ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

KALUKUNDI COPPER/COBALT MINE PROJECT DEMOCRATIC REPUBLIC OF CONGO

PART A – ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT

October 2008

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ACKNOWLEDGEMENTS

Envirolution would like to sincerely thank the entire team that were responsible for the compilation of this report and the specialist reports that contributed to it.

Thanks are also due to the Africo Resources team that provided support to the ESIA team members. In particular, Jacqui Raynes and Sauda Kilumanga are to be thanked for their generous assistance on site.

EXECUTIVE SUMMARY

Introduction

African Resources Limited (ARL) is the holder of an exploitation permit to mine copper and cobalt on the Kalukundi Concession in the Katanga Province of the Democratic Republic of the Congo (DRC). This concession is located 50 km east of the town of Kolwezi and 205 km west northwest of Lubumbashi, the provincial capital. Prior to exercising the right to mine, ARL has committed to complying with requirements for environmental and social impact assessment, both in terms of Congolese legislation and it terms of the requirements of international financial institutions that subscribe to the Equator Principles. ARL submitted an Environmental Adjustment Plan to the DRC government (approved April 2007) to fulfil its legal requirements. Subsequent to this, ARL appointed Envirolution Consulting to prepare the current Environmental and Social Impact Assessment (ESIA) to fulfil the requirements of the Equator Principles.

The ESIA is a comprehensive assessment of impacts that could occur throughout the life-cycle of the proposed mining project and it recommends measures to prevent and mitigate these impacts.

Motivation for the mining project

ARL is a publicly listed company and therefore needs to deliver value to its shareholders. Furthermore, the following direct and indirect benefits are expected to result from mining on the Kalukundi Concession:

- Capital investment of more than US$ 250 million;
- Generation of taxes and royalties to the DRC government;
- Assisting with the revitalisation of the Katanga region;
- Supporting the local transport industry;
- Injection of an estimated US$ 800 million into the local economy during the ten years (plus) of operation;
- Providing a market for local goods and services;
- Providing employment assurance for between 500 and 600 people and indirect support of an estimated 3000 people;
- Improvements in water, roads and communications infrastructure;
- Employee development through training programs;
- A general improvement in the standard of living;
- Provision of alternative livelihoods;
- Development of community organisational capacity.

Project description

The currently defined ore resources at Kalukundi occur within four fragments. The resources are predominantly composed of sulphides of copper and cobalt. However, the near-surface resources are oxides and an exclusively oxide ore zone has been delineated for processing for the first 10 years of operation. Mine life is expected to be extended through further exploration. Current planning includes the following phases:

- Phase 1: Site preparations and pre-production (Year 0);
- Phase 2: Mine production (Year 1 - Year 10);
- Phase 3: Future expansion (not covered by this ESIA);
- Phase 4: Decommissioning and closure.

Over the current planned life of the mine approximately 39.3 Mt of material will be removed. All operations will be by open pit mining methods.

An ore processing plant will be built on the site. The plant will operate according to well-established solvent extraction and electrowinning (SX-EW) process. Annual production of copper and cobalt cathodes will be 16,400 t and 3,800 t respectively. Waste rock from the open pits will be deposited in waste rock dumps adjacent to the pits. A single large tailings storage facility will be established on site to cater for waste generated by the SX-EW process. Due to dewatering of the open pits through boreholes and the use of minimal volumes of water in the SX-EW process, the mine will have a surplus of 22000 m^3 per day, which will be discharged into the streams on site. The footprint of the infrastructure on the concession totals 302 hectares.

The project will require the relocation of the existing Kisankala Village, which is located close to the middle of the concession area.

Description of the existing environment

Natural environment

The Kalukundi Concession is located in a belt of copper and cobalt-bearing ores, which extend over 700 km from Luanshya in Zambia in the southeast to Kolwezi in the northwest.

The concession ranges in altitude between 1375 m and 1500 m. The land is characterised by low relief, with the exception of the low metalliferous outcrops. The concession is drained by two westwards-flowing perennial streams in the northern portion of the concession, namely the Kii and Kisankala Rivers. Both of these watercourses have their origin on the concession. These streams enter the Lualaba River some 25 km west of the concession. Habitat integrity in these systems varies from undisturbed to highly disturbed: the most prominent source of disturbance being artisanal mining, which has deposited large volumes of sediment directly into the rivers.

The climate of the concession is characterised by summer rainfall (an average of around 1200 mm per year) and temperatures of between 20 and 28 ºC per year.

