly (during the wet season) at a location upstream of the mine site in order to evaluate river element loadings and to ensure that the river diversion scheme is adequately designed.

4.16.3 Domestic Water Usage

The Mine Village potable water supply will be monitored quarterly to evaluate drinking water quality using the sampling procedures outlined in Appendix II. Water samples will be analysed at the mine for the following parameters:-

pH
Sulphate
T. Manganese
Conductivity
T. Arsenic
T. Copper
TDS
T. Chromium
Faecal Coliform
TSS

Compliance will be based on World Health Organisation (WHO) drinking water quality standards outlined in Appendix I.

The HSE department will regularly liase with residents of Dikulushi Village to monitor domestic water requirements. It is likely that the demand on water supply will increase with the influx of people seeking employment opportunities.

4.16.4 Ground Water Monitoring

Groundwater quality in the vicinity of the mine will be monitored on a monthly basis to evaluate possible contamination from mine operations. Groundwater monitoring will be done from boreholes equipped with piezometers (refer to Figure 5.1). Groundwater will be analysed at the mine analytical laboratory for pH, TDS, sulphate and total copper. Sampling will be conducted according to the sampling procedures outlined in Appendix II.

4.16.5 Dust Monitoring

Ambient and source dust monitoring will be conducted by the HSE department at strategic locations on the mine to assess the risk to worker health and to evaluate compliance with DRC Air Quality Regulations and World Bank Guidelines.

Anvil will purchase dust monitoring equipment and train an OHS officer to carry out dust monitoring and analysis. Dust monitoring will be conducted monthly at the crusher plant, analytical lab and mine village. Dust samples will be analysed for total dust, and respirable dust particles ($<10\mu m$). Copper and lead in dust will also be determined. Workers in high-risk areas will undergo annual silicosis tests.

4.16.6 Noise Monitoring

The HSE department, to assess the risk to worker health and to evaluate compliance with DRC Noise Regulations and World Bank Guidelines will conduct monitoring of noise levels on the mine.

Anvil will purchase noise monitoring equipment and train an OHS officer to carry out noise monitoring. Noise monitoring will be conducted quarterly in areas identified as high risk to workers. Workers in high-risk areas i.e. crusher and generator buildings will undergo annual hearing loss tests.

4.16.7 Soil Monitoring

Surface soil monitoring will be conducted by the HSE department at 5 year intervals to evaluate possible soil contamination. A soil sampling programme will be developed by the mine.

4.16.8 Local Weather Monitoring

Precipitation, temperature, humidity, wind speed and direction will be monitored daily to provide accurate climatic data for the mine site. This meteorological data will assist in the design of new mine components and identify those areas likely to be affected by dust blow. Anvil will purchase a weather station to record daily climatic conditions.

4.16.9 Document Control

An environmental monitoring database linked to a geographical information system (GIS) will be constructed. The database will include sampling locations, date of sampling, monitoring results and comments. The HSE department will submit quarterly monitoring reports on surface water and groundwater quality, and noise and dust levels to the mine manager highlighting significant results, areas of non compliance and proposed measures to mitigate any issues of concern. The HSE department will produce an annual environmental monitoring report, which will review environmental performance in all areas of operations.

4.17 Non-Compliance Procedures

4.17.1 Surface Water

If monitoring data indicates discharge from mine sedimentation ponds to be out of compliance, then:-

- The pollution source will be identified and the relevant mine department notified;
- Immediate action will be taken to bring the discharge back into compliance;
- Daily monitoring of non-complaint parameters will be conducted until the effluent discharge is brought back into compliance; and
- A non-compliance report will be issued by the relevant official and submitted to the HSE manager and mine manager.

If potable water is significantly out of compliance with WHO safe drinking water quality guidelines, then:-

- Water users will be made aware of the problem;
- An investigation will conducted to determine if the water supply can be treated and brought back into compliance; and
- An alternative water supply will be sourced if the water cannot be treated.

In the event that insufficient water is available to supply the Dikulushi village, Anvil will investigate the possibility of supplementing water supply from mine sources.

4.17.2 Sedimentation Ponds

If solids build up in the sedimentation ponds to the extent that their function and efficiency is compromised:-

- Responsible officials will be alerted and the sedimentation ponds will be de-silted; and
- If the silting problem persists the design capacity of the sedimentation pond will be reviewed and/or the ponds will be dredged at the end of each dry season.

4.17.3 Tailings Dam

If the tailings dam wall is at risk of failure due to inadequate freeboard, a high phreatic surface or flood event, the mine manager will be notified immediately. Emergency procedures described in the dam safe operating manual will be followed to make the tailings dam safe.

4.17.4 Groundwater

If monitoring data indicates a significant deterioration of groundwater quality:-

- The risk to the mine village potable water supply will be assessed;
- The source of groundwater contamination will be determined; and
- Groundwater contamination will be modelled to assess the likely extent of contamination and any likely impact on groundwater usage outside the immediate mine area.

4.17.5 Noise and Air quality

If monitoring data indicates that noise and/or dust levels exceed the compliance limits set by the DRC Environmental Regulations or World Bank Guidelines, the HSE manager will inform the mine manager. Operators will be made aware of the OHS risks associated with noise and dust and workers in high risk areas will be issued with appropriate ear protection and/or protective masks.

Possible measures to lessen exposure to noise and/or dust in the workplace will be investigated. These measures will likely include:-

- Rotation of operators in and out of high risk areas;
- Regular maintenance of machinery and equipment and replacement of worn out components; and
- Implementation of dust and noise suppression systems.

4.17.6 Soil

If soil monitoring (after 5 years) indicates soil contamination:-

- A soil survey will be conducted in the vicinity of the mine to determine the extent and depth of soil contamination; and
- Based on the results of the soil survey a soil remediation plan will be developed, if necessary.

4.18 Emergency Management Plan

In the event of an emergency, the HSE manager and mine manager will be notified immediately and contingency measures will be implemented. These measures will focus on minimising impacts and alerting potentially affected people as soon as possible. The cause and extent of the impact will be investigated and appropriate remediation measures actioned. An emergency incident report detailing the type of emergency, causes, impacts, remedial measures and action taken to ensure a similar emergency does not recur will be prepared by the relevant mine department and submitted to the mine manager.

A set of specific simple emergency response procedures will be developed and published on the main office notice boards. This will include contact details of all relevant officials.

In the event of a large-scale pit wall failure, release of tailings to the environment, major diesel spill or release of concentrate/reagents/chemicals to surface water the Emergency Response Plan (ERP) to be developed by Anvil will be implemented.

4.19 Social Management Plan

In order to mitigate negative social-cultural impacts and to ensure measures are put in place to promote economic diversification and sustainable development beyond closure Anvil will implement the following programmes.

4.19.1 Implementation of an HIV/AIDS awareness campaign

AIDS/HIV awareness seminars and campaigns will be held regularly in association with regional and local NGO's for the benefit of the whole community. These campaigns will be sensitive to the local culture and customs. A DRC doctor will conduct medical awareness seminars on a quarterly basis. Educational AIDS/HIV awareness posters will be placed in strategic areas around the mine site, Dikulushi village and port facilities. Free condoms will be made available to all mine employees.

4.19.2 Malaria Roll Back Programme

A malaria awareness and prevention programme will be implemented to control the incidence of malaria at the mine, mine village and Dikulushi village. Seminars on how to reduce the risk of contracting malaria will be conducted and awareness posters will be put up. Mosquito spraying will be carried out around the mine and local areas. Employees will be encouraged to use treated mosquito nets provided by Anvil.

4.19.3 Unskilled/Semi Skilled Job Seekers Inventory

An inventory of job seekers will be created recording, names, addresses, ages, skills, and ability in order to fairly distribute jobs. Preference will be given to local people provided they have the necessary qualifications, experience and ability. Unskilled jobs will be offered to local people only.

4.19.4 Employee Environmental Awareness

Environmental workshops will be held to encourage environmental protection and sustainable development practice within the Company. Anvil's Corporate Environmental Policy as well as posters on environmental protection will be displayed on notice boards and in work areas throughout the mine.

4.19.5 Development of Joint Task Forces

The company will liase with Local Government, non-governmental organisations (NGO's) and churches to develop a sustainable development plan for the Dikulushi and Kilwa areas. The plan will centre on alternative economic activities such as sustainable farming, forestry, fishing, small business and other activities that will be independent of the mining project.

4.19.6 Local Business Support

The company will be proactive in assisting local entrepreneurs to develop their business ideas and preference will be given to employing local contractors providing they can demonstrate ability to carry out work diligently, to the correct standard, within budget and on schedule. Anvil will produce an information package on how to do business with the mine. The package will be available at the mine general offices.

4.19.7 Energy

Anvil will conduct a preliminary investigation into alternative renewable energy sources such as hydropower, which could provide electricity supply to the mine and surrounding villages. The Company will engage local government to discuss the possibility of a joint project. Benefits of a sustainable renewable energy source are reduced air emissions from the mine and electricity supply that will continue beyond the closure of the mine.

4.19.8 Communication

A forum will be created where the community can voice its concerns regarding mine operations. This forum will also be used by the Company to communicate effectively with the local community. The forum will comprise company representatives appointed by the mine manager and community leaders. Meetings will be held regularly at an appropriate venue.

4.19.9 Social Services

Social services will be provided in association with the local government and NGO's. Emphasis will be placed on sustainable health and education programmes, which will continue post closure.

4.19.10 Cultural Heritage

Mine employees will be briefed on procedures to be followed in the event of an archaeological find. The HSE officer will be notified of any find. All artefacts will be documented, photographed and removed. An archaeological expert may be contacted to assess the significance of the find and advise on any further action to be taken.

4.20 Environmental Auditing, Reporting and Management Structure

4.20.1 Auditing

Anvil will prepare annual internal reports to evaluate progress in implementing the Company's environmental and social management plans, monitor environmental and social performance and assess compliance with relevant DRC standards and World Bank guidelines. Where actions are found to be inadequate or not achieving the desired results alternative measures will be considered and management plans amended accordingly. Thus, annual reporting will result in continued environmental and social improvement.

In addition to annual reporting, quarterly reports will be compiled for the following:-

- Surface water quality;
- Groundwater quality;
- Site air quality;
- Tailings disposal facility;
- Sedimentation ponds; and
- Drinking water quality.

The annual environmental and social monitoring report will review the following:-

- Surface water quality;
- Groundwater quality;
- Site air quality;
- Waste rock dump;
- Tailings disposal facility;
- Sedimentation ponds;

- Site meteorology data;
- Drinking water quality;
- Surface water flow;
- Soil (every 5 years);
- Noise;
- Waste management;
- Progressive rehabilitation of mine site;
- Safety performance/ statistics; and
- Implementation of social plan.

External environmental and social monitoring reports (audits) will be conducted every 2 years by an independent expert to assess environmental and social performance against existing management plans, company environmental and social policy, DRC environmental standards and World Bank Guidelines, where appropriate.

4.20.2 Environmental Management Structure

Anvil's corporate management structure is shown in Appendix I. Anvil's head office is in Perth, Australia. A chief executive officer (CEO) supported by a financial controller and company secretary head all Anvil operations. The mine manager is responsible for the operation of Dikulushi mine and reports directly to the CEO. Operations are divided into 4 departments each headed by a manager who report to the mine manager. These departments are:-

- Health, Safety and Environment Department;
- Mining/Geology Department;
- Processing Department; and
- Administration Department.

The Health, Safety and Environment (HSE) Department is responsible for occupational health and safety and environmental protection. Monthly environmental meetings are held at management level to discuss progress in implementing environmental and social plans and any new issues arising. All employees are encouraged to actively participate in environmental management and report any instances of pollution to the HSE Department. Major environmental occurrences/incidents will be reported immediately to the mine manager and relevant DRC authorities.

Mine personnel responsible for implementation of actions in the environmental and social management plans are included in the Environmental and Social Management Plan Tables in Appendix VIII.

4.21 Decommissioning and Closure Plan

The mine Decommissioning and Closure Plan will include the following:-

- Dismantling and removal of all mining equipment, process plant and machinery;

- Rehabilitation of open pit, plant area, waste rock dump, ROM pad and tailings dam and return to sustainable land use;

- Implementation of retrenchment training and counselling plan; and

- Implementation of post closure environmental monitoring and inspection plan.

4.21.1 Dismantling and Removal of Mine Assets

Prior to mine closure Anvil will prepare a detailed inventory and description of all mine assets (including mining equipment, process plant, machinery, buildings and infrastructure) to evaluate various decommissioning options i.e. reuse, recycling, sale or appropriate safe disposal, and associated costs. This inventory will enable Anvil to determine the best course of action for the decommissioning of mine assets with appropriate consideration of the economic, environmental and social implications.

Plant Area

The mine crushing plant, HMS plant and Concentrator will be dismantled and removed from site for reuse, sale, recycling or disposal. All reinforced concrete foundations will be broken out to 0,5 metres depth and the sites re-profiled to re-establish natural drainage.

The mining contractor will dismantle the open pit workshop and remove all its equipment and machinery from site.

Exxon Mobil will dismantle and remove fuel storage facilities including underground tanks and pipes. Contaminated soil from fuel handling spills will be removed to an approved disposal site.

Port Facilities

Anvil and the DRC/Zambia authorities will study the economic viability of the barge and port facilities post closure. These facilities could be offered to the DRC or Zambian Governments or operated by a private company to provide a ferry service between the DRC and Zambia.

Buildings and Housing

Anvil will offer housing and buildings located in the mine area to employees and/or the local community.

4.21.2 Rehabilitation of Mine Area

The mine area will be rehabilitated to establish some form of sustainable land use.

Open Pit

At closure Anvil will construct a perimeter bund wall around the open pit and erect warning signs to prevent inadvertent access by the general public. All machinery, plant equipment and potentially hazardous materials will be removed from the pit. The pit will be allowed to flood by groundwater ingress and/or inflow from the Dikulushi River. A study will be undertaken to assess the feasibility of converting the flooded open pit into an aquatic ecosystem, which could provide sustainable fishing, water supply/irrigation and/or social amenities to the local community.

Dikulushi River Diversion Scheme

The upstream dam may be breached to allow the river to flow through the disused pit. The river channel will be re-profiled at the dam and the diversion canal backfilled.

Tailings dam

A detailed decommissioning plan for the tailings dam will be developed by Anvil prior to mine closure. However, decommissioning will involve the re-profiling of the upper surface of the dam and construction of evaporation paddocks, sealing of the decant tower and pipe, backfilling and re-profiling of the return water dam, removal of the tailings delivery pipeline and redundant equipment and materials, maintenance of the perimeter drainage system and re-vegetation of the dam walls and upper surface excluding the pond area.

Plant Area

After dismantling of the plant site and breaking out of reinforced concrete foundations any residual contaminated soil will be treated or collected and removed to an approved disposal site. After re-profiling the site will be re-vegetated.

Waste Rock Dump

The upper surface of the waste rock dump will be re-profiled to control surface runoff and drainage in order to prevent erosion. Perimeter drains will be maintained and the upper surface will be re-vegetated.

ROM Pad

The ROM pad area will be re-profiled to establish natural drainage, and re-vegetated.

4.21.3 Pre Closure Training and Counselling

Pre-closure retrenchment training and counselling of employees will be conducted. Retrenchment packages will be properly designed to promote sustainable livelihoods. Provision of training and counselling will probably require additional personnel and skills over a 6 month period prior to closure.

4.21.4 Post Closure Monitoring and Inspection

The following post closure mine site monitoring and inspection programme is proposed:-

- Monitoring of surface water quality of the Dikulushi river upstream and downstream, and within the disused open pit;
- Monitoring of groundwater water quality at the tailings dam and waste rock dump;
- Mine site walk over to inspect the open pit perimeter, river diversion scheme, plant area, tailings dam, waste rock dump and ROM pad to assess the success of decommissioning activities and re-establishment of natural vegetation across the mine site.

Mine site monitoring and inspections are to be conducted at 6 monthly intervals for the first 2 years after closure. Monitoring results will determine the frequency of subsequent inspections. Monitoring will continue until such time that the mine site is fully rehabilitated and there is no indication of surface or groundwater pollution or further soil erosion.

4.22 Environmental Monitoring and Protection Costs

Dikulushi environmental protection and monitoring costs are estimated on an annual basis and include one-off costs for the purchase of environmental monitoring equipment and training of environmental personnel. Costs are quoted in United States Dollars. A 15% contingency has been included in the cost estimate.

4.22.1 Environmental Protection Costs

Site air and water quality, noise and dust levels will be monitored throughout the life of the mine. The main costs associated with the environmental monitoring programme are for analytical test work. Estimated annual sampling/analytical and staff training costs are shown in Table 5. 1.

Table 5. 1 Estimated Annual Environmental Monitoring Costs

Item No.	Environmental Monitoring	Number (Per year)	Unit Cost US$	Total Cost US$
1.	5 No. sedimentation pond discharge	80	$15	$1,200
2.	Dikulushi River	52	$15	$780
3.	3 No. groundwater monitoring wells	36	$15	$540
4.	Potable water supply	4	$15	$60
5.	Quality Control/Assurance (10%)	17	$60	$1,020
6.	Water sampling bottles	120	$1	$120
7.	Dust	12	$16	$192
8.	Noise	4	$0.	$0
9.	Soil*	0	$0	$0
10.	Probe calibration solution	1	$50	$50
11.	Annual repair & replacement of all environmental equipment	lump sum	$8,000	$8,000
Sub Total				**$11,962**
15% contingency				**$1,794**
TOTAL (per annum)				**US$13,756**

* Soil surveys will be conducted every 5 years and at closure

Ongoing Annual Environmental & Social Management Costs

Ongoing environmental and social management costs include health and social programmes, progressive rehabilitation and environmental auditing. The cost estimate for these items is shown in Table 5.2.

Table 5.2 Ongoing Annual Environmental and Social Management Costs

Item No.	Description	Qty	Unit	Unit Cost US$	Total Cost US$
1.	HIV/AIDS awareness seminars	4	ea.	$2,000	$8,000
2.	Malaria roll back program (mosquito spraying)	6	ea.	$1000	$6,000
3.	Progressive site rehabilitation	2	ha.	$1,000	$2,000
4.	Social Consultant	30	30	$400	$ 12 000
5.	Environmental auditing	-	l.s.	$7,500	$7,500
Sub Total					**$35,500**
15% contingency					**$5,325**
TOTAL (per annum)					**US$40,750**

One-Off Environmental & Social Management Costs

The one-off environmental and social management costs estimate is shown in Table 5.3.

Table 5.3 - One off Environmental & Social Management Costs

Item No.	Description	Qty	Unit	Cost Per Unit (US$)	Total Cost US$
1.	Environmental monitoring training	3	days	$700	$2,100
2.	Installation of groundwater monitoring wells	3	ea.	$4,000	$12,000
3.	Installation of weir in Dikulushi River	1	ea.	$2,000	$2,000
4.	Piezometers tips & HDPE pipe	6	ea.	$50.00	$300
5.	Noise dB Meter	1	ea.	$1,450	$1,450
6.	Konimeter (dust monitoring)	1	ea.	$3,500	$3,500
7.	Gravimetric personal sampler (dust monitoring)	2	ea.	$1,000	$2,000
8.	Treated mosquito nets	400	ea.	$12	$4,800
9.	Water Quality Probe (EC & pH)	1	ea.	$1,500	$1,500
10.	ARD study on tailings and waste rock	-	l.s.	$10,000	$10,000
11.	Weather station	1	ea.	$ 2,000	$ 2,000
12.	Erection of warning signs	25	ea	$50	$1,250
13.	Establishment of nursery garden	-	l.s.	$3,000	$3,000
Sub Total					**$45,900**
15% contingency					**$6,885**
TOTAL (per annum)					**US$52,785**

The estimated annual environmental protection cost including a contingency of 15% is US$ 54,506 (fifty four thousand five hundred & six United States Dollars).

The estimated one-off environmental and social management cost including a contingency of 15% is US$52,785 (fifty two thousand seven hundred & eighty five United States Dollars).

4.22.2 Mine Decommissioning Costs

The mine decommissioning cost estimate assumes that the mine village, offices, stores, workshops, non-hazardous scrap and reusable materials, mobile assets, barge and port facilities are successfully offered for sale to local government, NGO's, the local community and/or private companies. It is also assumed that the mining contractor will remove all its equipment from site and undertake any necessary clean-up works. Exxon Mobil will remove from site all fuel storage facilities. Decommissioning costs relate only to the dismantling and disposal of mine components, equipment and machinery that cannot be sold, rehabilitation of potentially hazardous areas, retrenchment training and counselling, post closure monitoring and inspection. Mine facilities to be decommissioned are:-

- The open pit mine;
- ROM pad and crushing plant;
- Waste rock dump;
- Heavy Media Separation (HMS) Plant;
- Mill and concentrator;
- Tailings dam
- Dikulushi river diversion scheme; and
- Sedimentation pond.

Design of the Dikulushi underground mine has not yet started and therefore associated decommissioning costs cannot be estimated.

The decommissioning cost estimate is based on regional unit costs for mine rehabilitation activities (Zambia Copperbelt) and serves only as a general indication of the final decommissioning cost. The estimated cost of mine decommissioning and closure will be updated throughout the life of the mine as progressive rehabilitation is undertaken and actual costs are incurred. All costs are inclusive of labour charges.

Mine Site Dismantling, Disposal and Clean-up Costs

Mine site dismantling, disposal and clean-up costs are summarised in Table 5.4.

Table 5.4 Mine Site Dismantling and Disposal Costs

Item No.	Description	Qty	Unit	Rate US$	Cost US$
1.	**Crushing Plant, HMS Plant, Mill & Concentrator**				
1a.	Dismantling of plant and removal of machinery, pipes, electrical cables and all equipment.	3	ha.	$18,000	$54,000
1b.	Break out of reinforced concrete foundations to 0.5 metres depth, backfill and re-profile area.	3	ha.	$6,500	$19,500
1c.	Disposal of non-hazardous waste i.e. rubble etc. in open pit.	-	l.s.	$5,000	$5,000
1d.	Clean up or removal and disposal of contaminated soils.	50	m^3	$10	$500
Sub total					**$79,000**
15% contingency					**$11,850**
TOTAL COST					**US$90,850**

Open Pit Decommissioning Costs

Open pit decommissioning costs are summarised in Table 5.5.

Table 5.5 Open Pit Decommissioning Costs

Item No.	Description	Qty	Unit	Rate US$	Cost US$
1.	**Open Pit**				
1a.	Construction of perimeter bund wall to prevent inadvertent access by general public.	3000	m^3	$5	$15,000
1b.	Erection of warning signs.	20	ea.	$50	$1,000
1c.	General site clean-up	-	l.s.	$2,500	$2,500
1d.	Study of possibility of establishing a sustainable aquatic ecosystem in the open pit.	-	l.s.	$10,000	$10,000
Sub total					**$28,500**
15% contingency					**$4,275**
TOTAL COST					**US$32,775**

Dikulushi River Diversion Scheme Decommissioning Cost

Anvil proposes to breach the upstream diversion dam to allow the Dikulushi river to flow into and through the disused open pit. However, this strategy may change following hydrological and geo-hydrological studies to be conducted during the life of the mine. Potential issues are change to river flow and water quality. Retaining the diversion canal will mitigate these potential issues but the diversion dam and canal will require improvement/upgrading and regular post closure inspection and monitoring. A detailed design study will probably be required. Current anticipated Dikulushi River Diversion Scheme decommissioning costs are summarised in Table 5.6.

Table 5.6 Dikulushi River Diversion Scheme Decommissioning costs

Item No.	Description	Qty	Unit	Rate US$	Cost US$
1.	**Dikulushi River Diversion Scheme**				
1a.	Breaching of river diversion dam wall to allow river to flow into the disused open pit.	-	l.s.	$2,000	$2,000
1b.	Re-profiling river channel at dam site	-	l.s.	$3,000	$3,000
Sub total					**$5,000**
15% contingency					**$750**
TOTAL COST					**US$5,750**

Tailings Dam Decommissioning Cost

Tailings dam decommissioning costs are summarised in Table 5.7.

Table 5.7 Tailings Dam Decommissioning Costs

Item No.	Description	Qty	Unit	Rate US$	Cost US$
1.	**Tailings Dam**				
1a.	Re-profiling upper surface of dam to create evaporation paddocks to control drainage & rainfall.	10	ha	$2,000	$20,000
1b.	Sealing decant tower and pipe with mass concrete.	-	l.s.	$1,500	$1,500
1c.	Removal of tailings delivery pipeline and redundant equipment/materials.	-	l.s.	$1,500	$1,500
1d.	Re-vegetation of upper dam wall slopes and upper surface (excluding pool area).	12	ha.	$1,000	$12,000
1e.	Backfilling and re-profiling of return water dam.	-	l.s.	$500	$500
1f.	Maintenance of perimeter drainage.	-	l.s.	$2,500	$2,500
Sub total					**$38,000**
15% contingency					**$5,700**
TOTAL COST					**US$43,700**

Waste Rock Dump & ROM Pad Decommissioning Cost

It is assumed that the waste rock dump is constructed with overall slope angles of 1:3 and post closure erosion of the walls will be minimal. It is also assumed that the ROM pad (transient stockpile) will be completely exhausted before closure.

Waste rock dump and ROM pad decommissioning costs are summarised in Table 5.8.

Table 5.8 Waste Rock & ROM Pad Decommissioning Costs

Item No.	Description	Qty	Unit	Rate US$	Cost US$
1.	**Waste Rock Dump**				
1a.	Re-profiling upper surface of dump to control drainage and prevent erosion.	3	ha.	$2,000	$6,000
1b.	Maintenance of dump perimeter drains.	-	l.s.	$2,500	$2,500
1c.	Re-vegetation of upper surface of dump.	3	ha.	$1,000	$3,000
2.	**ROM Pad**				
1a.	Re-profiling ROM Pad and re-establishing drainage.	1	ha.	$2,000	$2,000
Sub total					**$13,500**
15% contingency					**$2,025**
TOTAL COST					**US15,525**

Pre Closure Retrenchment Training and Counselling

The pre-closure retrenchment training and counselling cost is estimated at US$30,000.

Post Closure Monitoring and Inspection Cost

The estimated annual monitoring and inspection cost (to be conducted by an independent expert) is summarised in Table 5.9.

Table 5.9 Annual Post Closure Monitoring and Inspection Costs

Item No.	Description	Qty	Unit	Rate US$	Cost US$
1.	**Surface & Groundwater Monitoring & Site Walk Over**				
1a.	Site visit by consultant & report writing	20	days	$550	$11,000
1b.	Consultants direct/indirect costs	14	days	$200	$2,800
1c.	Analytical Costs	10	ea.	$60	$600
Sub total					**$14,400**
15% contingency					**$2,160**
TOTAL COST					**US16,560**

Summary of Mine Decommissioning & Closure Costs

Mine decommissioning and closure costs are summarised in Table 5.10

Table 5.10 Summary of Mine Decommissioning & Closure Costs

Item No.	Description	Cost (US$)
1.	Mine Site Dismantling & Disposal Cost	$90,850
2.	Open Pit Decommissioning Cost	$32,775
3.	Dikulushi River Diversion Scheme	$5,750
4.	Tailings Dam Decommissioning Cost	$43,700
5.	Waste Rock Dump & ROM Pad Decommissioning Cost	$15,525
6.	Pre-closure Retrenchment Training & Counselling	$30,000
7.	Post Closure Monitoring & Inspection (2 years)	$33,120
TOTAL COST (incl of 15% contingency)		**US$251,720**

The total Dikulushi mine decommissioning and closure cost estimate is US$251,720 (two hundred and fifty one thousand seven hundred and twenty United States Dollars). This figure includes a 15% contingency.

5 REFERENCES

African Mining Consultants Ltd., Anvil Mining Zambia Limited, *"Dikulushi Project, Environmental Project Brief, Nchelenge Port Facility"*. December 2002.

African Mining Consultants Ltd., Anvil Mining N.L., *"Dikulushi Copper – Silver Deposit, Environmental Scoping Study"*. December 2001.

African Mining Consultants Ltd., Anvil Mining N.L., *"Dikulushi Copper – Silver Deposit – Addendum to Environmental Scoping Study"*. December 2001.

Anvil Mining N.L., *"Dikulushi Copper Project, Project Implementation Plan"*, April 2002.

Anvil Mining N.L., *"Draft Report on the Geology of Dikulushi Deposit"*. As of December 2002.

Anvil Mining N.L., *"Dikulushi Copper – Silver Deposit, Katanga Province, Democratic Republic of Congo, 1997 Programme of Work: Review of Work Undertaken and Analysis of Results"*. May 1998.

Earthscan Pty Ltd., Anvil Mining N.L. ,*"Geological, Structural & Mineral Alteration Interpretation from Merged Landsat ETM+ 7 & SPOT Panchromatic Satellite Data & Aerial Photography for Dikulushi Project Area, Democratic Republic of Congo"*. 2002.

FAO-ISRIC-ISS, "*World Resource Base for Soil Resources*". 1998.

Knight Piésold Consulting, Anvil Mining, *"Dikulushi Phase I Tailings Dam Design Report"*. February, 2002.

Metallurgical Design and Management Pty Ltd., Anvil Mining, *"Dikulushi HMS Preconcentrator, Drawings 0498-F(01-06)"*. January 2002.

Metallurgical Design and Management Pty Ltd, Anvil Mining N.L., *"Dikulushi Copper Project, Definitive Costing Study"*. September 2001.

N.C. Journet, DevMin Pty Ltd., Anvil Mining N.L., *"Dikulushi Project, Democratic Republic of Congo, Life-of-Mine Open Pit Plan and Investigation to Identify Economic Interface between Open Pit and Underground Mining"*. July 2002.

United States Department of Agriculture, World Soil Resources, "*Distribution of Soil Orders*". 1996.

APPENDIX I - CONTENT OF AN ENVIRONMENTAL ASSESSMENT REPORT FOR A CATEGORY A PROJECT, WORLD BANK OPERATIONAL POLICY 4.01, WORLD BANK HEALTH AND SAFETY GUIDELINES, MINING AND MILLING, POLLUTION PREVENTION AND ABATEMENT HANDBOOK, 1998.

(Note that the Dikulushi Project could possibly be classified as a Category B Project)

OP 4.01 -- Annex B
January 1999

THE WORLD BANK OPERATIONAL MANUAL

Operational Policies

Content of an Environmental Assessment Report for a Category A Project

1. An environmental assessment (EA) report for a Category A project[1] focuses on the significant environmental issues of a project. The report's scope and level of detail should be commensurate with the project's potential impacts. The report submitted to the Bank is prepared in English, French, or Spanish, and the executive summary in English.

2. The EA report should include the following items (not necessarily in the order shown):

(a) *Executive summary.* Concisely discusses significant findings and recommended actions.

(b) *Policy, legal, and administrative framework.* Discusses the policy, legal, and administrative framework within which the EA is carried out. Explains the environmental requirements of any cofinanciers. Identifies relevant international environmental agreements to which the country is a party.

(c) *Project description.* Concisely describes the proposed project and its geographic, ecological, social, and temporal context, including any offsite investments that may be required (e.g., dedicated pipelines, access roads, power plants, water supply, housing, and raw material and product storage facilities). Indicates the need for any resettlement plan or indigenous peoples development plan[2] (see also subpara. (h)(v) below). Normally includes a map showing the project site and the project's area of influence.

(d) *Baseline data.* Assesses the dimensions of the study area and describes relevant physical, biological, and socioeconomic conditions, including any changes anticipated before the project commences. Also takes 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 mitigatory measures. The section indicates the accuracy, reliability, and sources of the data.

(e) *Environmental impacts.* Predicts and assesses 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. Explores opportunities for environmental enhancement. Identifies and estimates the extent and quality of available data, key data gaps, and uncertainties associated with predictions, and specifies topics that do not require further attention.

(f) *Analysis of alternatives.*3 Systematically compares feasible alternatives to the proposed project site, technology, design, and operation—including the "without project" situation—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. For each of the alternatives, quantifies the environmental impacts to the extent possible, and attaches economic values where feasible. States the basis for selecting the particular project design proposed and justifies recommended emission levels and approaches to pollution prevention and abatement.

(g) *Environmental management plan (EMP).* Covers mitigation measures, monitoring, and institutional strengthening; see outline in **OP 4.01, Annex C**.

(h) *Appendixes*

(i) List of EA report preparers—individuals and organizations.

(ii) References—written materials both published and unpublished, used in study preparation.
(iii) Record of interagency and consultation meetings, including consultations for obtaining the informed views of the affected people and local nongovernmental organizations (NGOs). The record specifies any means other than consultations (e.g., surveys) that were used to obtain the views of affected groups and local NGOs.
(iv) Tables presenting the relevant data referred to or summarized in the main text.
(v) List of associated reports (e.g., resettlement plan or indigenous peoples development plan).

---

1. The EA report for a Category A project is normally an environmental impact assessment, with elements of other instruments included as appropriate. Any report for a Category A operation uses the components described in this annex, but Category A sectoral and regional EA require a different perspective and emphasis among the components. The Environment Sector Board can provide detailed guidance on the focus and components of the various EA instruments.
2. See OP/BP 4.12, *Involuntary Resettlement* (forthcoming), and **OD 4.20**, *Indigenous Peoples*.
3. Environmental implications of broad development options for a sector (e.g., alternative ways of meeting projected electric power demand) are best analyzed in least-cost planning or sectoral EA. Environmental implications of broad development options for a region (e.g., alternative strategies for improving standards of living an a rural area) are best addressed through a regional development plan or a regional EA. EIA is normally best suited to the analysis of alternatives within a given project concept (e.g., a geothermal power plant, or a project aimed at meeting local energy demand), including detailed site, technology, design, and operational alternatives.

World Bank Health and Safety Guidelines

Mining and Milling – Open Pit

Pollution Prevention and Abatement Handbook 1998

Guideline Limits for Ambient Air Pollutants

Parameter	Reference Time	Guideline Limit
Particulate Matter (<10um)	Annual Arithmetic Mean	100 g/m3
	Maximum 24 - hour average	500 ug/m3
Nitrogen Oxides, as NO2	Annual Arithmetic Mean	100 g/m3
	Maximum 24 - hour average	200 ug/m3
Sulphur Dioxide	Annual Arithmetic Mean	100 g/m3
	Maximum 24 - hour average	500 ug/m3

1) Respirable particles (PM $_{10}$) are particles with a diameter less than 10 micrometers (µm). These can penetrate the ancilliated regions of the deep lung.

Work Place Air Quality Guidelines

Parameter	Threshold Limit Values Mg/m^3
Arsenic	0.5
Carbon Monoxide	29
Copper	1
Free Silica	5.0
Hydrogen Cyanide	11
Hydrogen Sulphide	14
Lead, Dust & Fumes as Pb	0.15
Nitrogen Dioxide	6
Particulate (Inert or Nuisance Dusts)	10
Sulphur Dioxide	5

1) Employees must use protective respiratory equipment when exposure exceeds the above Threshold Limit Value.

World Bank Health and Safety Guidelines

Mining and Milling – Open Pit

Pollution Prevention and Abatement Handbook 1998

Table of Guideline Limits for Effluent Discharge into Receiving Waters

Parameter	Effluent and Waste Water into Aquatic Environment
pH	6 to 9
BOD	50 mg/l
Oil and Grease	20 mg/l
Total Suspended Solids	50 mg/l
Temperature - at the edge of a designated mixing zone	Max 5C above Ambient Tem[perature of Receiving waters - max 3C if receiving waters > 28C
Arsenic	1.0 mg/l
Cadmium	0.1 mg/l
Chromium, Hexavalent	0.05 mg/l
Chromium, Total	1.0 mg/l
Copper	0.3 mg/l
Iron, Total	2.0 mg/l
Lead	0.6 mg/l
Mercury	0.002 mg/l
Nickel	0.5 mg/l
Zinc	1.0 mg/l
Cyanide (Free)	0.1 mg/l
Cyanide (Total)	1.0 mg/l
Ammonia	10 mg/l
Fluoride	20 mg/l
Chlorine, total residual	0.2 mg/l
Phenols	0.5 mg/l
Phosphorus	2.0 mg/l
Sulfide	1.0 mg/l
Coliform Bacteria	< 400MPN/100ml

NOISE

Personnel must use hearing protection when exposed to noise levels exceeding 85 dBA.

WHO Drinking Water Quality Standards

Parameter	**Concentration**
Asbestos	7 million fibres/l
Alkalinity (CaCO3)	500mg/l
ammonia	0.5mg/l
Aluminium	0.05-0.2mg/l
Arsenic	0.05mg/l
Bacteria faecal coliform count	0/100ml (NIL)
Barium	1mg/l
Boron	5mg/l
Cadmium	0.005mg/l
Calcium	200mg/l
Caesium	50Bq/l
Chloride	250mg/l
Chromium	0.05mg/l
Colour	15TCU
Copper	1mg/l
Cyanide	0.2mg/l
Conductivity	1500µS/cm
Chlorine	50mg/l
Cobalt	1mg/l
Carbon Dioxide	N/A
Carbon Monoxide	1mg/l
Dissolved Oxygen	10-12mg/l
Fluoride (Fluorine)	1.5mg/l
Hardness (CaCO3)	120mg/l
Iodine	10Bq/l
Iron	0.3-1mg/l
Lead	0.05mg/l
Magnesium	150mg/l
Manganese	0.05mg/l
Mercury	1µg/l
Nitrate	10/mg/l
Nitrite	1mg/l
Oil and Grease	ND
pH	6.5-8.5
Phenol	0.02mg/l
Phosphates	0.4-5mg/l
Alpha-Radiation	0.02Bq/l
Beta-Radiation	0.19Bq/l
Selenium	0.01mg/l
Silver	0.05mg/l
Sodium	270mg/l
Strontium	10mg/l
Silica	N/A
Sulphate	500mg/l
Sulphide (H2S)	0.05mg/l
Total Dissolved Solids	500mg/l

APPENDIX II - ENVIRONMENTAL BASELINE STUDY, SURFACE WATER, GROUND WATER AND STREAM SEDIMENT SAMPLING PROTOCOL

Surface Water and Groundwater Sampling Protocol

New 500ml plastic, lock-cap fitting bottles were used for the storage of all water samples. Sample bottles were used once only to avoid cross contamination. All sample bottles were filled to the top leaving no air space.

Two x 500ml water samples were taken for physical, chemical, bacteriological and total metal analysis. These samples were immediately placed in a cool box packed with ice and maintained at a temperature of between 2 and 6 °C.

Water samples for dissolved metal analysis were filtered directly from the stream or bore hole into a 500ml sample bottle. A peristaltic pump and 45 micron sealed in-line geo-filter was used for this purpose. The first 50ml of sample water was discarded. Each 500ml filtered sample was preserved with 20 drops of Nitric Acid (HNO_3). Thus sample pH was reduced to <2 to prevent the precipitation of metals contained in solution. Filtered samples were also immediately placed in a cool box. The rubber tubing used with the pump was decontaminated after filtering by pumping distilled water through the tube in both directions.

Sampling bottles were clearly labelled using indelible ink. The labelling format was *DIK*/SW/01-NF or F or *DIK*/GW/01 – NF or F and date. *DIK* identifies the project, SW indicates sample type (Surface water), GW indicates Ground water and 01 denotes location. F denotes a filtered sample and NF denotes a non-filtered sample.

Samples are stored in the field in a cool box filled with ice and later transferred to a refrigerator awaiting transport to A H Knight Analytical Services in Kalulushi. Samples were delivered to the laboratory in a cool box with ice and Head Chemist Mr Junuis Hamadudu took delivery and signed the chain of custody form.

The Alfred H Knight laboratory is BSI 9002 accredited and has undertaken similar analyses for large-scale mining companies including Noranda Inc, Phelps Dodge Corporation and Anglovaal Mining Limited.

The quality assurance / quality control (QA/QC) procedure adopted was to carry out duplicate analyses on 10 % of the surface water and groundwater samples and to carry out additional checks using standard reference materials and spiked samples.

Stream Sediment Sampling Protocol

Sediment sampling is done in the middle of small streams or 2 metres from the shoreline in wider streams and rivers. The sampling tool consists of a stainless steel spade. The spade is decontaminated with distilled water and finally stream water before each sediment sample is taken. The sampler equipped with spade wades into the stream taking care to stand downstream of the sampling point to avoid disturbance of the stream sediment. The spade is carefully lowered into the water and pushed in to the sediment to a depth of approximately 150 mm. The spade containing the sample is slowly brought back to the surface and poured into zip-lock bags. The following sediment sample conditions must be met before the sediment sample is accepted:-

- Overlying water is present indicating minimal leakage;
- The overlying water is not excessively turbid indicating minimal sample disturbance;
- The surface of the sediment should appear relatively undisturbed, indicating a lack of channelling or sample wash-out; and
- The desired penetration depth was achieved.