On a regional level, the study area is situated within the Miombo woodland belt of central Africa. Regionally, 475 vascular plants have been identified within this vegetation community. However, the local area is relatively fragmented and modified by human activity, reducing the numbers of species that exist. Broadly speaking four vegetation communities occurs within the concession area:

- Miombo woodland;
- Copper-cobalt outcrop associated vegetation;
- Dambo Wetland; and
- Gallery forest.

A total of 266 plant species have been identified within the mine concession. In addition, 11 species that were not identifiable to family or genus level occur within the study area. Miombo woodland was found to be the most diverse with 183 species recorded, copper outcrops with 69 species but with a high degree of endemism; riparian communities with 35 species; dambo communities with 24 species and disturbed areas recorded 17 species.

The mine region is located in an area of relatively uniform biotic complexity that has previously been poorly surveyed. It has high faunal species diversity, but no centres of endemism. The large bird and large mammal faunas are impoverished due to overgrazing and other human-induced impacts. Thirteen amphibians were confirmed on the mine site during the field survey, none of which are threatened. Eighteen reptile species were recorded in the field survey and a further 39 species probably occur in the region. One problematic species (Variable skink, *Trachylepis varia* complex) was collected and may represent a novelty that requires further study. Seventy-three bird species were recorded on the concession, including most of the common resident species. Many species occurring in the region are, however, absent from the Kalukundi concession due to high levels of disturbance. Over 200 mammal species occur in southern Katanga, but most large mammals are absent on the concession due to hunting. A very large proportion of the mammals that do occur on the site are insectivores, particularly bats.

Ten species of fish belonging to seven families have been found in four sampling sites within the concession area. These include an unknown snoutfish (*Hippopotamyrus spp*.) and an unknown earfish (*Keneria spp*.).

These are of particular importance in terms of conservation, as both species are considered to be un-described and in need of further investigation.

Social and economic environment

The closest major town to the concession area is Kolwezi. This is a well-established mining town, with considerable existing infrastructure including a railway, power supply, and a small airport with international status. Kolwezi town has an estimated population of 418,000 people. The two closest permanent settlements to the project area are Kisanfu and Kisankala villages. Kisankala village is within the concession area while Kisanfu is 2.5 km south of the concession area boundary. Conditions within these villages are poor, with most structures being temporary structures erected by highly mobile artisanal miners. The artisanal miners' population makes up 75% of Kisankala Village, which is far greater than that of 'original' inhabitants.

There is very little educational infrastructure in and around the Kalukundi Concession. There are only three primary schools within the immediate area, including one in Kisankala village.

Health services in the area around the proposed Kalukundi mine are poor. Clinics provide very basic services. Although there are six "clinics" in Kisankala village, none of these are run by trained personnel. The nearest formal clinic is in Kisanfu. Prior to the establishment of boreholes and taps by ARL, Kisankala village had no formal water supply and was dependent on water from springs. There is no electricity supply in the area, although high-tension lines cross the southern part of the concession. The road network is in poor condition and telecommunications services are sparse.

Stakeholder engagement

Stakeholder engagement has been ongoing since the Environmental Adjustment Plan was prepared in 2007. This included an initial census and identification of permanent residents of Kisankala village. The Social Impact Assessment undertaken for this ESIA included a comprehensive social survey to determine attitudes to the mining proposal. This survey included semi-structured questionnaires and quantitative household surveys, focus group discussions. The issues that were raised by the public and responses to these issues are indicated in an Issues and Response Report.

Environmental and social impacts

The most significant impacts that would be caused by the proposed mining project at the Kalukundi concession are indicated in the table below.