The sample bags are labelled with indelible ink. The labelling format was *DIK*M/SED-01 and date. DIK indicates the project area, SED indicates sample type and 01 denotes sample location.

Samples are stored in the field in a cool box filled with ice and later transferred to a refrigerator awaiting transport to A H Knight Analytical Services in Kalulushi. Samples were delivered to the laboratory in a cool box with ice and Head Chemist Mr Junuis Hamadudu took delivery and signed the chain of custody form.

The Alfred H Knight laboratory is BSI 9002 accredited and has undertaken similar analyses for large-scale mining companies including Noranda Inc, Phelps Dodge Corporation and Anglovaal Mining Limited.

The quality assurance / quality control (QA/QC) procedure adopted was to carry out duplicate analyses on 10 % of the sediment samples and to carry out additional checks using standard reference materials and spiked samples.

APPENDIX III - ENVIRONMENTAL BASELINE STUDY (November 2002), SURFACE WATER, GROUND WATER, SEDIMENT AND SOIL QUALITY RESULTS

Surface and Ground Water Quality – Field Results

Surface Water Quality and Stream Flow Rate - Field Measurements

Sampling Point	Date	***Parameters*** PH	Conductivity (μS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/l)	Temp. (°C)	Salinity (%)	Stream flow rate l/s	*Comments*
DIK/SW/01	28/11/02	7.4	46	0	2.0	20.2	0.00	<0.5	10:45hrs. Weather- warm, cloudy, rain previous night up to 8am this morning. Water – clear, low flow, pooling and stagnant. Sediment- black/grey, high in organic matter, little amount of debris. Vegetation- dense cover over stream, garden nearby (N fertiliser used in last 5 days) Fauna – some small aquatic insects observed (skimmers)
DIK/SW/02	28/11/02	6.9	270	10	4.5	20.6	0.01	<0.5	10:00hrs Weather- warm cloudy, rain last night up to 8 am. Water – murky/cloudy/grey, very low flow, stagnant pooling. Sediment- Black high in organic matter and debris. Vegetation – Extremely dense untouched riparian zone with dense over cover. Fauna –macrophytes observed in the stream as well as small surface water insects.

Surface Water Quality (Lake Water) - Field Measurements

Sampling Point	Date	***Parameters***						*Comments*
		PH	Conductivity (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/l)	Temp. (°C)	Salinity (%)	
Kil/SW/03	29/11/02	8.5	47	2	8.20	28.6	0	12:15hrs Weather hot and sunny, intermittent showers within the last 24hrs gentle breeze. Lake is calm Water slightly tainted brown, some foam on surface, slight fishy odour. Rocky sediment. Sample taken within 2m of port facility, fishing activities taking place within 30m of sample, barge left yesterday
Nch/SW/04	30/11/02	7.2	52	1	8.2	25.4	0	08:00hrs Weather – warm and clear no rain within last 24hrs, calm inland breeze, Water tainted green, with high presence of algae. Two barges currently harboured at the port, people washing clothes and selling fish nearby, Cement rings are curing in the water

Groundwater Quality - Field Measurements

Sampling Point	Date	***Parameters***						*Comments*
		pH	Conductivity (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/l)	Temp. (°C)	Salinity (%)	
DIK/GW/01	28/11/02	6.99	456	0	1.56	23.2	0.01	08:20hrs Weather- Cloudy overcast, rain/showers just stopped, rain all night. Water- clear (pumped from borehole and used as drinking water)
DIK/GW/02	28/11/02	6.81	534	0	6.33	24.3	0.02	09:10 hrs weather – cloudy cool, rain stopped 1hr ago after ran during the night. Water clear (pumped from borehole near the pit, used for drinking)
DIK/GW/03	29/11/02	6.5	80	0	7.0	27.3	0	10:15hrs – Hot clear morning, intermittent rain showers in last 24hrs. Hand pumped well, in Dikulushi village in good condition.

Surface and Ground Water Quality – Analysis Results

Surface Water Quality - Physical, Chemical & Bacteriological Analysis

Sampling Point	Sample No.	Sampling Date	*Physical, Chemical & Bacteriological Parameters*														
			pH	Cond. µS/cm	TDS mg/l	TSS mg/l	SO_4^{2-} mg/l	F^- mg/l	Cl^- mg/l	NO_3 mg/l	PO_4^{3-} mg/l	CN^- mg/l	Turbidity NTU	Colour Hazen (units)	Total Coliform (100 ml)	Faecal Coliform (100 ml)	Total Organic Content mg/l
SW-01	DIK/SW/01	28/11/02	7.9	680	505	55	65	0.2	8	<0.1	<0.1	<0.1	7	<5	Nil	Nil	-
SW-02	DIK/SW/02	28/11/02	7.4	384	335	40	50	0.2	8	<0.1	<0.1	<0.1	32	<5	Nil	Nil	-
SW-03	KIL/SW/03	29/11/02	8.1	98	87	35	10	<0.1	6	<0.1	<0.1	<0.1	8	<5	6	Nil	<10
SW-04	NCH/SW/04	30/11/02	7.6	92	76	45	45	<0.1	8	<0.1	<0.1	<0.1	8	<5	Nil	Nil	<10

Surface Water Quality - Total Metal Analysis

Sampling Point	Sample No.	*Sampling Date*	*Total Metals* TOC mg/l	T.Al mg/l	T.As mg/l	T.B mg/l	T.Ba mg/l	T.Be mg/l	T.Ca mg/l	T.Cd mg/l	T.Cr mg/l	T.Cu mg/l	T.Fe mg/l
SW-01	DIK/SW/01-NF	28/11/02	-	<0.1	<0.01	<0.1	<0.1	<0.1	80	<0.01	<0.1	<0.1	<0.1
SW-02	DIK/SW/02-NF	28/11/02	-	<0.1	<0.01	<0.1	<0.1	<0.1	42	<0.01	<0.1	0.5	0.2
SW-03	KIL/SW/03-NF	29/11/02	<10	2	<0.01	<0.1	<0.1	<0.1	7	<0.01	<0.1	<0.1	<0.1
SW-04	NCH/SW/04-NF	30/11/02	<10	<0.1	<0.01	<0.1	<0.1	<0.1	8	<0.01	<0.1	<0.1	<0.1

NF denotes non-filtered water sample

Surface Water Quality - Total Metal Analysis (cont.)

Sampling Point	Sample No.	*Sampling Date*	*Total Metals* T.Hg mg/l	T.Mg mg/l	T.Mn mg/l	T.Mo mg/l	T.Ni mg/l	T.Pb mg/l	T.Se mg/l	T.V mg/l	T.Zn mg/l
SW-01	DIK/SW/01-NF	28/11/02	<0.001	38	0.1	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1
SW-02	DIK/SW/02-NF	28/11/02	<0.001	21	<0.1	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1
SW-03	KIL/SW/03-NF	29/11/02	<0.001	4	<0.1	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1
SW-04	NCH/SW/04-NF	30/11/02	<0.001	5	<0.1	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1

NF denotes non-filtered water sample

Surface Water Quality - Dissolved Metal Analysis

Sampling Point	Sample No.	*Sampling Date*	*Dissolved Metals* D.Al mg/l	D.As mg/l	D.B mg/l	D.Ba mg/l	D.Be mg/l	D.Ca mg/l	D.Cd mg/l	D.Cr mg/l	D.Cu mg/l	D.Fe mg/l
SW-01	DIK/SW/01-F	28/11/02	<0.1	<0.01	<0.1	<0.01	<0.1	50	<0.01	<0.1	<0.1	<0.1
SW-02	DIK/SW/02-F	28/11/02	<0.1	<0.01	<0.1	<0.01	<0.1	17	<0.01	<0.1	0.5	0.2
SW-03	KIL/SW/03-F	29/11/02	<0.1	<0.01	<0.1	<0.01	<0.1	4	<0.01	<0.1	<0.1	<0.1
SW-04	NCH/SW/04-F	30/11/02	<0.1	<0.01	<0.1	<0.01	<0.1	4	<0.01	<0.1	<0.1	<0.1

F denotes filtered water sample

Surface Water Quality - Dissolved Metal Analysis (cont.)

Sampling Point	Sample No.	*Sampling Date*	*Dissolved Metals* D.Hg mg/l	D.Mg mg/l	D.Mn mg/l	D.Mo mg/l	D.Ni mg/l	D.Pb mg/l	D.Se mg/l	D.V mg/l	D.Zn mg/l
SW-01	DIK/SW/01-F	28/11/02	<0.001	38	0.1	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1
SW-02	DIK/SW/02-F	28/11/02	<0.001	19	<0.1	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1
SW-03	KIL/SW/03-F	29/11/02	<0.001	4	<0.1	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1
SW-04	NCH/SW/04-F	30/11/02	<0.001	4	<0.1	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1

F denotes filtered water sample

Ground Water Quality - Physical, Chemical & Bacteriological Analysis

Sampling Point	Sample No.	Sampling Date	*Physical, Chemical & Bacteriological Parameters*													
			pH	**Cond.** µS/cm	TDS mg/l	TSS mg/l	SO_4^{2-} mg/l	F^- mg/l	Cl^- mg/l	NO_3 mg/l	PO_4^{3-} mg/l	CN^- mg/l	Turbidity NTU	Colour Hazen (units)	Total Coliform (100 ml)	Faecal Coliform (100 ml)
GW-01	DIK/GW/01	28/11/02	6.9	724	470	10	10	<0.1	4	<0.1	<0.1	<0.1	2	<5	Nil	Nil
GW-02	DIK/GW/02	28/11/02	7.1	862	535	20	45	<0.1	5	<0.1	<0.1	<0.1	2	<5	Nil	Nil
GW-03	DIK/GW/03	29/11/02	7.1	153	103	20	65	<0.1	9	<0.1	<0.1	<0.1	3	<5	Nil	Nil

Ground Water Quality - Total Metal Analysis

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*									
			T.Al mg/l	T.As mg/l	T.B mg/l	T.Ba mg/l	T.Be mg/l	T.Ca mg/l	T.Cd mg/l	T.Cr mg/l	T.Cu mg/l	T.Fe mg/l
GW-01	DIK/GW/01	28/11/02	<0.1	<0.01	<0.1	<0.1	<0.1	120	<0.01	<0.1	<0.1	<0.1
GW-02	DIK/GW/02	28/11/02	0.1	<0.01	<0.1	<0.1	<0.1	60	<0.01	<0.1	<0.1	<0.1
GW-03	DIK/GW/03	29/11/02	<0.1	<0.01	<0.1	<0.1	<0.1	7	<0.01	<0.1	<0.1	<0.1

NF denotes non-filtered water sample

Ground Water Quality - Total Metal Analysis (cont)

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*								
			T.Hg mg/l	T.Mg mg/l	T.Mn mg/l	T.Mo mg/l	T.Ni mg/l	T.Pb mg/l	T.Se mg/l	T.V mg/l	T.Zn mg/l
GW-01	DIK/GW/01	28/11/02	<0.001	8	<0.1	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1
GW-02	DIK/GW/02	28/11/02	<0.001	45	<0.1	<0.1	<0.1	<0.1	<0.01	<0.1	0.1
GW-03	DIK/GW/03	29/11/02	<0.001	5	<0.1	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1

NF denotes non-filtered water sample

Ground Water Quality - Dissolved Metal Analysis

Sampling Point	Sample No.	*Sampling Date*	*Dissolved Metals*									
			D.Al mg/l	D.As mg/l	D.B mg/l	D.Ba mg/l	D.Be mg/l	D.Ca mg/l	D.Cd mg/l	D.Cr mg/l	D.Cu mg/l	D.Fe mg/l
GW-01	DIK/GW/01	28/11/02	<0.1	<0.01	<0.1	<0.1	<0.1	90	<0.01	<0.1	<0.1	<0.1
GW-02	DIK/GW/02	28/11/02	0.1	<0.01	<0.1	<0.1	<0.1	57	<0.01	<0.1	<0.1	<0.1
GW-03	DIKL/GW/03	29/11/02	<0.1	<0.01	<0.1	<0.1	<0.1	6	<0.01	<0.1	<0.1	<0.1

F denotes filtered water sample

Ground Water Quality - Dissolved Metal Analysis (cont.)

Sampling Point	Sample No.	*Sampling Date*	*Dissolved Metals* D.Hg mg/l	D.Mg mg/l	D.Mn mg/l	D.Mo mg/l	D.Ni mg/l	D.Pb mg/l	D.Se mg/l	D.V mg/l	D.Zn mg/l
GW-01	DIK/GW/01	28/11/02	<0.001	8	<0.1	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1
GW-02	DIK/GW/02	28/11/02	<0.001	44	<0.1	<0.1	<0.1	<0.1	<0.01	<0.1	0.1
GW-03	DIK/GW/03	29/11/02	<0.001	4	<0.1	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1

Surface Water Sediment Quality

Surface Water Sediment Quality - Total Metal Analysis

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*				
			Hg µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Ni µg/g
SS-01	DIK/SS/01	28/11/02	<1	3400	89	<10	<10
SS-02	DIK/SS/02	28/11/02	<1	896	60	<10	<10

Surface Water Sediment Quality - Total Metal Analysis (con)

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*													
			Al µg/g	As µg/g	B µg/g	Ba µg/g	Be µg/g	Ca µg/g	Cd µg/g	Cr µg/g	Cu µg/g	Fe µg/g	Se µg/g	Zn µg/g	V µg/g	Pb µg/g
SS-01	DIK/SS/01	28/11/02	2800	<1	<10	<10	<10	7300	<1	46	22	6800	<1	<10	<10	12
SS-02	DIK/SS/02	28/11/02	1600	<1	<10	<10	<10	996	<1	57	149	4000	<1	20	<10	<10

Soil Quality – Analysis Results

~~**Soil Quality Total Metal Analysis**~~

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*										
			Al µg/g	As µg/g	B µg/g	Ba µg/g	Be µg/g	Ca µg/g	Cd µg/g	Cr µg/g	Cu µg/g	Fe µg/g	Se µg/g
SOS -01	DIK/SOS-10 (0-10cm)	29/11/02	3100	<1	<10	<10	<10	1600	<1	24	18	3200	<1
SOS -02	DIK/SOS-11 (0 – 10cm)	29/11/02	2300	<1	<10	<10	<10	299	<1	15	10	5500	<1
SOS- 03	DIK/SOS-12 (0-10cm)	29/11/02	2800	<1	<10	<10	<10	2500	<1	17	20	7100	<1
SOS -04	DIK/SOS-13 (0 – 10cm)	29/11/02	2200	<1	<10	<10	<10	199	<1	25	16	3700	<1
SOS- 05	DIK/SOS-14 (0-10cm)	29/11/02	3300	<1	<10	<10	<10	1900	<1	30	48	3500	<1
SOS- 06	DIK/SOS-15 (0 – 10cm)	29/11/02	2900	<1	<10	<10	<10	797	<1	30	10	3300	<1
SOS-07	DIK/SOS-15 (0 – 10cm)	29/11/02	3700	<1	<10	<10	<10	595	<1	30	18	5200	<1

Soil Quality - Total Metal Analysis Continued

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*								
			Hg µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Ni µg/g	Hg µg/g	Zn µg/g	V µg/g	Pb µg/g
SOS-10	DIK/SOS-10 (0-10cm)	29/11/02	<1	499	90	<10	<10	<1	<10	<10	12
SOS-11	DIK/SOS-11 (0 – 10cm)	29/11/02	<1	797	249	<10	<10	<1	<10	<10	12
SOS-12	DIK/SOS-12 (0-10cm)	29/11/02	<1	998	289	<10	<10	<1	<10	<10	10
SOS-13	DIK/SOS-13 (0 – 10cm)	29/11/02	<1	397	199	<10	<10	<1	<10	<10	<10
SOS-14	DIK/SOS-14 (0-10cm)	29/11/02	<1	398	189	<10	<10	<1	<10	<10	15
SOS-15	DIK/SOS-15 (0 – 10cm)	29/11/02	<1	299	100	<10	<10	<1	<10	<10	<10
SOS-16	DIK/SOS-15 (0 – 10cm)	29/11/02	<1	893	228	<10	<10	<1	<10	<10	<10

APPENDIX IV - ENVIRONMENTAL SCOPING STUDY (December 2001), SURFACE WATER, GROUND WATER, SEDIMENT AND SOIL QUALITY RESULTS

Surface and Ground Water Quality – Field Results

Surface Water Quality and Stream Flow Rate –Field Measurements

Sampling Point	Description	Date	***Parameters***						***Stream*** flow rate l/s	*Comments*
			PH	Conductivity (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/l)	Temp. (°C)	Salinity (%)		
DIK/SW/01	Dikulushi R	24/10/01	6.7	59	8	3.4	21.9	0	-	No surface flow, tainted brown water
DIK/SW/02	Dikulushi R	24/10/01	7.0	59	80	1.4	23.1	0	-	No surface flow, tainted brown water
Nch/SW/01	Nchelenge Lake Mweru	05/12/01	5.9	54	9	8.1	26.4	0	-	Sample taken 5m out from shoreline at proposed port site in Nchelenge

Groundwater Quality - Field Measurements

Sampling Point	Date	***Parameters***						*Comments*
		pH	Conductivity (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/l)	Temp. (°C)	Salinity (%)	
DIK/GW/01	24/10/01	6.5	31	76	1.9	23.8	0	Old Drill hole close to exploration Camp Water Table at 4.7m. Rusty water

Surface and Ground Water Quality – Analysis Results

Surface Water Quality - Physical, Chemical and Bacteriological Analysis, Environmental Scoping Study Results (October 2001)

Sampling Point	Sample No.	Sampling Date	***Physical, Chemical & Bacteriological Parameters***													
			pH	**Cond.** mS/cm	TDS mg/l	TSS mg/l	SO_4^{2-} mg/l	F^- mg/l	Cl^- mg/l	NO_3 mg/l	PO_4^{3-} mg/l	CN^- mg/l	Ca mg/l	Colour Hazen (units)	Total Coliform (100 ml)	Faecal Coliform (100 ml)
SW-01	DIK/SW-01-NF	24/10/01	7.6	82	505	10	40	0.2	3	2	8	<0.1	86	<5	1800	26
SW-02	DIK/SW-02-NF	24/10/01	7.9	83	510	50	5	<0.2	6	126	8	<0.1	78	<5	1800	292
SW-03	Nch/SW-01-NF	05/12/01	7.1	80	50	20	50	<0.2	15	5	9	<0.1	6	<5	1400	860

Surface Water Quality - Total Metal Analysis

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*									
			T.Al mg/l	T.As mg/l	T.B mg/l	T.Ba mg/l	T.Be mg/l	T.Cd mg/l	T.Co mg/l	T.Cr mg/l	T.Cu mg/l	T.Fe mg/l
SW-01	DIK/SW-01-NF	24/10/01	0.1	0.1	<5	0.6	<0.1	<0.01	<0.1	1.8	<0.1	0.2
SW-02	DIK/SW-02-NF	24/10/01	1.4	0.06	<5	0.7	<0.1	<0.01	<0.1	<0.1	<0.1	1.2
SW-03	Nch/Sw-01-NF	05/12/01	<0.1	<0.01	<5	<0.1	<0.1	<0.01	<0.1	0.1	<0.1	0.1

NF denotes non-filtered water sample.

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*									
			T.Hg mg/l	T.Mg mg/l	T.Mn mg/l	T.Mo mg/l	T.Ni mg/l	T.Pb mg/l	T.Se mg/l	T.V mg/l	T.Zn mg/l	T.U mg/l
SW-01	DIK/SW-01-NF	24/10/01	<0.001	58	0.3	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	-
SW-02	DIK/SW-02-NF	24/10/01	<0.001	62	0.8	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	-
SW-03	Nch/SW-01-NF	05/12/01	<0.001	4	<0.1	<0.1	<0.1	<0.01	<0.01	<0.1	<0.1	<0.1

NF denotes non-filtered water sample

Surface Water Quality - Dissolved Metal Analysis

Sampling Point	Sample No.	*Sampling Date*	*Dissolved Metals* D.Al mg/l	D.As mg/l	D.B mg/l	D.Ba mg/l	D.Be mg/l	D.Cd mg/l	D.Co mg/l	D.Cr mg/l	D.Cu mg/l	D.Fe mg/l
SW-01	DIK/SW-01-F	24/10/01	<0.1	0.01	<5	0.4	<0.1	<0.01	<0.1	0.5	<0.1	<0.1
SW-02	DIK/SW-02-F	24/10/01	0.1	0.06	<5	0.5	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1
SW-03	Nch/SW-01-NF	05/12/01	<0.1	<0.01	<5	<0.1	<0.1	<0.01	<0.1	<0.1	<0.1	0.1

F denotes filtered water sample

Sampling Point	Sample No.	*Sampling Date*	*Dissolved Metals* D.Hg mg/l	D.Mg mg/l	D.Mn mg/l	D.Mo mg/l	D.Ni mg/l	D.Pb mg/l	D.Se mg/l	D.V mg/l	D.Zn mg/l	D.U mg/l
SW-01	DIK/SW-01-F	24/10/01	<0.001	58	0.3	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	-
SW-02	DIK/SW-02-F	24/10/01	<0.001	62	0.8	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	-
SW-03	Nch/SW-01-NF	05/12/01	<0.001	4	<0.1	<0.1	<0.1	<0.01	0.01	<0.1	<0.1	<0.1

F denotes filtered water sample

Ground Water Quality - Physical, Chemical & Bacteriological Analysis

Sampling Point	Sample No.	Sampling Date	***Physical, Chemical & Bacteriological Parameters***													
			pH	**Cond.** mS/cm	TDS mg/l	TSS mg/l	SO_4^{2-} mg/l	F^- mg/l	Cl^- mg/l	NO_3 mg/l	PO_4^{3-} mg/l	CN^- mg/l	Ca mg/l	Colour Hazen (units)	Total Coliform (100 ml)	Faecal Coliform (100 ml)
GW-O1	DIK/GW –01-NF	24/10/01	7.7	44	220	50	<5	<0.2	9	7	3	<0.1	49	<5	-	-

NF denotes non-filtered water sample

Surface Water Quality - Total Metal Analysis

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*									
			T.Al mg/l	T.As mg/l	T.B mg/l	T.Ba mg/l	T.Be mg/l	T.Cd mg/l	T.Co mg/l	T.Cr mg/l	T.Cu mg/l	T.Fe mg/l
GW-O1	DIK/GW –01-NF	24/10/01	0.6	0.12	<5	2	<0.1	<0.01	<0.1	0.3	0.1	17

NF denotes non-filtered water sample

Surface Water Quality - Total Metal Analysis continued

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*									
			T.Hg mg/l	T.Mg mg/l	T.Mn mg/l	T.Mo mg/l	T.Ni mg/l	T.Pb mg/l	T.Se mg/l	T.V mg/l	T.Zn mg/l	T.U mg/l
GW-O1	DIK/GW –01-NF	24/10/01	<0.001	8	0.4	<0.1	,0.1	<0.1	<0.01	<0.1	0.1	-

NF denotes non-filtered water sample

Surface Water Quality - Dissolved Metal Analysis

Sampling Point	Sample No.	*Sampling Date*	*Dissolved Metals*									
			D.Al mg/l	D.As mg/l	D.B mg/l	D.Ba mg/l	D.Be mg/l	D.Cd mg/l	D.Co mg/l	D.Cr mg/l	D.Cu mg/l	D.Fe mg/l
GW-O1	DIK/GW –01-F	24/10/01	<0.1	0.12	<5	0.3	<0.1	<0.01	<0.1	0.3	<0.01	0.4

F denotes filtered water sample

Surface Water Quality - Dissolved Metal Analysis continued

Sampling Point	Sample No.	*Sampling Date*	*Dissolved Metals*									
			D.Hg mg/l	D.Mg mg/l	D.Mn mg/l	D.Mo mg/l	D.Ni mg/l	D.Pb mg/l	D.Se mg/l	D.V mg/l	D.Zn mg/l	D.U mg/l
GW-O1	DIK/GW –01-F	24/10/01	<0.001	8	0.3	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	-

F denotes filtered water sample

Surface Water Sediment Quality

Sediment Quality - Total Metal Analysis

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*									
			Al µg/g	As µg/g	B µg/g	Ba µg/g	Be µg/g	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe µg/g
SS-01	DIK/SS-01	24/10/01	800	6	<5	200	<1	<1	<1	17	9	1200
SS-02	DIK/SS-02	24/10/01	2500	2	<5	200	<1	<1	1	51	30	4300

NF denotes non-filtered water sample

Sediment Quality - Total Metal Analysis (con)

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*									
			Hg µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Ni µg/g	Pb µg/g	Se µg/g	V µg/g	Zn µg/g	U µg/g
SS-01	DIK/SS-01	24/10/01	5	900	20	10	<1	<1	2	<1	4	-
SS-02	DIK/SS-02	24/10/01	2	1500	146	8	5	<1	3	<1	14	-

NF denotes non-filtered water sample

Sediment Pore Water Quality - Dissolved Metal Analysis

			Dissolved Metals									
Sampling Point	Sample No.	*Sampling Date*	D.Al µg/g	D.As µg/g	D.B µg/g	D.Ba µg/g	D.Be µg/g	D.Cd µg/g	D.Co µg/g	D.Cr µg/g	D.Cu µg/g	D.Fe µg/g
SS-01	DIK/SS-01	24/10/01	4	<0.01	<5	0.3	<0.1	<0.01	0.5	<0.1	0.8	1.4
SS-02	DIK/SS-02-F	24/10/01	1.5	0.02	<5	0.4	<0.1	<0.01	0.1	0.1	0.2	0.3

F denotes filtered water sample

Surface Water Quality - Dissolved Metal Analysis (con)

			Dissolved Metals									
Sampling Point	Sample No.	*Sampling Date*	D.Hg µg/g	D.Mg µg/g	D.Mn µg/g	D.Mo µg/g	D.Ni µg/g	D.Pb µg/g	D.Se µg/g	D.V µg/g	D.Zn µg/g	D.U µg/g
SS-01	DIK/SS-01	24/10/01	<0.001	49	0.3	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	-
SS-02	DIK/SS-02	24/10/01	<0.001	46	0.5	<0.1	<0.1	<0.1	<0.01	<0.1	<0.1	-

F denotes filtered water sample

Soil Quality – Analysis Results

Soil quality - Total Metal Analysis

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*									
			Al µg/g	As µg/g	B µg/g	Ba µg/g	Be µg/g	Cd µg/g	Co µg/g	Cr µg/g	Cu µg/g	Fe µg/g
SOS-01	DIK/SOS-01 (0-10cm)	24/10/01	2500	4	<5	200	5800	<1	2	<1	74	2400
SOS-01	DIK/SOS-01 (15 – 30cm)	24/10/01	3400	<1	<5	200	1600	<1	1	88	1400	2900
SOS-03	DIK/SOS-03 (0-10cm)	24/10/01	4500	4	<5	200	1900	<1	10	59	1100	5400
SOS-03	DIK/SOS-03 (15 – 30cm)	24/10/01	4900	<1	<5	400	600	<1	<1	<1	900	4400
SOS-04	DIK/SOS-04 (0-10cm)	24/10/01	3000	4	<5	200	6000	<1	3	61	200	4000
SOS-04	DIK/SOS-04 (15 – 30cm)	24/10/01	3600	2	<5	400	1800	<1	8	8	200	4900
SP-01	Nch/SOS-01(0-15cm)	05/12/01	489	<1	46	21	<1	<1	<1	4	10	628
SP-02	Nch/SOS-01(0-15cm)	05/12/01	806	<1	44	31	<1	<1	<1	<1	10	1230
SP-03	Nch/SOS-01(0-15cm)	05/12/01	561	<1	44	33	<1	<1	<1	3	9	1784

Soil quality - Total Metal Analysis (con)

Sampling Point	Sample No.	*Sampling Date*	*Total Metals*									
			Hg µg/g	Mg µg/g	Mn µg/g	Mo µg/g	Ni µg/g	Pb µg/g	Se µg/g	V µg/g	Zn µg/g	Ca µg/g
SOS-01	DIK/SOS-01 (0-10cm)	24/10/01	6	1800	107	11	3	14	3	<1	15	5800
SOS-01	DIK/SOS-01 (15 – 30cm)	24/10/01	1	1500	36	11	2	7	10	<1	10	1600
SOS-03	DIK/SOS-03 (0-10cm)	24/10/01	<1	2000	114	11	5	11	3	<1	32	1900
SOS-03	DIK/SOS-03 (15 – 30cm)	24/10/01	<1	1300	31	10	3	11	1	<1	23	600
SOS-04	DIK/SOS-04 (0-10cm)	24/10/01	2	2000	177	11	6	4	10	<1	16	6000
SOS-04	DIK/SOS-04 (15 – 30cm)	24/10/01	4	2000	180	10	7	4	6	<1	16	1800
SP-01	Nch/SOS-01(0-15cm)	05/12/01	<1	106	11	<2	<1	<1	<1	<1	1	5200
SP-02	Nch/SOS-01(0-15cm)	05/12/01	<1	79	85	<2	<1	4	<1	<1	16	1500
SP-03	Nch/SOS-01(0-15cm)	05/12/01	<1	31	32	<2	<1	<1	<1	<1	4	679

APPENDIX V - FLORA AND FAUNA SPECIES LISTS, FREQUENCY DISTRIBUTIONS OF TREE SPECIES, RAINFALL DATA and USEPA BIO – ASSESSMENT PROTOCOLS

GENERAL FLORAL SPECIES LIST FOR THE AREA

Woody species		
Acacia nigrescens	o-lf	
Acacia polycantha	f-lc	
Acacia sieberana	lf	
Annona senegalensis		lf
Albizia adianthifolia		
lc		
Albizia versicolor	lc	
Azanza gackeana	lf	
Boehmeria platyphylla	lf	
Borreria sp		
lo		
Boscia angustifolia		lf
Brachystegia bussei		c
Brachystegia floribunda	lc	
Brachystegia longifolia	lf	
Brachystegia spiciformis	lc	
Brachystegia taxifolia		f-
lc		
Bridelia macrantha		
o-lf		
Byrsocarpus orientalis	o-lf	
Canthium captum	lo	
Canthium frangula	lf	
Canthium vulgare	lo	
Cassia katangensis		
o-lf		
Combretum molle	lf	
Combretum mweorense	f	
Combretum zeyherii		lf
Clausena anisata	lc	
Craibia spp		
o-lf		
Dombeya rotundifolius	lo	
Dichrostachys cinerea	lc	
Diplorynchus condylocarpon		c
Diospyros batocana		lf
Diospyros kirkii	lf	
Diospyros mespiliformis	lc	
Erythrina abyssinica		
lc		
Erythrina excelsa	o-lf	
Euclea schimperi	o-lf	
Faurea speciosa	r-lf	
Flacourtia indica	lf	
Ficalhoa laurifolia	lc	
Ficus sycamorus	lf	
Ficus spp		r-
lo		
Gardenia imperialis		
lo		

Gnidia spp			
o-lf			
Grewia flavescens		o-lc	
Hymenocardia acida			lf
Julbernardia globiflora		c	
Julbernardia paniculata		lc	
Khaya anthoteca		o-lf	
Isoberlinia angolensis		lc	
Maytenus senegalensis	r-lo		
Markhamia obtusifolia		lf	
Monotes katangensis		lf	
Monotes africanum		o-lf	
Ochna spp		o-lf	
Lannea discolor	lf		
Lantana trifolia	lf		
Lippia spp		lf	
Loranthus spp		o-lf	
Peltophorum africanum	lo		
Pericopsis angolensis		lf	
Piliostigma thonningii		lo	
Pseudolachnostylis maprouneifolia	lf		
Raphia farinifera	lo		
Shizophyton rautanenii	r-lo		
Rothmannia whitfieldii		lf	
Rhus longipes		lf	
Rytyginia umbellulata		r-lo	
Schrebra trichoclada		o-lf	
Steganotaena araliacea	r-lo		
Sterculia qunqueloba		lf	
Strychnos cuccoloides	o-lf		
Strychnos innocua	lf		
Strychnos spinosa	lf		
Swartzia madagascarensis	o-lf		
Tabernaemontana angolensis	lo		
Terminalia mollis	lf		
Terminalia sericea		lf	
Uapaca benguelensis		lc	
Uapaca kirkiana	c		
Vitex payos		o-lf	
Xylopia katangensis		o-lf	
Zanha africana	lf		
Ziziphus abyssinica		lf	

SYMBOLS
f = Frequent,
c = Common,
o = Occasional
l = Local
o-lf = Occasional to locally frequent
v-lf = very locally frequent
lf = Locally frequent
lc = Locally common,

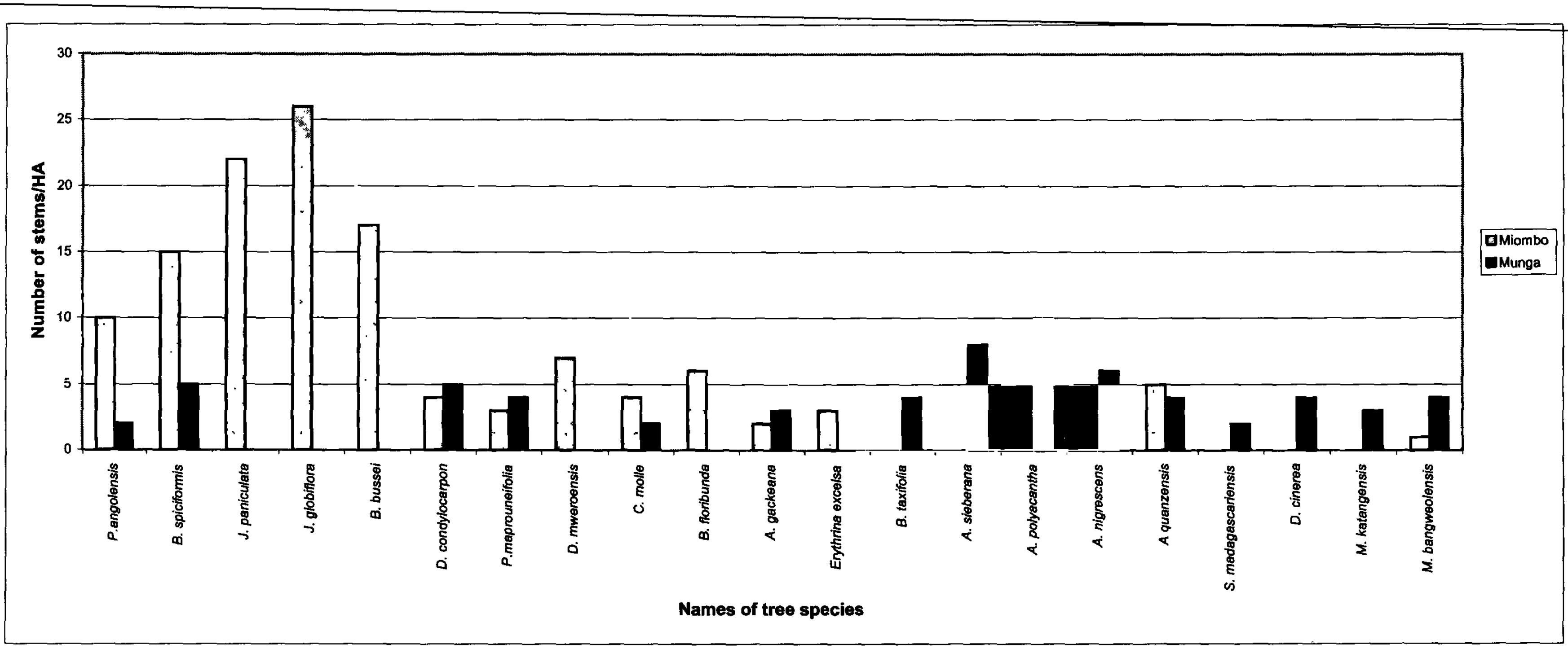
Sub-shrubs, Climbers and Herbaceous species

Acacia pentagons	o-lf	
Albuca spp		lo
Achylanthus spp	lf	
Adenia lobata		v-lf
Asparangus asiaticus		lf
Ampelocissus africana	lo	
Barleria spp		c
Cissus cornifolia	lc	
Cissus quadrangularis	lf	
Cissus spp		lo
Commelina benghalensis	c	
Clematopsis chysocarpa	lc	
Clerodendrum taganyikense		c
Clerodendrum uncinatum	lc	
Clerodendrum violaceum	lf	
Crotalaria spp		lf
Fadogia monticola	lc	
Fadogia spp		lf
Indigofera capitata	c	
Indigofera spp		lc
Loudetia simplex	v-lf	
Mucuna gabrialata	o-lf	
Pteridium aquirium		lc
Tacca leontoptaloides		lf
Smilax kraussiana	c	
Spuriodaucus quarrei		lf

SYMBOLS

f = Frequent,
c = Common,
o = Occasional
l = Local
o-lf = Occasional to locally frequent
v-lf = very locally frequent
lf = Locally frequent
lc = Locally common,

FREQUENCY DISTRIBUTION OF DOMINANT AND CO-DOMINANT TREE SPECIES ACCORDING TO VEGETATION TYPES



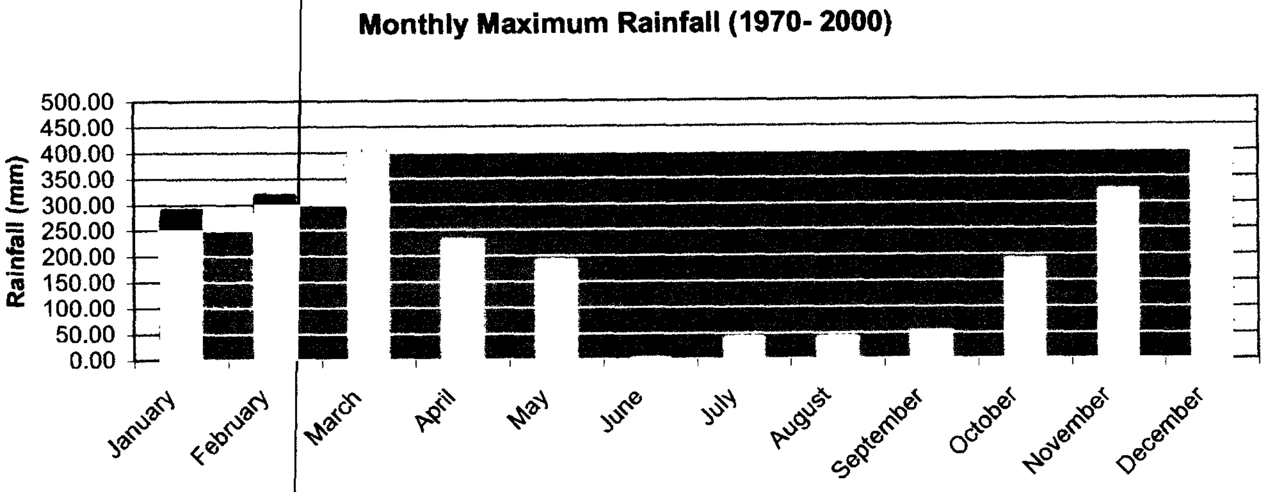
AQUATIC SPECIES IN LAKE MWERU

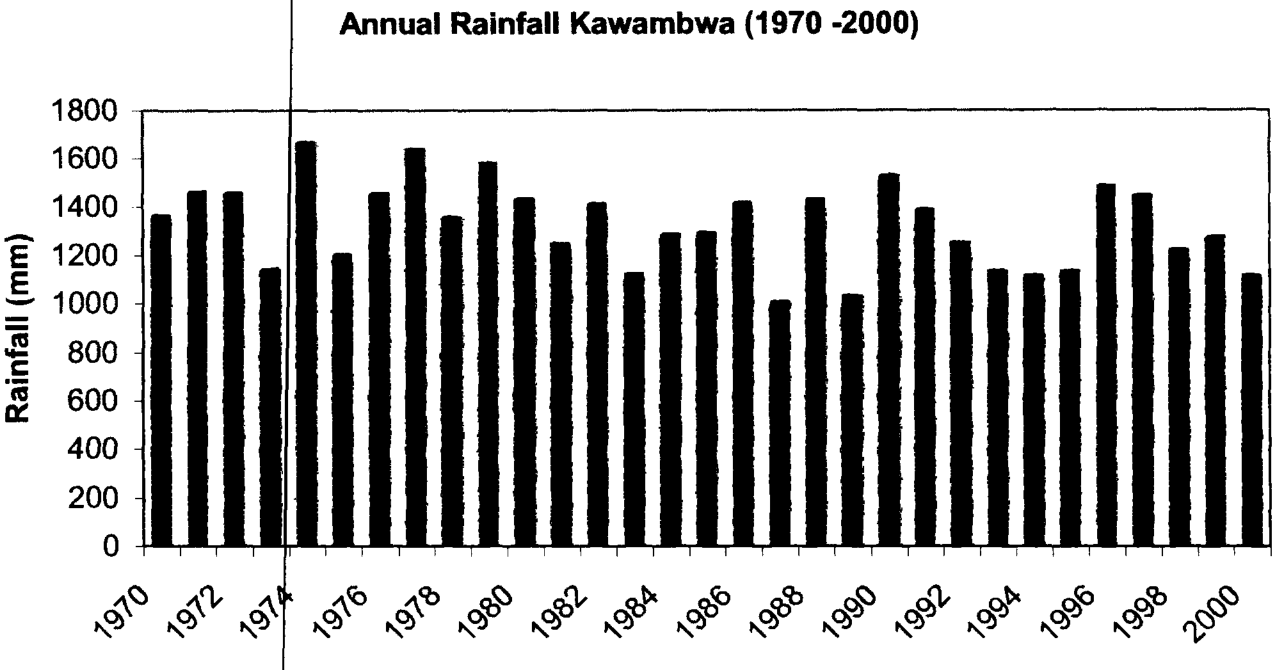
Fish Species in Lake Mweru

No.	Scientific Name	Kibemba Name	Remarks
1.	*Mormyrus longirostris*	Kafutwe (Ndomondomo)	
2.	*Mormyrop*	Mulobe	
3.	*Gnathonemus*	Kise	
4.	*Petrocephalus*	Kifutu	
5.	*Hydrocyon*	Manda	
6.	*Sarcolaces odoe*	Mubombo	Has become rare
7.	*Distichblus faciolatus*	Lukusu	
8.	*Labeo barbus*	Mpifu	Has become rare
9.	*Labeo altivels*	Mpumbu	Has disappeared
10.	*Chysichtys*	Monde	
11.	*Auchenoglanis*	Mbwa-Lupembe	
12.	*Clarias silure*	Muta (Kabambale)	
13.	*Eutropius*	Libanga	
14.	*Tilapia melanopleura*	Pale	
15.	*Tilapia macrochir*	Kituku	
16.	*Tilapia sparmanni*	Katenge	
17.	*Serranachromis*	Makobo	
18.	*Alestes*	Kyaka	
19.	*Tylochromes*	Maela	
20.	*Synondothis*	Bongwe	