Summary of the most significant impacts

Index no.	Impact	Phase	Significance	Significance with mitigation
1.1	Direct localised loss of rare habitats, in copper-cobalt vegetation communities within the concession	Construction, Operation & Closure	Very high	Don't Know
1.2	Direct localised loss of local endemic species, in copper-cobalt vegetation communities within the concession	Construction, Operation & Closure	High	Don't Know
1.3	Loss of sensitive habitats	Construction	High	Moderate
1.6c	Direct localised loss of biodiversity including rare habitats and local endemic species in Miombo vegetation communities	Closure	High	Moderate
1.6d	Direct localised loss of biodiversity including rare habitats and local endemic species, in Miombo vegetation communities. (94ha for WRDs 64ha for TSF causes loss of habitat for small mammals, birds and insects)	Construction, Operation	High (low)	Moderate
2.2	Water Quality – sedimentation & elevated turbidity	Operation	High	Moderate
3.1	Reduction in water quality	Construction, operation and closure	High	Low
3.2	Reduction in water quality due to metals from mining activities	Operation & closure	High	Low
3.6	Pesticide-induced increased mortality amongst pollinators, leading to reduced pollination of indigenous plants	Operation	High	Moderate (No significance)
5.1	Reduction in connectivity of habitats affecting movements of wildlife species that may be pollinators or dispersal agents of flora within Copper deposits	Construction, Operation, Closure	High	High
7.2	Stream Flow Reduction and flow alteration due to dewatering of the mine pits and lowering the water table	Construction, Operation & Closure	High	Moderate
8.1	Impact of changed flow regime on riparian plant communities (Gallery Forest and Dambo Wetlands)	Construction, Operation & Closure	High	Moderate
8.2	Impact of increased stream flow on the aquatic system	Construction & Operation	High	Moderate
12a	Public safety impact due to TSF failure	Operational	High	High
16	Intensification of utilization of areas outside of the concession area as a result of displacement of people from within the concession area	Construction, Operation & Closure	High	Moderate
19.1	Feelings of displacement for Kisankala village residents	Construction	High	Low
19.10	Dependency after closure of Kalukundi mine	Closure	High	Low
19.14	Sprouting of uncontrolled settlements	Construction and operation	High	Low

Index no.	Impact	Phase	Significance	Significance with mitigation
19.17	Economic displacement (Loss of livelihood and income) of those that had businesses in Kisankala village	Construction and operation	High	Low

Conclusions

The impacts of highest significance are those that will affect the natural environment. Although there are a number of social impacts of high significance, the majority are of moderate significance. Furthermore, it is clear from the description of the existing environment that the social fabric in the Kalukundi concession and indeed in the entire Katanga Province is already highly disrupted, and that the additional impacts that will be imposed by the project are similar in nature to the impacts that have already occurred through the migration of significant numbers of artisanal miners into the study area. Therefore, the disruption to social conditions and the existing social impacts are already very severe, and the project will not add substantially new impacts to those that are already present.

The positive economic impact of the project is highly significant, and the revenue from taxation that will accrue to government provides resources that can be used to significantly improve the condition of infrastructure in the Katanga region. The economic benefit to the local economy is also significant, since the project will not only support several hundred Congolese employees directly, but it will also support their dependents. This should result in a general improvement in standards of living in the study area.

In contrast to the social impacts, the majority of the impacts on biophysical resources are negative in nature and some of them will be difficult to mitigate. These include the impact on the aquatic systems and the impact on copper-cobalt associated flora, which occurs exclusively on the outcrops where the open pits will be created. Habitat for copper-cobalt associated flora is likely to disappear completely within the concession. Outcrops within the concession such as the Kesho fragment and Kinshasa fragment will not be mined in terms of current mining proposals, but are likely to be included in later plans. When the Katanga region is considered, it is clear that the cumulative impacts on copper-cobalt associated flora could be a potentially significant due to the proliferation of mining concessions across the province.

The impact on the aquatic environment will also be severe. Firstly, during operation of the mine, dewatering of the pits will lead to the Kii and Kisankala springs drying up. The surplus water will be released into the streams which will alleviate this, but may alter the flow dynamics and seasonality to such an extent that instream aquatic fauna will not be able to survive. After decommissioning, the water table is predicted to take 45 years to recover to its pre-mining level meaning these springs will remain dry during the dry season for decades after mining has ceased.

There is a relatively high degree of uncertainty associated with the mitigation of the impact on floral biodiversity and on the impacts on the aquatic environment. Further studies on the mitigation of the aquatic impacts and co-operation between the mines and government on a regional level to mitigate the impacts on copper-cobalt flora are essential.

Cumulative impacts associated with the proposed mining project are those related to the effects of the proliferation of mining operations in the region. The most important cumulative impacts are expected to be the following:

Recommendations

It is vital that further research is carried out in order to develop effective mitigation measures for the impacts on the aquatic system and offset conservation measures are implemented to mitigate the impact on copper-cobalt associated flora. Such measures must be undertaken in association with other mining companies and government.

It is recommended that Alternative Layouts B or D must be implemented, as this provides the greatest degree of certainty that impacts on the aquatic environment can be avoided in the event of failure of the tailings storage facility.