Source: Mulomba Mwanzambala, 1974:37

Rainfall Data 1970 – 2000 (Kawambwa Weather Station, Zambia)





PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET

STREAM NAME – Dikulushi Stream	LOCATION – Up stream of plant area.
STATION # DIK/SW/01	STREAM CLASS 1
FORM COMPLETED BY Nyundo Armitage DATE 26/07/02	TIME 10:45
UTM E 639936 **UTM N 9016011**	REASON FOR SURVEY EIA for ANVIL MINING CONGO SARL

WEATHER CONDITIONS	**Now**	**Past 24 hours**
	rain (steady rain)	[✓ rain (steady rain)]
	[✓ showers (intermittent)]	showers (intermittent)
	clear/sunny	clear/sunny
	50 %cloud cover	90 % Cloud cover

Has there been heavy rain in the last 7 days

[✓ Yes] No

Air Temperature 27 C

Other

SITE PHOTOGRAPH

STREAM CHARACTERIZATION	**Stream Subsystem** Perennial [✓ Intermittent] Tidal **Stream Origin** Glacial Spring-fed Non-glacial montane [✓ Mixture of origins] Swamp and bog Other_ **Stream Type** Coldwater [✓ Warmwater] **Catchment Area**__________km$_2$
WATERSHED FEATURES	**Predominant Surrounding Landuse** [✓ Forest] Commercial Field/Pasture Industrial Agricultural Other _ Residential **Local Watershed NPS Pollution** [✓ No evidence] Some potential sources Obvious sources **Local Watershed Erosion** [✓ None] Moderate Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** [✓ Trees] Shrubs Grasses Herbaceous **Dominant species present** _Miombo ____________________
INSTREAM FEATURES	**Estimated Reach Length** _1000____m **Estimated Stream Width** __1.5___m **Sampling Reach Area** ___1500__m$_2$ **Area in km$_2$ (m$_2$x1000)** __1..5__km$_2$ **Estimated Stream Depth** __0.2___m **Flow rate** _1_l/sec **Channelized** Yes [✓ No] **Canopy Cover** Partly open Partly shaded [✓ Shaded] **High Water Mark** __0.6___m **Proportion of Reach Represented by Stream** **Morphology Types** Riffle_20_% Run____10___% Pool_70_% **Dam Present** Yes [✓ No]
LARGE WOODY DEBRIS LWD	LWD____0.7___m$_2$ **Density of LWD** ___0.46____m$_2$/km$_2$ **(LWD/ reach area)**
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** [✓ Rooted emergent] [✓ Rooted submergent] Rooted floating Free floating Floating Algae [✓ Attached Algae] **Dominant species present** _ **Portion of the reach with aquatic vegetation** 90 %
WATER QUALITY	**Temperature**_20.2_$_0$C **Specific Conductance**__0.046_µs/cm___ **Dissolved Oxygen** __2.0 **pH** 7.4 **Turbidity** _0_ **WQ Instrument Used** _Horiba_U 10 WQC **Turbidity (if not measured)** [✓ Clear] Slightly turbid Turbid Opaque Stained Other________ **Water Odors** [✓ Normal/None] Sewage Petroleum Chemical Fishy Other_______________ **Water Surface Oils** Slick Sheen Globs Flecks [✓ None] Other
SEDIMENT/ SUBSTRATE	**Odors** Slight Moderate Profuse Chemical [✓ None] Other **Deposits** Sewage Petroleum Sludge Sawdust Paper fiber Sand Relict shells Other Organic

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)		
Substrate Type	**Diameter %**	**Composition in Sampling Reach**
Bedrock		
Boulder	**256mm**	
Cobble	**64 – 256mm**	
Gravel	**2 – 64mm**	
Sand	**0.06 – 2 mm(gritty)**	60%
Silt	**0.004 – 0.06mm**	20%
Clay	**0.004 mm (slick)**	20%

ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Characteristic**	**% Composition in Sampling Area**
Detritus	**sticks, wood, coarse plant materials**	10%
Muck-Mud	**black very fine organic**	90%
Marl	**grey, shell fragments**	

Mineral 40%
Organic 60%

SAMPLERS NOTES	Sampling point is located next to a small garden (0.5 hectares approximately), on the left hand side of the stream disrupting the natural riparian zone. Weather – warm, cloudy, heavy rain during the night. Water – Clear, very low flow rate, a large pool is located in the sampling area. Sediment – black/grey, mineral sediment, high in organic matter, little amount of organic debris. Vegetation – dense cover over sampling point, Fauna – some small aquatic insects were observed. Other points – Nitrogen fertiliser was used on the garden 5 days before sampling 28/11/02 – Nyundo Armitage

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS)

Habitat Parameter	**Condition Category**			
	Optimal	**Sub-optimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization.	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 [✓ 19] 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	[✓ 20] 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small - shallow or pools absent.
SCORE	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 [✓ 14] 13 12	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely
Score	[✓ 20] 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	[✓ 20] 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 [✓ 6]	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 [✓ 9]	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	[✓ 5] 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 [✓ 9]	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12- 18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 [✓ 6]	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	[✓ 8] 7 6	5 4 3	2 1 0

Total Score _158 Optimal Habitat
Average Score = 15.8

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET

STREAM NAME – Dikulushi Stream	LOCATION – Down stream of plant area
STATION # DIK/SW/02	STREAM CLASS 1
FORM COMPLETED BY Nyundo Armitage DATE 26/07/02	TIME 10:00hrs
UTM E 640066 UTM N 9017943	REASON FOR SURVEY EIA for ANVIL MINING CONGO SARL

WEATHER CONDITIONS

Now	**Past 24 hours**
rain (steady rain)	[✓ rain (steady rain)]
[✓ showers (intermittent)]	showers (intermittent)
clear/sunny	clear/sunny
50 %cloud cover	90 % Cloud cover

Has there been heavy rain in the last 7 days
[✓ **Yes**] **No**
Air Temperature 27 C
Other

SITE PHOTOGRAPH

STREAM CHARACTERIZATION	**Stream Subsystem** Perennial [✓ Intermittent] Tidal **Stream Origin** Glacial Spring-fed Non-glacial montane [✓ Mixture of origins] Swamp and bog Other_ **Stream Type** Coldwater [✓ Warmwater] **Catchment Area**________km^2
WATERSHED FEATURES	**Predominant Surrounding Landuse** [✓ Forest] Commercial Field/Pasture Industrial Agricultural Other _ Residential **Local Watershed NPS Pollution** [✓ No evidence] Some potential sources Obvious sources **Local Watershed Erosion** [✓ None] Moderate Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** [✓ Trees] Shrubs Grasses Herbaceous **Dominant species present** _Riparian ________________
INSTREAM FEATURES	**Estimated Reach Length** 4000 m **Estimated Stream Width** 1 m **Sampling Reach Area** 4500 m^2 **Area in km** 4..5 km^2 **Estimated Stream Depth** 0.2 m **Flow rate** 1 l/sec **Channelized** Yes [✓ No] **Canopy Cover** Partly open Partly shaded [✓ Shaded] **High Water Mark** 0.6 m **Proportion of Reach Represented by Stream** **Morphology Types** Riffle 0 % Run 10 % Pool 90 % **Dam Present** Yes [✓ No]
LARGE WOODY DEBRIS LWD	LWD 1 m^2 **Density of LWD** 0.22 m^2/km^2 **(LWD/ reach area)**
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** [✓ Rooted emergent] Rooted submergent Rooted floating [✓ Free floating] Floating Algae Attached Algae **Dominant species present** _ **Portion of the reach with aquatic vegetation** 20 %
WATER QUALITY	**Temperature** 20.6 ^{0}C **Specific Conductance** 0.27 µs/cm__ **Dissolved Oxygen** 4.5 **pH** 6.9 **Turbidity** 10 **WQ Instrument Used** Horiba U 10 WQC **Turbidity (if not measured)** Clear Slightly turbid Turbid Opaque Stained Other_______ **Water Odors** [✓ Normal/None] Sewage Petroleum Chemical Fishy Other______________ **Water Surface Oils** Slick Sheen Globs Flecks [✓ None] Other
SEDIMENT/ SUBSTRATE	**Odors** Slight Moderate Profuse Chemical [✓ None] Other **Deposits** Sewage Petroleum Sludge Sawdust Paper fiber Sand Relict shells Other Organic

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)		
Substrate Type	**Diameter %**	**Composition in Sampling Reach**
Bedrock		
Boulder	**256mm**	
Cobble	**64 – 256mm**	
Gravel	**2 – 64mm**	
Sand	**0.06 – 2 mm(gritty)**	60%
Silt	**0.004 – 0.06mm**	20%
Clay	**0.004 mm (slick)**	20%

ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Characteristic**	**% Composition in Sampling Area**
Detritus	**sticks, wood, coarse plant materials**	80%
Muck-Mud	**black very fine organic**	20%
Marl	**grey, shell fragments**	

Mineral 30%
Organic 70%

SAMPLERS NOTES	Weather – warm, cloudy, heavy rain during the night. Water – Murky cloudy grey, very low flow rate, much of the water is pooling. Sediment – black/grey, mineral sediment, high in organic debris. Vegetation – extremely dense cover over sampling point, Fauna – Many small aquatic insects were observed. 28/11/02 – Nyundo Armitage

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS)

Habitat Parameter		Condition Category			
		Optimal	**Sub-optimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover		Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE		20 [✓ 19] 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization		Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE		[✓ 20] 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability		Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE		20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition		Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE		[✓ 20] 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status		Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE		20 19 18 [✓ 17] 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration		Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely
Score		[✓ 20] 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	[✓ 20] 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank [✓ 10] 9	8 7 6	5 4 3	2 1 0

Total Score _186_ Optimal Habitat
Average Score = 18.6

APPENDIX VI - ENVIRONMENTAL BASELINE STUDY. SOCIO-ECONOMIC DATA (PROFESSOR KALABA's REPORT 2001)

Socio- Economic Data

Available Skills in Pweto Territory

Nature of activities	**Number**
Builders	123
Radio repairmen	70
Joiners	60
Tailors	82
Welders	42
Boatmen	60
Blacksmiths	58
Mat weavers	130
Video	3
Shoe repairer	50
Photographers	70
Pit sawyers	58
Total	**806**

Source: Annual Report 1988

KEY INFORMANTS

1. Mr. Bill Turner
2. Mr. James Morris
3. Bishop J. P. Tafunga Catholic Bishop, Kilwa-Kasenga Diocese
4. Bishop Delphin Mbayo Vice Administrator, Kilwa-Kasenga Diocese
5. Mr. Kasanda Ngoie Head of Kilwa Post
6. Mr. Pweto, Coordinator of Catholic Schools
7. Methodist Pastor
8. Garenganze Church Elders
9. Mr. Kisenji, Head of Kabangu Post (Kasongo-Mwana Grouping)
10. Chief of Kabangu Village
11. Mr. Lubele, Chief of Dikulushi Village
12. Chief of Ngwena Village
13. Chief of Mubanga Village
14. Chief Katendezi
15. Chief of Lumekete
16. Chief of Kashinda
17. Chairperson and members of Groupe des Volontaires de Kilwa
18. Mr. Kapotwe Limpanti, Former Advisor of Pweto Territory
19. Abbots Kalenga
20. Christophe Mwale
21. Cleophas
22. Dèsirè (Prosecutor)
23. Mr. Lubembo, Assistant, Lubumbashi University (Native of Kilwa)

TERMS OF REFERENCE FOR SOCIAL IMPACT ASSESSMENT OF DIKULUSHI PROJECT

I. Community awareness of the project

1. Who is the community?

2. Local community

   a) Which are the main villages/towns?
   b) What are the predominant cultural and religious practices?
   c) What are the dominant community structures?
   d) What is the structure of the Local Authority?
   e) What is its political profile?
   f) What is the leadership profile i.e. who are the prominent individuals in this structure?
   g) Who do they represent?
   h) What influence to they wield with regard to:
      i. The community
      ii. Local authority
      iii. Regional authority
      iv. National structures
      v. Which are the prominent civil society groups

3. Which are potentially affected nearby communities in terms of?

   a) Sources of labour
   b) Supplying goods and services
   c) Government services and administrative centres

4. What is the nature and extent of local awareness of the project?

   a) Local understanding of what the project is about
   b) Perceptions of the project - positive or negative

5. What are the community fears and concerns of the project?

6. What are the community objections to the project?

7. What are the community expectations of the project?

II. OVERVIEW OF LOCAL ECONOMY

Describe the local economy in terms of:

8. Primary industries i.e. fishing, agriculture, mining, manufacturing, tourism;

9. Secondary industries i.e. consumers of raw material from primary industries and suppliers of goods and services directly to these industries
10. Tertiary industries including commercial and financial suppliers to the dependent community as well as government at local, regional and national levels

11. Major imports in the area

12. Exports from the area

III. EXISTING INFRASTRUCTURE

Describe the infrastructure in the immediate vicinity of the mining project. This should include the nature and condition of:

13. Transport

    a) Main trunk roads in the area
    b) Local roads
    c) Taxi and bus services
    d) Cargo services and;
    e) Airfields

14. Communications

    a) Telephone
    b) Radio and;
    c) postal

15. Physical

    a) Power
    b) Sewerage and;
    c) Water

16. Commercial

    a) Shops
    b) Offices
    c) Informal; business enterprises
    d) Markets
    e) Restaurants and catering facilities; and
    f) Accommodation and tourist facilities

17. Industrial

    a) Workshops
    b) Factories
    c) Small industrial enterprises

18. Administrative

    a) Civic and local authority management
    b) Central and regional authority offices; and
    c) Non-governmental organizations assisting civil society to meet challenges of government institutions

19. Security

a) National police service infrastructure in the area
b) Local military presence
c) Local or metropolitan police services
d) Local privately run security and para-military services and;
e) Local vigilante groups

20. Medical services

a) Government hospitals and clinics
b) Private clinics
c) Private medical, dental and paramedical services
d) Ambulance services and;
e) Medical evacuation services

21. Education facilities

a) Schools, crèches and childcare facilities at various levels
b) Secondary education and training facilities
c) Tertiary education and training and;
d) Any technical and vocational training facilities in the immediate area of the mine

22. Sport and recreation

a) Local sports politics and structure

IV. SUBSISTENCE

d) The traditional structure of immediate family units
e) Local diet
f) Family consumption of traditional subsistence foodstuffs
g) The carrying capacity of local land to produce these foodstuffs
h) The size of plot of land to support a typical family unit

APPENDIX VII - ENVIRONMENTAL AND SOCIAL IMPACT MATRIX

ENVIRONMENTAL AND SOCIAL IMPACT MATRIX

pact Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
n Pit and Underground								
ra and Fauna	Phase 1	Removal of all indigenous forestry in the vicinity of the pit as well as destruction of wildlife habitats	*Has occurred*	Negative	Instant	Local	Moderate	Permanent
	Phase 2	Continued removal of indigenous forestry in the vicinity of the pit as well as destruction of wildlife habitats	High					
	Underground Phase 3	Revegetation of old pit walls may begin, impacts to flora and fauna will be reduced as pit expansion stops.			Cumulative			
	Decommissioning	Indigenous flora and fauna will begin to recolonise the area but will be restricted by the perimeter of the open pit as the pit floods with water. The inundated open pit could become a potential habitat for aquatic flora and fauna.						
urface water	Phase 1	Increased sediment loads in the Dikulushi River from disturbed soils, blasting and excavation are likely as well as contamination from fuel and lubricant spills from vehicles developing the pit.	High	Negative	Instant	Local	Moderate	Long Term
	Phase 2	Water from pit dewatering is likely to alter the composition of the Dikulushi River water. River diversion will remove the natural habitat for aquatic flora and fauna. Pit development will affect surface water quality as described for Phase 1.						
	Underground Phase 3	Continued addition of water from mine dewatering systems in to the stream.						
	Decommissioning	Breaching of diversion channel will allow water to flow into the open pit area temporarily disrupting the amount of water available to the downstream environment.						

act Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
roundwater	Phase 1	Mine dewatering will reduce the height of the water table causing a decrease in the amount of groundwater available and increasing the oxidation potential of sulphide minerals, possibly causing increased acid production and metal dissolution.	High	Negative	Cumulative	Local	Low	Medium Term
	Phase 2							
	Underground Phase 3	Diesel and oil spills could contaminate ground water.						Long Term
	Decommissioning	The water table will rebound to its original level infilling the open pit and underground workings. Groundwater quality may be affected by diesel spills from previous undergoing workings, as well as surrounding geology resulting in acid generation and metal leaching, possibly affecting future users and habitats.						
Soil	Phase 1	Contamination of soils around the pit due to blasting and excavation and removal of soils from the pit area.	High	Negative	Instant	Local	Low	Medium Term
	Phase 2	Continued impact on and removal of soil material.						
	Underground Phase 3	Minimal impact during this phase	-					
	Decommissioning							
ndscape and ual Character	Phase 1	Landscape of the site area is altered by the open pit although the impact is currently reduced due to the distance to settlements.	Has occurred	Negative	Instant	Local	Low	Permanent
	Phase 2	Visual impact will increase as development of the open pit continues.	High					
	Underground Phase 3	Infrastructure such as mine shafts etc will impact the visual character of the landscape.						
	Decommissioning	Large scar will remain in the landscape which will eventually be revegetated and form a small lake.						

act Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
loise and Vibration	Phase 1	Noise and vibrations will arise from drilling, blasting, excavation and haulage.						
	Phase 2							
	Underground Phase 3	Noise and Vibration will mostly be restricted to underground areas reducing noise to surrounding areas but intensifying the impact to mine workers.	High	Negative	Cumulative	Local	Low	Medium Term
	Decommissioning	No Impact will occur	-					
Air	Phase 1	Dust is generated by drilling, blasting and vehicle movement. Especially during the dry season. Vehicles also generate emissions.	High	Negative	Cumulative	Local	Moderate	Medium Term
	Phase 2	Dust is generated by blasting and vehicle movement. Especially during the dry season Vehicles also generate emissions.						
	Underground Phase 3	Dust is generated by blasting and vehicle movement. Vehicles also generate emissions. The majority of air and dust pollution will be confined to underground areas increasing the effect of dust on occupational health						
	Decommissioning	minimal impact	-					
tural Heritage	Phase 1	Archaeological heritage could be potentially destroyed or disturbed	Low	Negative	Instant	National	Moderate	Permanent
	Phase 2							
	Underground Phase 3	Archaeological heritage or paleontological remains could be destroyed or disturbed.						
	Decommissioning	The Mine may be regarded as part of local heritage and history, the cultural value attached to the mine is difficult to predict, but any value will be eroded by mine inundation or removed by decommissioning		Positive	Cumulative	Local		Long Term

pact Source	**Phase**	**Impact Description**	**Likelihood of Impact occurring**	**Nature of Impact**	**Temporal Nature**	**Geographic Extent**	**Significance**	**Duration**
ilushi Stream Diversion								
opography	**Construction**	750m of the river will be diverted via a drainage ditch altering local topography.	High	Negative	Instant	Local	Low	Permanent
	Operation							
	Decommissioning							
ırface Water	**Construction**	Surface water flow will be disrupted while construction of the diversion channel takes place.	High	Negative	Instant	Local	Low	Medium Term
	Operation	Flow regime will be altered due to the straight nature of the diversion channel compared to the meandering nature of the current river channel.			Cumulative			
	Decommissioning	When the project finishes and the diversion is breached to allow the pit to flood, flow rates will be significantly disrupted for a period of time.	Moderate		Instant			
quatic Flora and Fauna	**Construction**	Riverine and Aquatic Flora and Fauna habitats will be destroyed in and close to the old river channel	High	Negative	Instant	Local	Low	Permanent
	Operation	Aquatic flora and fauna may have the chance to develop in the new diversion channel.	Moderate	Positive	Cumulative			Short Term
	Decommissioning	Once the diversion channel is breached, downstream aquatic flora and fauna may be affected by low flow rate due to flooding of the abandoned pit.	High	Negative				Long Term
ırchaeology	**Construction**	Risk of Archaeological sites in the area being disrupted or destroyed during construction	Low	Negative	Instant	Local	Low	Permanent

act Source	Phase	Impact Description	Likelihood of impact occurring	Nature of impact	Temporal Nature	Geographic Extent	Significance	Duration
ess Plant								
ir Quality	**Construction**	Some dust generation will occur during the construction phase as well as some vehicle exhaust emission.	Has occurred	Negative	Cumulative	Local	Moderate	Medium Term
	Phase 1 HMS	Dust is generated by crushers, with major impact occurring during dry months. Effect of dust (respirable and copper) is likely to affect health of workers	High					
		Diesel emissions from the diesel generators (including SOx NOx VOC's and combustion leads) impacting air quality.						
	Phase II & III Concentrator	As during Phase 1	-					
	Decommissioning	Some dust may be generated when assets are removed, exposed areas will be susceptible to dust until revegetation.	Moderate					
rface Water	**Construction**	Surface water runoff regime will be altered by the removal of vegetation and the compaction of ground	Has occurred	Negative	Instant	Local	Moderate	Long Term
	Phase 1 Heavy Media Separation	Surface water could become contaminated by processed material and machinery. Impermeable layers are also likely to increase surface water runoff.	Moderate		Cumulative			
	Phase II Concentrator Mill and Flotation							
	Decommissioning	Residual, contaminated soil around stockpile areas and dilapidated assets could affect surface water quality for a period of time.						

act Source	Phase	Impact Description	Likelihood of impact occurring	Nature of impact	Temporal Nature	Geographic Extent	Significance	Duration
restrial Flora nd Fauna	Construction	Terrestrial flora and the habitats available for terrestrial fauna will be destroyed or disrupted during construction	Has occurred	Negative	Instant	Local	Low	Long Term
	Phase 1 Heavy Media Separation	Surrounding flora and fauna will be affected by dust generated by crusher plant.	High		Cumulative			
	Phase II Concentrator Mill and Flotation							
	Decommissioning	Revegetation of the process plant area is likely to occur.	-					
Noise and Vibration	Construction	Some noise and vibration will arise from construction equipment and vehicles in the first stages of construction	Has occurred	Negative	Cumulative	Local	Low	Medium term
	Phase 1 Heavy Media Separation	Crusher and plant machinery constitutes the largest producer of background noise. If worker exposure to noise exceed 85 decibels over 8 hours, this can cause impaired hearing.	High					
	Phase II Concentrator Mill and Flotation							
	Decommissioning	Noise will reduce to baseline levels.	-		Instant			
frastructure and nmunications	Construction	Infrastructure in the local area will be significantly enhanced. Encouraging the development of other mineral deposits or other industries.	Has occurred	Positive	Cumulative	Local	High	Long Term
	Phase 1 Heavy Media Separation							
	Phase II Concentrator Mill and Flotation							
	Decommissioning	Infrastructure will be removed or left to dilapidate	High	Negative			Low	

pact Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
Accidental Impacts	Operation	Major accidental releases of process or plant chemicals.	Low	Negative	Instant	Local	High	Short Term
		Risk of general worker accident at the Plant	Moderate					
		Accidental spillage of diesel from fuel farm could enter ground- or surface water.	Low				Very High	

act Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
kpiles								
a and Fauna	**Construction**	Removal of vegetation to make way for the stockpiles	Has occurred	Negative	Instant	Local	Moderate	Long Term
	Operation	Impact to Flora from contaminated surface runoff and groundwater. Degree of impact depends on composition of stockpile material, duration and nature of stockpiles.	High					
	Decommissioning	All stockpiles will be removed, any contamination of soil may affect revegatation.	Moderate		Cumulative			
rface water	**Construction**	Stockpiles are potentially sources of Acid Rock Drainage, which could affect surface water quality.	Moderate	Negative	Instant	Local	Low	Long Term
	Operation				Cumulative			
	Decommissioning	Minor impacts if stock piles are removed.						
roundwater	**Construction**	Percolation of water through stockpiles could result in contaminated ground water.	Moderate	Negative	Cumulative	Local	Low	Long Term
	Operation							
	Decommissioning	Minor impacts if stock piles are removed.	-					
Soil	**Construction**	Soils are locally affected by earthmovers and other machinery. Any ARD can affect soil quality.	Has occurred	Negative	Cumulative	Local	Low	Long Term
	Operation	Soil underlying stockpile could become contaminated by leaching of elements into soil. Surrounding soil could be impacted by dust deposition arising from the stockpiles	High					
	Decommissioning	Soil underlying stockpiles may remain contaminated for a long period of time.	Moderate					

act Source	Phase	Impact Description	Likelihood of impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
dscape and al Character	**Construction**	Local visual character will be affected, but the extent of the impact will not affect the majority of local people	Moderate	Negative	Instant	Local	Low	Long Term
	Operation							
	Decommissioning	Visual impact will be significantly less after the removal of the stockpile, however a large unvegetated area will be left over which may take some time to revegetate due to potential soil contamination			Cumulative			
Air	**Construction**	Dust could arise from the movement of material onto and off the stockpile as well as due to wind action. The nature of the stockpile means that a large quantity of dust is not expected	Moderate	Negative	Cumulative	Local	Low	Long Term
	Operation							
	Decommissioning	Dust impact is likely to decrease significantly at decommissioning	-					

act Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
ngs Dam								
rface Water	Construction	Removal of soil and vegetation as well as a change to the surface water runoff regime caused by the construction of the Tailings Dam.	Has occurred	Negative	Instant	Local	Moderate	Long Term
	Operation	Tailings dam wall material may wash into the Dikulushi River. Runoff entering the Dikulushi River from the tailings dam wall could contain dissolved elements (copper) and silt . Seepage of tailings material through the dam wall could contaminate surface water.	High		Cumulative			
		In the event of tailings discharge into the Dikulushi River from the dam or spillway canal, there could be negative impacts to the water quality in the Dikulushi River.						
	Decommissioning	Release of tailings into the Dikulushi River during storm events and seepage of contaminated water into the river could occur and affect water quality over a long period of time. Acid generating tailings material would more severely effect surface water quality.						

act Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
ound Water Quality	**Construction**	Some impact would have occurred in the construction phase, from the increase in groundwater infiltration due to the reduction in vegetation.	Has occurred	Negative	Cumulative	Local	Moderate	Long Term
	Operation	Seepage of tailings with relatively high concentrations of copper and other elements could contaminate groundwater. If the tailings material is acid producing the contamination will be more severe.	Moderate					
	Decommissioning	Contaminated water from the tailings dam will continue to seep into groundwater for a long period of time, this impact may have a long resilience depending on the nature of the groundwater conditions and the nature of tailings material.						
Soil	**Construction**	Removal and disturbance of soil by vehicles and heavy machinery.	Has occurred	Negative	Instant	Local	Low	Long Term
	Operation	Wind erosion of tailings could occur during the dry season and is likely to affect soils around the tailings dam.	Moderate		Cumulative			
	Decommissioning	Wind erosion of tailings is likely to continue although this impact will gradually decline over a period of time when revegetation occurs.	High					

act Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
egetation	Construction	Removal of all vegetation within the 1.8 hectare area and on access roads.	Has occurred	Negative	Instant	Local	Low	Long Term
	Operation	Extension of tailings deposition area in phase II due to addition of 12.8ha tailings dam.	High					
	Decommissioning	Vegetation may not immediately recolonise tailings dam area due to possible plant toxicity of tailings. Re-vegetation is likely to be grass, bushes and small trees, eventual return to baseline conditions will take a long period of time.			Cumulative			
Air	Construction	Increase in localised air pollution from vehicle emissions as well as increased dust generation.	Has occurred	Negative	Instant	Local	Low	Long Term
	Operation	Dust generation from wind blown tailings particularly during dry or windy months is likely to spread tailings away from the tailings dam and could be deposited on nearby land affecting the nearby mine village or the soil within the vicinity of the Tailings Dam.	Moderate		Cumulative			
	Decommissioning	Wind blown tailings are likely to continue to affect local air quality, until revegetation has occurred.	High		Cumulative			
rchaeology	Construction	Destruction or unknowing removal of Archaeological artefacts.	Low	Negative	Instant	Local	Low	Permanent
	Operation	Further destruction or removal of archaeological artefacts in phase II						
	Decommissioning	no likely impact	-		-			

pact Source	Phase	Impact Description	Likelihood of impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
andscape	Construction	Localised visual impact will be relatively severe but, the area is screened by vegetation and is far away from nearby villages.	Has occurred	Negative	Instant	Local	Low	Long Term
	Operation	The tailings dam is a large open area cleared of forest with a large amount of soil exposure. The maximum area the two tailings dams will occupy is 15 ha	High					
	Decommissioning	Visual impact of the tailings dam is likely to decrease as time goes by and revegetation occurs						
Accidental Releases	Operation and Decommissioning	Tailings dam failure - Will result in excessive loads of contaminated sediments in watercourses, with impact on aquatic habitats, deterioration of water quality and stream sediments.	Low	Negative	Instant	Local	Very High	Medium Term
		In case of tailings overflow, overflowing water could carry relatively high concentrations of certain elements such as copper.	Moderate				Moderate	Short term
		Tailings pipe breaches will cause localized pollution and eventual run off into the Dikulushi River					Low	

act Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
te Rock Dump								
rface Water	**Construction**	Contamination from fuel and lubricants can have occurred as well as increased sediment load due to disturbed soils exposed to surface runoff.	High	Negative	Instant	Local	Moderate	Long Term
	Operation	Acid generation from sulphide minerals in rock material and dissolution of metals if dumped material is acid generating. Metals and acid may enter watercourses. Contaminated runoff from the dumps could overflow storm water drains, and the sedimentation pond may not adequately reduce siltation.	Moderate		Cumulative			
	Decommissioning	Contaminated surface water arising from storm events and from dump runoff will continue to enter the Environment for a long period of time via the sedimentation pond.						
Soil	**Construction**	Soil will be disrupted by earthmoving equipment.	Has occurred	Negative	Instant	Local	Low	Long Term
	Operation	Soils under and around the dump will be affected by leaching of dump material.	High		Cumulative			
	Decommissioning	Contamination of soil below and around the waste dump is likely to continue.						
Vegetation	**Construction**	Removal of all vegetation in the waste dump area	Has occurred	Negative	Instant	Local	Moderate	Long Term
	Operation	If the need arises to extend the waste dump, more vegetation would have to be cleared.	High					
	Decommissioning	Indigenous species of trees may not be able to recolonize the dump area due to the nature of the waste, lack of soil and possible plant toxicity of waste rock material.	Moderate		Cumulative			

pact Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
Air	Construction	Increase in localized air pollution from vehicles emission as well as increase in dust generation.	High	Negative	Instant	Local	Low	Mediu term
	Operation	Some impact from airborne dust, especially during dumping of material.			Cumulative			
	Decommissioning	Some impact from wind blown dust during periods of high winds.	Low					
tural heritage	Construction	Destruction or unknowing removal of Archaeological artefacts.	Low	Negative	Instant	National	Low	Permanent
	Operation	Further destruction or removal of archaeological artefacts as the waste dumps are expanded.						
	Decommissioning	no likely impact						
Visual	Construction	Localized visual impact will be relatively severe but, the area is screened by vegetation and is far away from the nearest villages.	High	Negative	Instant	Local	Low	Long Term
	Operation							
	Decommissioning	Impact of the dump decreases with time as revegetation occurs.	Moderate		Cumulative			

pact Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
ste Rock Dump								
roundwater	**Construction**	Insignificant impact	-	Negative	-	-	Low	Long term
	Operation	Percolation of precipitation through the dump could cause an increase in acid and metal loads, impacting negatively on the ground water quality. The impact would depend on the composition of waste material.	Moderate		Cumulative	Local		
	Decommissioning	Depending on the nature and composition of WRD material, continued percolation of rain water through the WRD could affect groundwater quality						

pact Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
Workshops, fuel and oil storage								
rface Water	**Construction**	Some disruption to surface water runoff regime	Moderate	Negative	Cumulative	Local	Low	Medium Term
	Operation	Possible contamination of surface water from accidental releases from fuel, lubricant and chemical storage facilities.						
	Decommissioning	Any remaining diesel or oil spill is likely to affect water resources.						
roundwater	**Construction**	No impact	-	Negative	Cumulative	Local	Low	Medium Term
	Operation	Possible contamination of ground water from fuel or chemical spills.	Low					
	Decommissioning	Some residual spill is likely to enter the groundwater.						
Waste	**Construction**	Some waste will be generated by construction workers and machinery	High	Negative	Cumulative	Local	Low	Medium Term
	Operation	Waste oil, scrap metal, etc will be produced during operation						
	Decommissioning	No waste will be generated	-					

act Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
structure and Communications								
oundwater	Construction	No impact	-	Negative	Cumulative	Local	Low	Long Term
	Operation	Release of waste water and sewerage into the groundwater regime from the septic tanks. Depending on groundwater flow, future or present boreholes could be affected by seepage of sewerage	Low					
	Decommissioning	No or minor impacts.	-					
frastructure and nmunications	Construction	No impacts	-	Positive	Instant	Local	Very High	Long Term
	Operation	Infrastructure (housing, recreational facilities etc) and communications through vhf and satellite phone will benefit all employees, and possibly local population.	High					
	Decommissioning	Infrastructure (housing) could be retained by workers.	-					
Waste	Construction	Some waste (oils, fuel) can be expected from machinery during construction of infrastructure	High	Negative	Cumulative	Local	Low	Long Term
	Operation	Waste will be generated from the people living on site and from offices.						
	Decommissioning	Some infrastructure may be left as waste.						

pact Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
ge and Port facilities								
rface water	**Construction**	~~Lake water is likely to have been significantly~~ disturbed by construction of ramps in Kilwa and Nchelenge, Pollution of water could have arisen from diesel and oil spill.	Has occurred	Negative	Cumulative	Local	Low	Medium Term
	Operation	Pollution of water could arise from spillage from diesel and oil from trucks on the barge or during barge refuelling. Sediment is disturbed by barge propellers, especially during periods when the water level is low. Pollution is likely to disperse and be significantly diluted.	High					
	Decommissioning	No impact will occur when operations finish	-					
Air	**Construction**	Local air quality could have deteriorated with increased amounts of dust and vehicle exhaust fumes	High	Negative	Cumulative	Local	Low	Medium Term
	Operation	Diesel fumes(SO2 etc) from the barges, trucks and service vehicles slightly affect air quality, But will be dispersed and diluted within a short period of time.						
	Decommissioning	No impact will occur when operations finish	-					
Noise and Vibration	**Construction**	Excavator noise and vibration would have affected the local population in Kilwa	Has occurred	Negative	Instant	Local	Low	Medium Term
	Operation	Noise is likely to be of short term duration, from the barge and truck engine start up. The affect of this is more likely to be felt by nearby local residents. Little impact from vibration would be expected	Moderate					
	Decommissioning	No impact will occur when operations finish	-					

pact Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
il and Lake Sediment	Construction	Soil and sediment would have been disturbed by excavation and the establishment of the port facilities	Has occurred	Negative	Instant	Local	Low	Medium Term
	Operation	Sediment would be disturbed during low water when barge propellers disturb sediments.	High		Cumulative	Regional		
	Decommissioning	No impact would be expected	-					
Fauna	Construction	Aquatic fauna would have been affected by noise and construction activities possibly affecting local fisheries, any pollutant would be significantly diluted.	High	Negative	Instant	Local	Low	Medium Term
	Operation	Aquatic fauna would be disturbed by noise and sediment churn up especially when water level is low. Any pollutant would be significantly diluted to affect aquatic fauna			Cumulative	Regional		
	Decommissioning	No impact is likely	-		Instant	Regional		

pact Source	Phase	Impact Description	Likelihood of impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
ge and Port facilities								
Vegetation	Construction	Reeds and grasses at Kilwa and Nchelenge were removed to accommodate the facilities	Has occurred	Negative	Instant	Local	Low	Medium Term
	Operation	Some disturbance to aquatic flora on lake bed due to disturbance from propellers	High		Cumulative	Regional		
	Decommissioning	No impact is likely	-		Instant			
Transport	Construction	Disruption of the movement of people along the beach at Nchelenge	Has occurred	Negative	Instant	Local	Low	Medium Term
	Operation	Increase in transport opportunity from the DRC to Zambia and vice versa	High	Positive	Cumulative	Regional	Very High	Long Term
	Decommissioning	Decrease in transport opportunity from the DRC to Zambia and vice versa	Moderate	Negative	Instant		Moderate	
Noise	Construction	Noise of graders would have temporarily impacted local population	High	Negative	Instant	Regional	Low	Medium Term
	Operation	Noise will be a definite impact on the lake, the barge is the largest vessel on the lake and motorized vessels are few. The duration of noise will last 6 hours/day on average but will only affect small portions of the lake for short periods as the barge travels.			Cumulative			
	Decommissioning	Traffic levels are likely to decrease significantly and therefore the amount of noise pollution	Moderate	Positive	Instant		Low	Long Term
ndscape and ual Character	Construction	The facilities are relatively small and the port facility fits into and enhances the urban setting in Kilwa and the industrial setting in Nchelenge	Has occurred	Positive	Instant	Local	Moderate	Permanent
	Operation							
	Decommissioning	Facilities will begin to depreciate when operations stop	Moderate	Negative	Cumulative		Low	Long Term

pact Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
cio -economic	**Construction**	Employment of construction workers and sourcing of local materials	Has occurred	Positive	Instant	Local	Very High	Long Term
	Operation	Revenue is derived from jobs, customs, link to the Congo increase in export opportunity, other barges to operate, or larger fishing vessels				Regional		
		A port facility, can be a magnet for other export/import industries to locate at Kilwa or Nchelenge	High		Cumulative			
	Decommissioning	There will be an impact to the economic ties between Zambia and Congo across Lake Mweru, if operations cease	Moderate	Negative	Instant		Low	

pact Source	Phase	Impact Description	Likelihood of impact occurring	Nature of impact	Temporal Nature	Geographic Extent	Significance	Duration
d and Airstrip Upgrade								
Water	**Construction**	Spillage of fuels and lubricants into watercourses may occur.	High	Negative	Instant	Regional	Low	Medium Term
	Operation	Risk of water pollution from accidents/spillages will increase.	Moderate		Cumulative			
	Decommissioning	Traffic levels are likely to decrease significantly and therefore the risk of water pollution			Instant			
Air	**Construction**	Dust increased due to road upgrading etc	High	Negative	Instant	Regional	Low	Medium Term
	Operation	Diesel fumes (SOx VOC's, CO2 , combustion leads, etc) from trucks leading to air pollution and greenhouse gas production. Although the amount of transport is unlikely to produce a severe impact to local air quality, as the nature of the area will significantly disperse and dilute pollutants.			cumulative			
		Localized dust generation along roads will occur			Instant			
	Decommissioning	Traffic levels are likely to decrease significantly and therefore the amount of air pollution	Moderate					