The Environmental and Social Management Plan must be implemented throughout the life of the mine and that a formal certified environmental, health and safety management system developed to give effect to the mitigation measures. An accredited certification body must certify such a system within a year of the commencement of operation.

Abbreviations/ Acronyms

AIDS	Acquired Immune Deficiency Syndrome
AMC	African Mining Consultants
ARL	Africo Resources Limited
ARD	Acid Rock Drainage
ASL	Above mean sea level
BFS	Bankable Feasibility Study
CCD	Counter Current Decantation
DRC	Democratic Republic of Congo
EAP	Environmental Adjustment Plan
EHS	Environment Health and Safety
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EW	Electrowinning
g/l	grams per litre
GÉCAMINES	Générales des Carrières et des Mines
HAZID	Hazard Identification Study
HAZOP	Hazard and Operability Study
HIV	Human Immunodeficiency Virus
IUCN	International Union for the Conservation of Nature
IFC	International Finance Corporation
LME	London Metal Exchange
l/s	litres per second
m	metre
m^3/d	cubic metres per day
m^3/h	cubic metres per hour
MSDS	Material Safety Data Sheet
MDM	Metallurgical Design and Management Ltd
Mt	Million tonnes
Mt/a	Million tonnes per annum
NAF	Non Acidic Forming
PE	Exploration Permit
PLS	Pregnant Liquor Solution
PMR	Plant Micro Reserve
PPE	Personal Protective Equipment
PS	Performance Standard
QRA	Quantitative Risk Assessment
RAP	Resettlement Action Plan
ROM	Run of Mine
SAWQG	South African Water Quality Guidelines
SIA	Social Impact Assessment
SNCC	Société National de chemins de fer Congolais
SOMIKA	Société Minière et Industrielle du Katanga
SSC	Species of Special Concern
STD	Sexually Transmitted Disease
SX	Solvent Extraction
TB	Tuberculosis
t	Tonnes
t/a	Tonnes per annum
TSF	Tailings Storage Facility
UNICEF	United Nations Children Fund
µm	micrometre
WHO	World Health Organisation
WRD	Waste Rock Dump

1 INTRODUCTION

1.1 Project Background

Gécamines and H & J Swanepoel Family Trust S.P.R.L ("H&J") formed a Joint Venture, known as the Swanmines S.P.R.L. in March 2001, with the intention of mining the copper and cobalt ore bodies at Kalukundi in Katanga Province of the Democratic Republic of the Congo (DRC). The DRC Ministry of Mines granted an exploitation permit (No. PE 591) to this Joint Venture on 11 October 2001

By way of an option agreement between Africo Resources Ltd (ARL), a then private British Columbian (B.C.) Corporation, and H&J, dated February 12th 2004, ARL could acquire 100% of the share capital of H&J by making cash payments totalling US$ 2.275 million over 4 years and by expending a minimum of US$ 3 million in exploration costs on the concession area.

In December 2007 ARL was listed on the Toronto Stock Exchange, Canada, and became a publicly traded company. ARL earned its 100% interest in H&J and had met its minimum work expenditure requirements in March 2007. As of the date of this report the ownership of the Swanmines S.P.R.L is in question and ARL is involved in various court proceedings to re-establish its ownership of Swanmines through its subsidiary H&J.

In December 2004 ARL/Swanmines S.P.R.L. engaged African Mining Consultants (AMC) to carry out an environmental impact assessment (EIA) and develop and environmental management plan for the Kalukundi Concession. The results of the studies were documented in an Environmental Adjustment Plan (EAP), which was compiled in terms of the requirements of the DRC's legislation (Mining Code of 2003 and associated regulations). This EAP was submitted to the DRC government in April 2007 and approved by the Secrétariat Général des Mines, Ministere des Mines on 25 April 2007.