pact Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
Noise	Construction	Noise of graders and other heavy vehicles would have temporarily impacted local population	Has occurred	Negative	Instant	Regional	Low	Medium Term
	Operation	Noise from haulage trucks, aircrafts and other traffic will affect people and wildlife along road network, airstrip and in-flight path.	High		Cumulative			
		Noise from haulage trucks and other vehicles will affect the route from Dikulushi to Kilwa, Nchelenge to Ongopolo mine (Namibia) the impact of noise will be more apparent in rural areas such as Dikulushi, but the amount of vehicle movement is relatively low.						
	Decommissioning	Traffic levels are likely to decrease significantly and therefore the amount of noise pollution	Moderate		Instant			

frastructure	Construction	Road network will improve and grow. Facilitate transportation not only for mine activities Road disruption may take place during construction stages.	Has occurred	Positive	Cumulative	Regional	Very High	Long Term
	Operation							
	Decommissioning	Road infrastructure may degenerate if maintenance is stopped	High	Negative			Low	Short Term

pact Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
Social	**Construction**	There would have been temporary disruption to road users.	-	Negative	Instant	Regional	Low	Short term
	Operation	Increase in risk to Road Users	High		Cumulative			
		Communication for the population in the area will be facilitated due to road network upgrade.		Positive			Very High	Long Term
		Revenue from customs and Immigration will be enhanced by the increase in amount of international traffic..	Moderate					
	Decommissioning	The risk to the safety of road users will decrease	High	Negative	Instant			
		Road infrastructure will deteriorate to pre mining levels.			Cumulative		Moderate	
		The availability of transport in the form of hitch hiking and buses for local people are likely to decrease.	Moderate					
		Revenue from customs and Immigration will decrease significantly due to the decrease in international traffic..			Instant			

pact Source	Phase	Impact Description	Likelihood of impact occurring	Nature of impact	Temporal Nature	Geographic Extent	Significance	Duration
ial								
Regional Impacts	**Construction**	The capital and economic investment of the project in the area will induce multiplier effects in the regional and local economy. The project is going to promote the business of local and regional suppliers and contractors providing goods and services to the mine	High	Positive	Cumulative	Regional	Very High	Long Term
	Operation							
	Decommissioning	Project decommissioning will induce negative economic multiplier effects as local and regional business will lose business from the mine.						
ployment and cal Economy	**Construction**	The direct economic impact of the project in Dikulushi will be the employment generated in the local community. These earning are going to promote the local economy through increased purchases of good and services	High	Positive	Cumulative	Regional	Very High	Long Term
	Operation							
	Decommissioning	Project decommissioning may result in unemployment and a decrease in the amount of disposable income in the area affecting the local economy.						
Social nfrastructure	**Construction**	The construction and rehabilitation of social infrastructure such as clinics for the direct welfare of employees is an important positive impact for the local community	High	Positive	Cumulative	Regional	Very High	Long Term
	Operation							
	Decommissioning	Project decommissioning may result in a decrease in support to local social infrastructure provided by the project resulting in its depreciation						

pact Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
takeholder xpectation	Construction	High expectation of the benefits of the project have already been identified in the Baseline study. If local people are not adequately informed about the nature and limitations of the mining project, resentment could arise if expectations are not met	Low	Negative	Cumulative	Regional	Low	Short Term
	Operation							
	Decommissioning							
ependency	Construction	Development of dependency on the mining project, arising from the receipt of financial and social benefits received from the mine by local people and businesses over the lifetime of the mine.	High	Negative	Cumulative	Regional	Low	Short Term
	Operation							
	Decommissioning	The cessation of mining could result in a loss of these benefits and create a significant impact to local people and business in the form of loss of income and the depreciation of social infrastructure						
Population	Construction	The project is likely to attract people from surrounding areas seeking employment increasing the population in the area and therefore increasing the demand on basic amenities, the competition for employment and the risk of disease.	High	Neutral	Cumulative	Regional	Low	Long Term
	Operation							
	Decommissioning	Although population is likely to decrease, the effects of the increased population may remain in the local community with empty housing and the feeling of desertion.						

pact Source	Phase	Impact Description	Likelihood of Impact occurring	Nature of Impact	Temporal Nature	Geographic Extent	Significance	Duration
ocal Culture nd Customs	Construction	The mining project will have an impact on the local customs and culture of the local communities, as some employees are drawn from outside the region and the country.	Moderatete	Neutral	Cumulative	Regional	Low	Long Term
	Operation							
	Decommissioning	The impact to local culture and customs is likely to remain in the community for a long period of time						
Disease	Construction	The project is likely to induce a large number of job seekers from outside the community This influx of population in the area has the potential of increasing the chances of the spread of diseases such as malaria and HIV/AIDS The development of health programmes should significantly reduce this risk and enhance local health	Moderatete	Positive	Cumulative	Regional	Very High	Long Term
	Operation							
	Decommissioning							

APPENDIX VIII - ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Area	Management Theme	Reason	Actions	Timing of Management		Responsibility	Documentation
Tailings Dam							
Dam Wall	Tailings discharge prevention.	Evaluation of dam wall erosion and seepage, and risk of a tailings breacht to ensure dam wall stability.	Monthly inspections will be undertaken to evaluate wall stability and document water levels/seepage	May 2003	End Operations	HSE and Processing Dept	Quarterly tailings dam report, including, dam wall stability, freeboard compliance, phreatic level, ground water seepage quality, dust levels and any additional concerns
Freeboard		Evaluation of minimum freeboard regulations compliance to reduce risk of dam overflow.	Monthly inspections will be undertaken to measure freeboard. Inspections will be carried out daily during the rainy season.	May 2003	End Operations	HSE and Processing Dept	
Phreatic level		Evaluation of ground water saturation within the tailings dam and risk to tailings wall stability caused by saturation to ensure dam wall stability.	Piezometers will be sunk within and around the tailings dam and phreatic level measured monthly	May 2003	End Operations	HSE and Processing Dept	
Ground water	Groundwater quality assurance.	To evaluate the contamination of ground water caused by tailings water seepage	One piezometer within the tailings dam and one piesometer outside the tailings dam will be sampled once per month using a bailer, and analysed for pH, TDS, Sulphate and Copper.	May 2003	End Operations	HSE and Processing Dept	
Maintenance	Tailings discharge prevention.	Maintenance of tailings dam to ensure that the Tailings Dam is working as per design.	Piezometers, slurry delivery systems and decant piping will be inspected once per month and maintained	May 2003	End Operations	HSE and Processing Dept	
Flora and Fauna	Flora and *fauna* protection.	To retain surrounding flora to act as a wind break and to encourage concurrent rehabilitation of the dam during operation	Vegetation surrounding the tailings dam will be retained and concurrent rehabilitation measures will be implemented to revegetate closed areas.	May 2003	End Operations	HSE	A section in the annual environmental report will *indicate* the timing and progress of rehabilitation efforts

Area	Management Theme	Reason	Actions	Timing of Management		Responsibility	Documentation
Air Quality	Air quality assurance.	To evaluate the amount of tailings lost through wind erosion and to identify areas of risk to the surrounding environment	Visual assessments on dust will be carried out monthly indicating direction of wind and amount of dust occurring	May 2003	End Operations	HSE and Processing Dept	Quarterly tailings dam report, including, dam wall stability, freeboard compliance, phreatic level, ground water seepage quality, dust levels and additional concerns
Waste Management Plan							
Ground water	Groundwater quality assurance.	To evaluate the contamination of ground water caused by Waste Rock Dump water seepage	One outside the Waste Rock Dump will be sampled once per month using a bailer, and analysed for pH, TDS, Sulphate and Copper.	May 2003	End Operations	HSE and Processing Dept	
Surface Run off	Surface water quality assurance.	Control of surface runoff from Waste Rock Dump to ensure that any contaminated surface runoff the Waste Rock Dump is controlled.	Surface run-off will be controlled by the construction of bund walls and perimeter drains around the waste rock dump. Any surface runoff or seepage from the toe drain will be monitored.	May 2003	End Operations	HSE and Processing Dept	
Flora and Fauna	Flora and fauna protection	To retain surrounding flora to act as a wind break and to encourage concurrent rehabilitation of the Waste Rock Dump during operation	Vegetation surrounding the Waste Rock Dump will be retained and concurrent rehabilitation measures will be implemented to revegetate closed areas.	May 2003	End Operations	HSE	A section in the annual environmental report will indicate the timing and progress of rehabilitation efforts
Air Quality	Air quality assurance.	To evaluate the amount of tailings lost through wind erosion and to identify areas of risk to the surrounding environment	Visual assessments on dust will be carried out monthly indicating direction of wind and amount of dust occurring	May 2003	End Operations	HSE and Processing Dept	

Area	Management Theme	Reason	Actions	Timing of Management		Responsibility	Documentation
Waste Management Plan							
Mine Village (household) Waste	General environmental protection.	Reduction, reuse, recycling or responsible disposal of waste to reduce the impact of waste and to ensure that waste is disposed of in a responsible manner.	Strategies to reduce or reuse waste, will be investigated and proper disposal sites will be identified, prepared and signposted	May 2003	End Operations	HSE	Annual waste management report outlining waste disposal sites and measures, success of the plan, and areas of concern
Biodegradable Waste		To reuse biodegradeable waste as a fertiliser	Depending on mine garden demand biodegradable waste will be used for compost	May 2003	End Operations	HSE	
Clinical Waste		To ensure clinical waste is responsibly disposed of so that the risk of contamination to workers is eliminated	A small incinerator will be constructed for the burning of clinical waste and ashes will be disposed of in a fill site	May 2003	End Operations	HSE	
Workshop Waste		To reduce the impact of waste and to ensure that waste is disposed of in a responsible manner	Strategies to reduce or reuse waste will be developed, material will be recycled where possible, scrap metal will be disposed of in a prepared/signposted area	May 2003	End Operations	HSE	
Waste Oil		To ensure that waste oil does not contaminate the environment	Oil traps will be installed at mine workshops, and vehicle bays. Waste oil will be collected regularly and disposed of by the fuel- or lubricant supplier.	May 2003	End Operations	HSE and fuel supplier	
Septic Tanks	Groundwater quality assurance.	Check function and isolationof septic tanks to ensure that septic tanks are functional and to prevent groundwater contamination.	No boreholes can be located within 150 m from septic tank. No surface water use near or downhill of any septic tank.	May 2003	End Operations	HSE	

Area	Management Theme	Reason	Actions	Timing of Management		Responsibility	Documentation
Transport Management Plan							
Barge and Port Facilities	General environmental protection.	Maintenance, environmental quality evaluation and pollution prevention to ensure that the barge and port facilities are in good working order, minimise the risk of pollution and monitor pollution impacts.	Regular maintenance of the barge and port facilities will be conducted ensuring that diesel storage facilities are adequate and any leaks are quickly contained/repaired	May 2003	End Operations	HSE	A section on transport and possible alternative fuel sources will be included in the annual environmental report
			Checking of trucks and vehicles for any oil or diesel leaks will be carried out before any truck embarks onto the barge; leaks will be repaired or contained	May 2003	End Operations	HSE	
			Monitoring of surface water around the vicinity of the port areas will be conducted on a monthly basis with emphasis on checking for organic carbon and lead arising from possible diesel spillage	May 2003	End Operations	HSE	
Feul Storage		Maintanence and leak prevention to reduce the risk of spills entering the environment.	Monitoring and maintenance of feul storage facilities will be undertaken regularly.	May 2003	End Operations	HSE	
Fuel		To of reduce the impact of transport and machinery emissions on air quality	Investigation into the use of low sulphur diesel will be carried out and if feasible implemented	May 2003	End Operations	HSE	
Vehicle Transport and Infrastructure	Health and safety.	To ensure that roads are maintained and the risk to road users is minimised	On site roads, as well as the Dikulushi Kilwa road will be regularly maintained. Speed restriction imposed on site roads and the Dikulushi -Kilwa road.	May 2003	End Operations	HSE	
Local Transport	Social service provision.	To benefit local travellers	Anvil will develop a policy on the transportation of people across Lake Mweru on their barges	May 2003	End Operations	HSE	

Area	Management Theme	Reason	Actions	Timing of Management		Responsibility	Documentation
Flora and Fauna Management Plan							
Flora	Flora and fauna protection.	Protection, and value retention to ensure that important plant species are conserved and to retain the value of tree species.	Important species in areas which will be developed will be identified extracted and replenated. Other species that can be used or sold will be harvested before development	May 2003	End Operations	HSE under approval of Mine Manager	A section will be included in the annual environmental report indicating actions taken.
Flora	Rehabilitation.	Concurrent Revegetation to ensure that the area quickly returns to baseline vegetative levels to reduce visual impacts, to stabilise soil and to provide a habitat for disturbed flora and fauna.	A section of the mine garden will be used as a nursery to grow seedlings of pioneer species such as *Acacia polycantha, A. sieberana, Albizia adianthifolia, Peltophorum africanum,* and *Dichrostachys cinere.* The seedlings raised will be planted during the rainy season in areas that have been significantly altered and are no longer required for use. The nursery will be maintained as a bank for revegetation and will be allowed to develop fully after revegetation of all areas is satisfactorily complete after decommissioning.	May 2003	End Operations	HSE under approval of Mine Manager	A section will be included in the annual environmental report describing actios completed and future planning
Fauna	Flora and fauna protection.	To ensure that important animal species are conserved.	Important species in areas which will be developed will be identified extracted and rehabitated	May 2003	End Operations	HSE under approval of Mine Manager	A section will be included in the annual environmental report describing actions completed..
Archaeological Plan							
Archaeology	Cultural heritage protection.	To ensure that archaeological heritage is not destroyed	All mining personnel will be briefed on the possibility of uncovering an archaeological artefact. If an artefact is found the HSE officer will be notified and the artefact photographed and removed to a safe place. An outside expert may be brought into evaluate the significance of the find	May 2003	End Operations	HSE	A section on Archaeology will be included in the annual environmental report

Area	Management Theme	Reason	Actions	Timing of Management		Responsibility	Documentation
Underground Management plan							
Safety Guidelines	Health and safety.	Safety guidelines appropriate for undergrond mining will be developed to ensure worker safety	A safety guide book will be produced describing important aspects of underground safety including likely hazards, safety equipment, clothing and accessories, emergency procedures, maintenance systems, ventilation safety, communications systems, evacuation procedures and emergency drills.	May 2003	End Operations	HSE	Safety guide book will be produced before underground mining commences
Safety		Allocation of safety responsibility to ensure that HSE is effective in ensuring that the mine is compliant with safety regulations	Responsibility for different aspects of underground safety will be reassigned to members of HSE.	May 2003	End Operations	HSE	
Environmental Protection	General environmental protection.	Establish an additional Environmental Management Plan to ensure contamination and possible damage to the environment is identified and mitigated for.	An underground environmental management plan including, waste water, dust, noise and vibration management will be developed.	May 2003	End Operations	HSE	Environmental Management Plan will be established before underground mining commences
Safety Management Plan							
Hazardous Areas	Health and safety.	Identification and signposting of hazardous areas to ensure that workers are alerted to risk areas and directed to wear safety protection	All areas of significant hazard (dangerous materials, noise and dust areas) will be sign posted and safety signs will regularly be checked and maintained	May 2003	End Operations	HSE	A section on these aspects will be included in the Annual Mine Safety Report
Safety Equipment		Provision of adequate safety clothing and accessories to ensure that workers are protected from any work related risk.	Clothing and safety accessories will be checked by shift bosses during weekly safety briefs to make sure they are appropriate and are used by workers in risk areas	May 2003	End Operations	HSE	
Fire Extinguishers		To ensure that any fire is quickly put out to avoid damage to workers and infrastructure	Fire extinguishers will be checked once per quarter	May 2003	End Operations	HSE	
Buildings		To ensure infrastructure safety	Buildings will be regularly checked and pipes and water supply maintained.	May 2003	End Operations	HSE	

Area	Management Theme	Reason	Actions	Timing of Management		Responsibility	Documentation
ROM PAD		To confirm the structural integrity of the ROM pad	The ROM pad will be inspected daily for any sign of structural failure. Corrective action will be taken if required to reduce the risk of ROM pad failure.	May 2003	End Operations	Engineering	A section on these aspects will be included in the Annual Mine Safety Report
Emergency Stop Buttons		To ensure that any risk to worker safety can quickly be addressed	Emergency stop buttons will be installed on the rotating machinery	May 2003	End Operations	HSE	
First Aid		To ensure that first aid is readily available to workers	First aid posts will be established, and nominated workers trained in basic first-aid.	May 2003	End Operations	HSE	
Hazardous Materials		To ensure worker safety and reduce risk of environmental damage	Hazardous materials on site will be adequately labelled and stored in appropriate, signposted locations installed with facilities to effectively ensure that any spillage of hazardous chemicals do not enter the environment.	May 2003	End Operations	HSE	
Safety Briefings		To ensure that workers are adequately informed of safety procedures	Supervisors will conduct safety briefings once per week and discuss all relevant safety aspects for their area of responsibility. Supervisors will check safety equipment daily and be responsible for the induction of visitors and new personnel.	May 2003	End Operations	HSE	

Area	Management Theme	Reason	Actions	Timing of Management		Responsibility	Documentation
Social Management plan							
Diseases	Health and safety.	To reduce the impact of infectious and generic diseases on the local population and employees	Awareness seminars and campaigns will be held conjunction with local authorities and NGO's for the benefit of the community.. A local doctor will conduct regular awareness seminars and educational posters will be placed in strategic areas around the mine site. The possibility of providing free condoms to employees will be examined.	May 2003	Continued by NGO or local authority	Anvil will develop a close association with a relevant NGO to facilitate the social management plan	A section on social development will be included in the Annual Environmental Report
			Control of Malaria will be undertaken by regular spraying of mine and local areas including Dikulushi village using an approved spray. Seminars on reducing the incidence of malaria will be conducted regularly (at the same time as the AIDS awareness seminar). Educational posters will be put up and treated mosquito nets will be provided to employees.	May 2003	Continued by NGO or local authority		
Job Seekers	Social service provision.	To ensure that management has information on applicants so that jobs can be allocated preferentially to local people	Anvil will create a database of Job seekers indicating skills, age, sex, residence and will positively discriminate for local people	May 2003	End Operations	Human Resources	
Joint Management Task Forces	Sustainable development.	To develop sustainable health, education and economic strategies to help the local community.	Anvil will discuss with Government and experienced NGO's the formulation of plans and strategies to implement sustainable health, education and economic development	May 2003	Dec 2003	Anvil will develop a close association with a relevant NGO to facilitate the social management plan	
Local Business Support		Ensure that sustainable development continues in the area after mine closure	Anvil will go into discussion with Government, and experienced NGO's in order to develop plans and strategies to implement the sustainable development of local businesses	May 2003	End Operations		

Area	Management Theme	Reason	Actions	Timing of Management		Responsibility	Documentation
Communication with Local People	Social service provision.	To inform employees and local people of the intentions of the Company and to provide a forum for local people to voice any concerns or queries	Anvil will develop a strategy to communicate with local people and employees about the nature and policy of the mine, expected life span and its economic plans, and will provide a forum for local people to voice concerns	May 2003	End Operations	HSE	
Socio-Economic Dependency	Sustainable development.	To ensure that employees do not become overly dependent on the project and can diversify into other activities using the mine as a springboard for economic development	Anvil will discuss sustainable development with Government, and experienced NGO's in order to formulate plans and strategies for sustainable health, education and economic development.	May 2003	End Operations	Anvil will associate with a relevant NGO to facilitate the social management plan	
Economic Diversification		To encourage the diversification of local economy so that local people are less dependent on the mine.		May 2003	End Operations		
Energy		To use renewable energy sources in the longer term to minimise the impact on air quality and the depletion of non renewable energy	Anvil will investigate options for establishing an alternative power supply to the mine and surrounding villages in joint consultation with Government	May 2003	End Operations	HSE	
Social Services	Social service provision.	To provide employees and the surrounding community with better health and education facilities	Anvil will develop joint strategies with Government and NGO's to provide social services that will be sustainable after mine closure.	May 2003	End Operations	Anvil will associate with a relevant NGO	