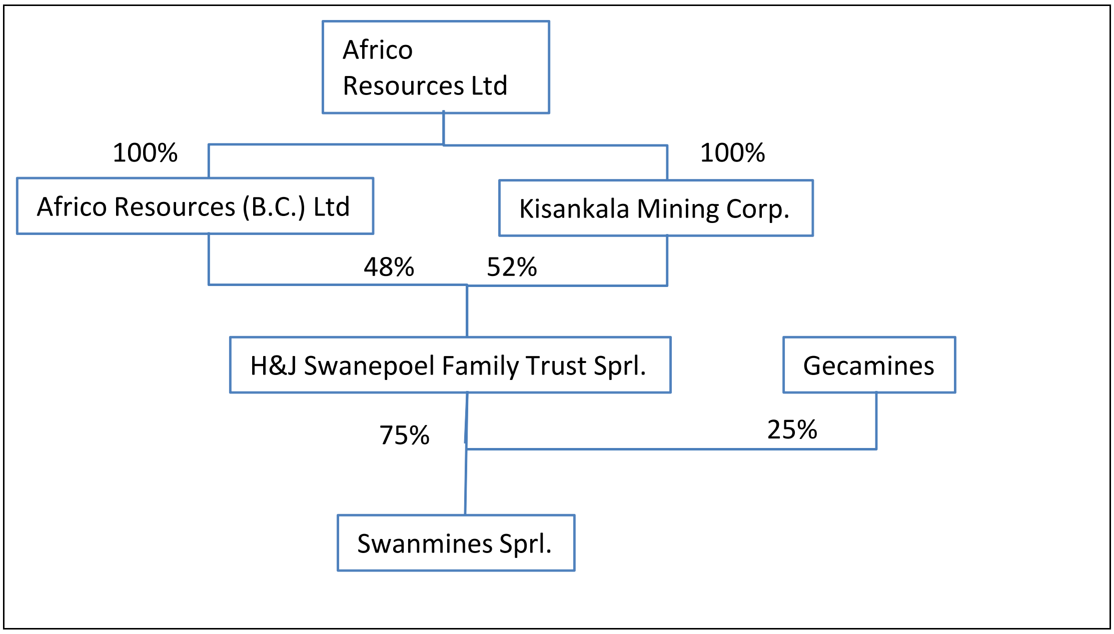

Figure 1: Corporate structure of ARL

Subsequent to this approval, ARL applied to the International Finance Corporation (IFC) for funding of the project. The IFC required amendments to the EAP so that it could fulfil their requirements of an Environmental and Social Impact Assessment (ESIA). Following a detailed review of the EAP by the IFC, the IFC produced a gap analysis that identified what additional work needed to be done in order to meet the IFC's requirements. This ESIA addresses the requirements of the IFC, although at the time of writing, ARL no longer intended to obtain financing through the IFC. ARL still intends to obtain financing through a bank that subscribes to the Equator Principles and as such, the IFC's requirements are an appropriate benchmark to use. The Equator Principles are an international set of principles used by participating banks to manage social and financial issues in project financing. They are designed to "*ensure that the projects that are financed are developed in a manner that is socially responsible and reflects sound environmental management practices*" (www.equator-principles.com. Accesses on 19 July 2008).

ARL appointed Envirolution Consulting (Pty) Ltd to compile the ESIA for the Kalukundi Project.

1.2 Project Location

The Kalukundi concession is located in the south east of the Democratic Republic of Congo in Katanga province within the Kolwezi District. The project area is located 50 km (56 km by road) east of Kolwezi and 205 km (220 km by road) west northwest of Lubumbashi, the provincial capital of the Katanga Province. The concession covers an area of 19.5 km^2.

The concession's southern boundary is located 2.5 km north of Kisanfu Village and the Likasi-Kolwezi railway line and 2 km north of the main Likasi-Kolwezi road. The concession area lies in the tribal administrative boundaries of the Kazembe Grouping, which forms part of the Luilu Sector. Kisankala Village, the only village within the concession, is located in the centre of the concession area. The villages of Kibenzebenze and Samba are located 10 km northwest and 6 km west north-west of the north-western corner of the concession area respectively. The project is located 32 km west of the Tenke Fungurume deposit controlled by Freeport–McMoRan Copper & Gold Inc. The Kolwezi - Lubumbashi High Tension power line (consisting of the Inga, Nseke and Nzilo power lines) passes through the concession area.