Area	Management Theme	Reason	Actions	Timing of Management		Responsibility	Documentation
Environmental Monitoring (General)							
Surface Water Quality	Surface water quality assurance.	To accurately assess impacts on the Dikulushi River	pH and EC measured weekly, additional TDS, TSS, Sulphate, T. Cu analysed monthly. Full suite analyses will be conducted twice a year. Additional parameters of concern to be included in monthly analysis.	May 2003	End Operations	HSE	Quarterly report indicating water quality levels and compliance
		Sedimentation ponds will be monitored to confirm that discharge is within effluent standards	pH, TDS, TSS, EC, and T. Cu will be analysed weekly when discharging. Full suite analyses will be conducted twice a year. Additional parameters of concern to be included in monthly monitoring	May 2003	End Operations	HSE	Quarterly report indicating water quality levels and compliance if discharging
Surface Water Flow		To ensure that localized flooding does not occur, to minimise direct surface runoff into the Dikulushi River and to reduce the risk of malaria.	Inspections will be undertaken once per month during the rainy season to ensure channels are free of debris and that stagnant pools are free of mosquitoes	May 2003	End Operations	HSE	To be included in annual report
		To contain contaminated surface run-off for possible treatment or recycling	Sediment Ponds will be constructed at the locations outlined in Figure 5.1	May 2003	End Operations	HSE	
		To confirm the sedimentation ponds are functioning according to design	Sedimentation ponds will be inspected monthly and freeboard recorded	May 2003	End Operations	HSE	Quarterly report indicating freeboard level and recommendations for dredging
		To aid design of the diversion system	Flow rate will be measured weekly during the rainy season	May 2003	End Operations	HSE	Annual report on flow rate will be produced
Surface Water Usage	Potable water quality assurance.	To benefit residents of Dikulushi village and villages downstream of the mine site	pH, conductivity, TDS, TSS, Sulphate, Arsenic, Chromium, Manganese, Faecal Coliform and Copper will be analysed quarterly. Full suite analyses will be conducted twice a year and additional parameters of concern included in the programme	May 2003	End Operations	HSE	Quarterly report will be produced indicating drinking water quality and compliance

Area	Management Theme	Reason	Actions	Timing of Management		Responsibility	Documentation
Groundwater	Groundwater quality assurance.	To evaluate contamination and effect on potable water supply.	Results from groundwater analysis will evaluate ARD potential. Quality to be checked if drinking water is derived from pit dewatering.	May 2003	End Operations	HSE	To be included in annual report
Soil Loss	Soil resource protection.	To minimise threats to future landuse and sedimentation of watercourses.	Inspections will be carried out of areas were soil surface is susceptible to erosion..	May 2003	End Operations	HSE	To be included in annual report
Soil Contamination		To evaluate the extent of soil contamination, and assess the potential for using soil for rehabilitation	Total copper levels will be analysed annually	May 2003	End Operations	HSE	Annual report on soil contamination.
Noise	Health and safety.	To evaluate the risk of chronic hearing loss to workers and to evaluate compliance	Noise levels at selected noisy locations will be measured once per quarter	May 2003	End Operations	HSE	Annual report will be produced indicating noise levels and affected employees and actions implemented to reduce effects.
			Employee hearing health assessments will be carried out annually on workers who are most at risk	May 2003	End Operations	HSE	
Air Quality		To evaluate the risk of chronic respiratory illness to workers and to evaluate compliance	Respirable dust levels at work stations at the crusher plant will be monitored once per month	May 2003	End Operations	HSE	Quarterly report will be produced indicating dust levels and actions implemented to reduce effects
			Respiratory health assessments of workers in risk areas will be conducted annually	May 2003	End Operations	HSE	Annual report will be produced summarising results.

Area	Management Theme	Reason	Actions	Timing of Management		Responsibility	Documentation
Climate	General environmental protection.	To evaluate maximum rainfall events, and map the areas of most risk to dust pollution	A weather station will be set up to measure temperature, rainfall, wind speed and direction on a daily basis.	May 2003	End Operations	HSE	A section on Meteorology will be included in the Annual Environmental Report
Acid Rock Drainage		To evaluate the potential of ARD from tailings, waste rock, overburden and stockpiles.	A complete ARD test programme should be carried out as early as possible.	May 2003	Dec 2003	HSE / Chief Geologist	Report on ARD testwork and evaluation by ARD expert.
Quality Control.		To ensure that analytical results are of good quality	Samples will be sent for full suite analysis twice annually for quality control at a different certified laboratory	May 2003	End Operations	HSE	Annual report on result will be produced.
Personnel		To ensure that environmental monitoring is undertaken correctly .	Personnel will be trained to sample water, air, noise and to measure flow and piezometers using the appropriate equipment	May 2003	End Operations	HSE	To be included in annual report

Non Compliance Procedures

	Component out of Compliance	Step 1	Step 2	Step 3	Step 4	Responsibility
General Procedure	Out of Compliance	Identify Source	Alert Mine Manager and responsible person	Identify best course of action	Undertake action and review its effectiveness	HSE
Surface Water	Dikulushi River is out of compliance with WB guidelines	Identify source of pollution	Notify person in charge of pollution source.	Measures to reduce discharge should be implemented. Treatment will be viewed as the last available option if pollution reduction is unsuccessful.	Implement, sample, monitor	Identifying source of pollution rests with the HSE. Restoring compliance is the responsibility of the HSE and offending party under the authority of the Mine Manager.
	Sedimentation pond is out of compliance					
	Sedimentation pond discharge is out of compliance					
Surface Water Usage	Potable water is out of compliance	Plant problems, weather	Find alternate water sources if water is dangerously out of compliance	Investigate options to treat water on site	Warn users	HSE is responsible for evaluating compliance. Mitigatory actions should be undertaken by the HSE officer under the authority of the Mine Manager
	Water supply at Dikulushi village is running low	Clarify reason for decrease in water supply	Investigate possibilities for correcting shortage e.g. by supplementing water to Dikulushi Village	Locate and test alternative supplies of potable water	Install additional pumps and piping. Warn users	HSE is responsible for evaluating water supply. Mitigatory actions should be undertaken by the HSE officer under the authority of the Mine Manager

	Component out of Compliance	Step 1	Step 2	Step 3	Step 4	Responsibility
Sedimentation ponds	Sediment has built up affecting the ability of the pond to settle fines effectively	Check if mine or plant conditions have changed	Alert metallurgist and HSE	Investigate options - dredging sediment / raising pond walls etc during the dry season, placing dredged material in the tailings dam	Implement and monitor	HSE to alert responsible persons who should act after authorisation from the Mine Manager
Tailings Dam	Possible dam wall instability	Determine cause and effect, eg heavy rain, poor freeboard, operating problems	Alert Mine Manager and Plant Manager	Determineappropriate actions to increase dam wall stability e.g. add waste rock, lower freeboard	Implement and monitor	HSE to alert responsible persons who should act after authorisation from the Mine Manager
Tailings Dam	Freeboard is below minimum guidelines	Plant problems, weather	Alert Plant Manager	Review options to increase freeboard (building up wall sides, decanting more water to the plant or sedimentation pond)	Implement short term corrective action immediately	HSE to alert responsible persons who should act after authorisation from the Mine Manager
	Phreatic level is too high causing risk to dam wall stability	Alert responsible person	Investigate actions to decrease phreatic level	Undertake actions to decrease phreatic level (pumping water out of peizometers into the plant or sedimentation ponds)		HSE to alert responsible persons who should act after authorisation from the Mine Manager
Ground water	Ground water is contaminated	Identify source of pollution	Alert responsible person	Contain contamination or pump out contaminated groundwater into Tailings dam or settlement pond for treatment	Careful review of cost implications	HSE to alert responsible persons who should act after authorisation from the Mine Manager

	Component out of Compliance	Step 1	Step 2	Step 3	Step 4	Responsibility
Soil	Soil is contaminated	Identify source of pollution	Notify person in charge of pollution source.	Investigate options to reduce contamination or to treat soil on site	Review cost implications	HSE to alert responsible persons who should act after authorisation from the Mine Manager
Noise	Noise levels are out of compliance	Alert workers in noise areas	Ensure that workers wear noise defenders	Rotate affected workers out of risk areas regularly	Investigate options to reduce noise	HSE to alert responsible persons who should act after authorisation from the Mine Manager
	Hearing loss in workers becomes significant	Identify risk areas by comparing hearing loss to work stations				
	Complaints about noise increase significantly	Identify area of high noise	Investigate ways of reducing noise impact	Rotate affected workers out of risk areas regularly	Repair cause	
Air Quality	Air Quality is out of compliance	Alert workers in dusty areas	Ensure that workers wear respiratory protection	Rotate affected workers out of risk areas regularly	Investigate options to reduce dust and air pollution	
	Respiratory illness in workers becomes significant	Identify risk areas by comparing respiratory illness to work stations				

Decommissioning Plan

Area	Management Theme	Reason	Actions	Responsibility
Post Closure Monitoring				
Surface Water	Surface water quality assurance.	Accurately asses the impact of surface water discharge from the site into Dikulushi River and evaluate compliance	Post closure monitoring parameters will be established based on operational monitoring results. Post closure monitoring will be conducted once every quarter until decommisioning inspections are satisfied, then at an agreed frequency thereafter.	HSE
Groundwater	Groundwater quality assurance.	To evaluate Acid Mine Drainage and possible contamination		HSE
Soil	Soil resource protection.	To evaluate the extent of soil contamination, and assess the potential for soil use in rehabilitation		HSE
Post Closure Inspection	General environmental protection.	To evaluate the extent of rehabilitation and evaluate post closure environmental status, establishing recommendations for any additional rehabilitation or mitigation measures. Evaluate the success of sustainable planning.		HSE
Open Pit				
Reprofiling	Rehabilitation.	To ensure long term physical stability	Pit wall will be re profiled in accordance with industry best practice	Engineering
Revegetation		To reduce visual impact	Soil and grasses will be planted concurrently as sectors become disused at feasible locations	HSE
Ecosystem Development		To ensure that the flooded open pit can develop into an aquatic ecosystem supporting aquatic flora and fauna which has the possibility of being used sustainably by the surrounding community	The feasibility of creating an appropriate aquatic ecosystem will be reviewed including the analysis of pit water, ecological assessment, and the stocking of appropriate aquatic flora and fauna.	HSE
Closed Dumps, ROM pad and Tailings Dam Management				
Reprofiling	Rehabilitation.	Toe ensure that the erosion of mine dumps is reduced and that dump areas are stabilised	Slopes will be reprofiled and evaporation paddocks will be redeveloped on the tailings dam surface	HSE
Dismantling		To ensure that any mechanical components from the dumps do not pose a threat to the surrounding community and so that they can be reused recycled or responsibly disposed of.	All pipelines and non-essential infrastructure will be removed	HSE
Revegetation		To ensure that the area returns quickly to baseline conditions	Revegetation of specific areas of the rock dumps and tailings dam as these become disused. The addition of organic matter, soil and saplings from the nursery will be done where appropriate to facilitate revegetation	HSE

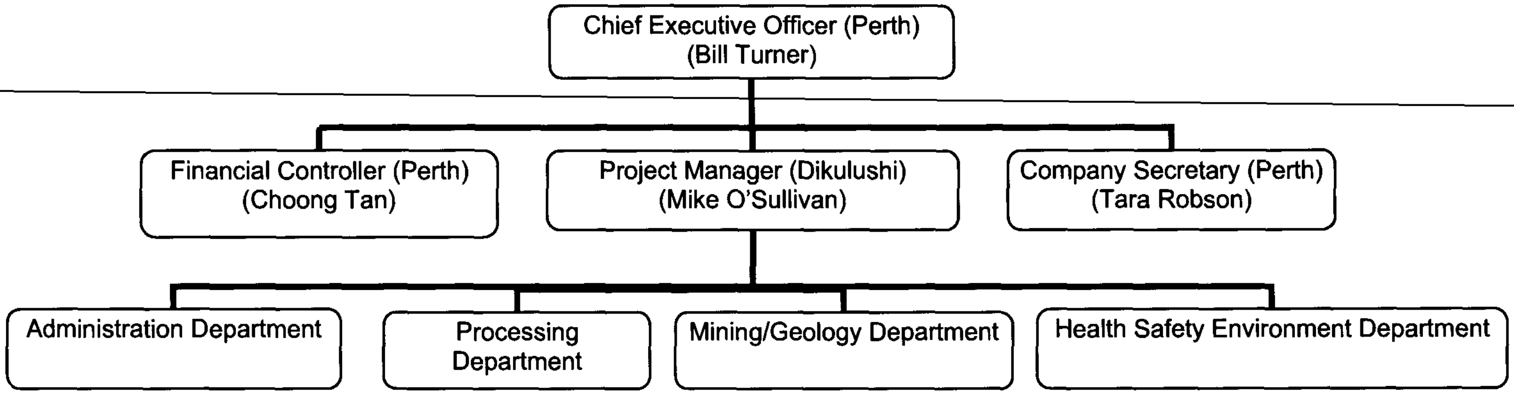
Area	Management Theme	Reason	Actions	Responsibility
Flora and Fauna management Plan				
Flora	Rehabilitation.	To ensure that the area returns quickly to baseline conditions where appropriate	Actions to encourage revegetation will be implemented after closure and the extent of revegetation will be analysed annually until decccomisioning inspections are satisfied.	HSE
Dismantling plan				
Infrastructure and Plant Machinery	General environmental protection and sustainable development.	To retain all value from decommissioned infrastructure and responsibly remove any unsafe infrastructure from the site	An inventory of all infrastructure on site will be conducted indicating, value, state, extent of piping and electrical cables, etc.a plan will be formulated to either sell off assets, make remaining infrastructure safe or remove assets for responsible disposal.	HSE
Barge and Port Facilities	Sustainable development.	To ensure the benefit of cross-border transport is retained	The Barge and port facilities provide benefits to international traffic and commerce. Anvil will develop a phased approach to handover or sale of the barges to local operators or Government appointees.	HSE
Safety Management Plan				
Hazardous Areas	Health and Safety.	To ensure that surrounding Community are aware and alerted to dangerous areas	Dangerous areas will be identified and signed posted and fenced if necessary and the local community informed of the dangers	HSE
Social				
Training	Sustainable development.	To ensure that staff have socio-economic stability after closure	Counselling and training options for staff will be provided 2 years before closure.	Social Consultant

Emergency Procedures

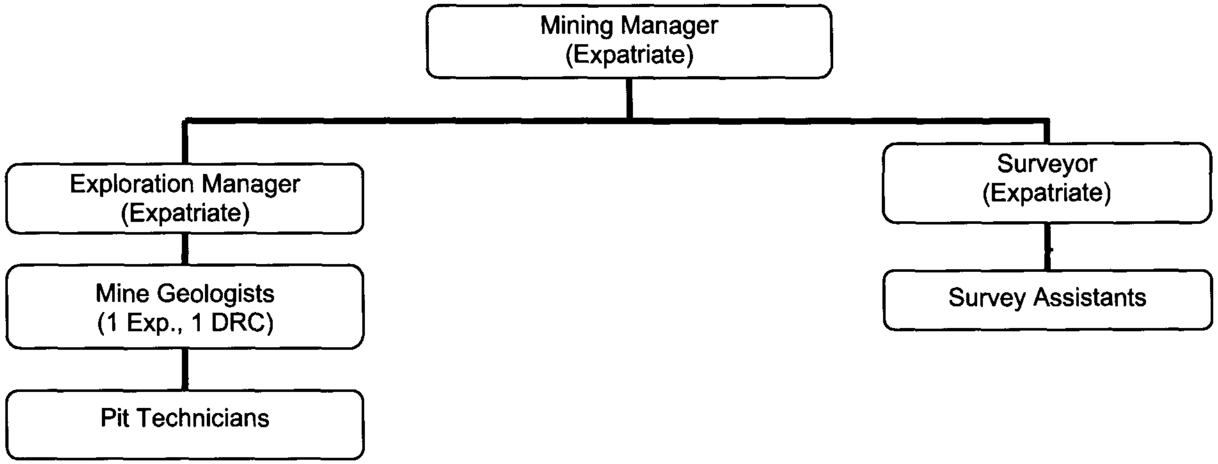
General Procedure	Immediate alert to designated personnel	Mobilisation of Emergency Task force	Implementation of Emergency Actions	Warning to affected persons	Evaluation of Impact	Implementation of Remediation Measures	Investigation into causes of the accident	Undertaking of measures to ensure no reoccurrence.
Tailings Dam Breach	Mine Manager	Yes	Plant shut-down. Mining equipment mobilised to seal breach with waste rock	Downstream users will be warned	The extent and nature of the breach will be evaluated by analysing water quality, sediment, flora and fauna	Options for remediation will be assessed and actions to be followed determined	Causes of the accident will be investigated	Measures to ensure no reoccurrence will be undertaken
Diesel Storage Facility Breach	Engineering Manager	If required	Actions to immediately secure breach and construct emergency dams to contain discharge					
Concentrator Storage Breach	Plant Manager	If required	Contain discharge by appropriate means					
Major Concentrate Spill (During Trucking or shipping)	Engineering Manager	If required	Actions to recover concentrate from spilled area will be immediately implemented	Affected people will be warned of any dangers associated with a concentrate spill	If concentrate is unrecoverable, actions to treat affected areas will be considered			
Open Pit Wall Collapse	Mine Manager	Yes	Immediately undertake rescue operations		Back analysis of cause			

APPENDIX IX - DIKULUSHI MINE ADMINISTRATIVE STRUCTURE

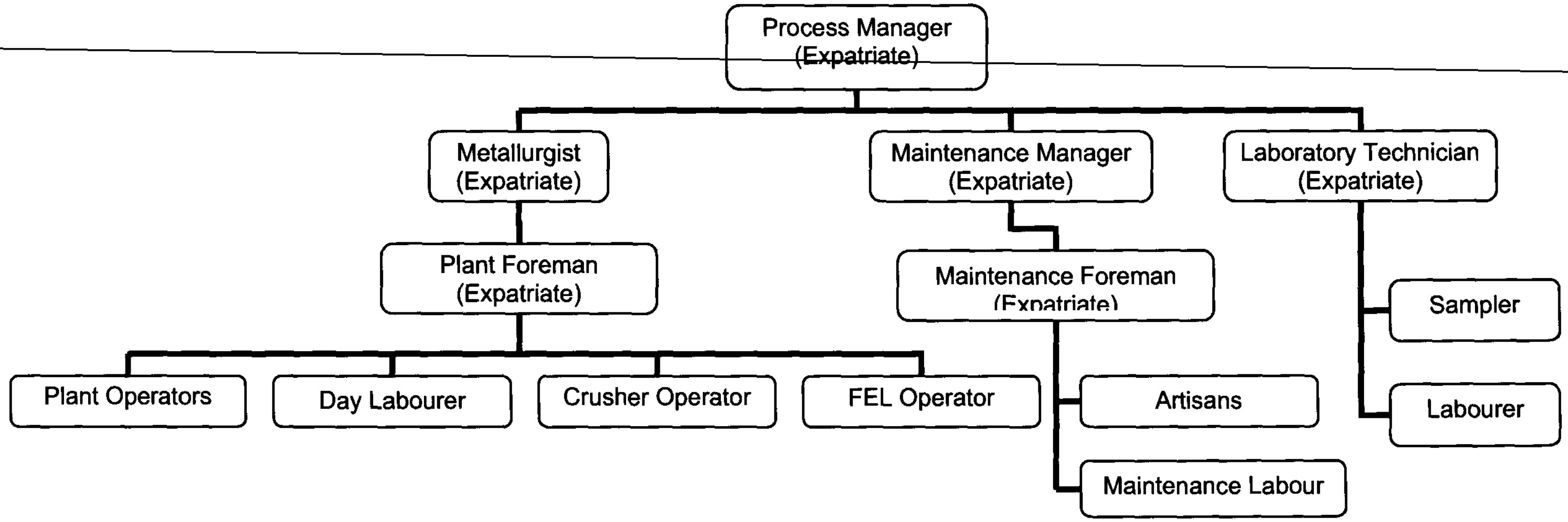
HEAD OFFICE



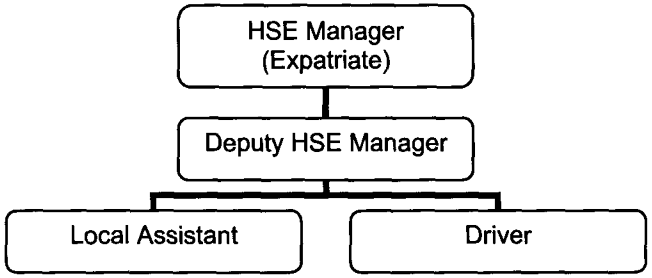
MINING/GEOLOGY DEPARTMENT



PROCESSING DEPARTMENT



HEALTH, SAFETY AND ENVIRONMENT DEPARTMENT



ADMINISTRATIVE DEPARTMENT