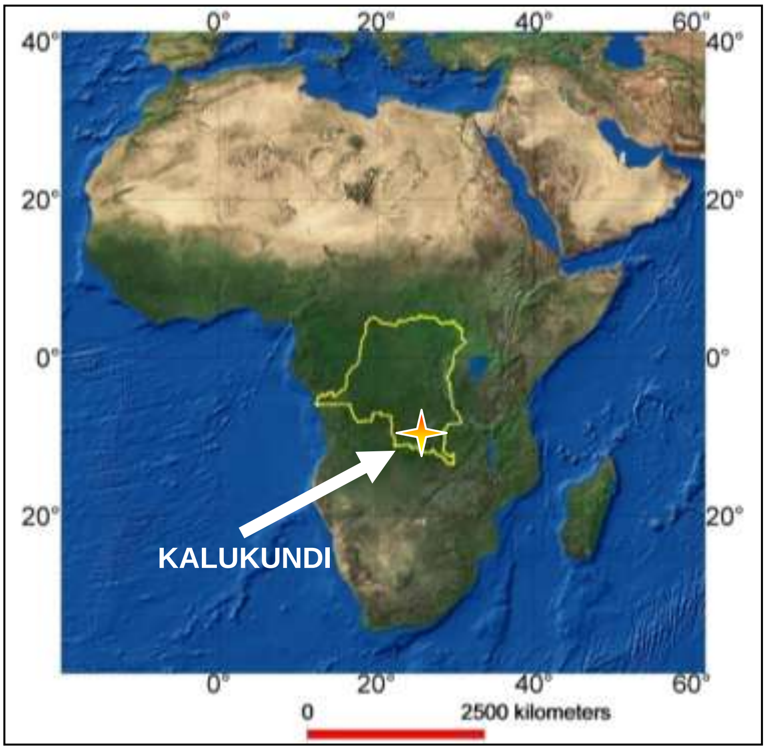

Figure 2: Regional location of Kalukundi project

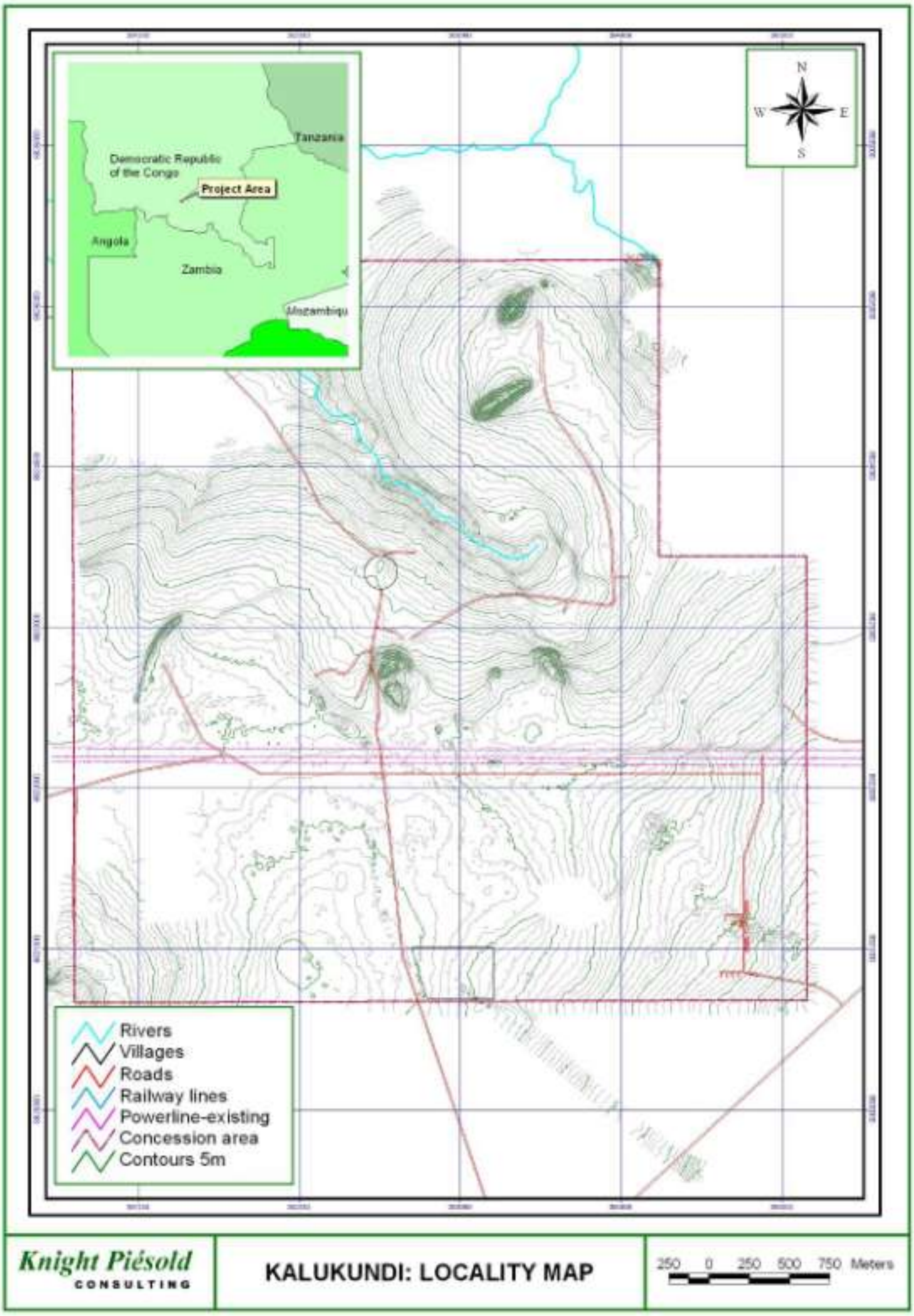

Figure 3: Locality map of the Kalukundi concession

1.3 Feasibility studies

Gécamines carried out exploration of the Kalukundi concession between 1986 and 1987. This preliminary work involved surface mapping, pitting, trenching and sampling followed by a limited diamond-drilling program. The Kalukundi concession contains a number of different structural "fragments" where viable ore is found. Exploration work carried out by Gécamines focused mainly on the Kalukundi C-5 Principal and Kalukundi North fragments; however there are at least a further five fragments (Kalukundi West, C-5 East, C-5 Southeast, C-5 West, and C-5 Southwest). Swanmines S.P.R.L. acquired the Kalukundi Mining Concession in 2001 and pre-feasibility work was undertaken in 2001 and completed in 2002. The pre-feasibility study included:

- A review of the Cobalt-Copper Potential of the Kalukundi Property undertaken by Albert John von Berg in May 2001. The work included a review of infrastructure, geology and proposed future exploration activities;
- Verification of Gécamines exploration results (GeoConsult December 2001-April 2002). Work undertaken included:
  - drilling of 12 boreholes (1440 metres);
  - clearing and re-sampling of existing trenches;
  - verifications of baselines and survey points; and
  - review of existing Gécamines documentation;
- Financial Modelling (Kalukundi Project-10 year base case) by M.P.D (Pty) Ltd. 2002;
- Metallurgical Report (Boylett, 2002).

In order to comply with the terms and conditions of the new Mines and Mineral Act of 2002, the boundaries of the EP242 were amended to the current configuration of 23 blocks, and the new exploitation permit (Permis de Exploitation) PE 591 was granted. A Bankable Feasibility Study (BFS) (MDM 2006) was carried out between October 2004 and May 2006. The work carried out in this study included the following:

- Ore reserve definition
- Optimisation of life of mine pit and sensitivity analyses;
- Analysis of pit development strategy and staged open pit designs;
- Preparation of proposed mine production schedules;
- Mining equipment productivity and first principles cost estimates;
- Sourcing and application of mining contractor budget quotes;
- Pilot plant metallurgical studies to optimise metal recoveries and processes;
- Design of process plant and site infrastructure;
- TSF design, water balance and drainage designs; and
- Geotechnical surveys of the mining area to determine building stability and safety requirements of all site infrastructure.

The Bankable Feasibility Study found the project to be technically and economically viable. Resource drilling was carried out by ARL staff and the feasibility report was prepared for H&J by the following team of consultants:

- MDM Ferroman Ltd, Process engineering (2005);
- RSG Global, resource & reserve definition, mine plan and financial modelling (April 2006);
- MDM Ferroman Ltd, Bankable Feasibility Study (2004/2006);
- AMC Consulting, Mitigation and Rehabilitation Plan (2004);
- AMC Consulting, Environmental Adjustment Plan (2007);
- Knight Piésold, Geotechnical evaluation (2006);
- Mintek, metallurgical Test work & pilot plant studies (2005); and
- Tailings design by Golder Associates Africa (Pty) Ltd.

1.4 Previous studies

The EAP was prepared by African Mining Consultants (AMC) of Zambia on behalf of ARL.

The Draft Resettlement Action Plan (RAP) was completed by Synergy Global Consulting Ltd (Synergy) of United Kingdom on behalf of ARL in May 2007 in accordance with IFC Performance Standard 5 on Land Acquisition and Involuntary Resettlement. A final RAP will be produced closer to the time of the resettlement of households and in consultation with the affected individuals.

1.5 Scope and Objectives of ESIA

The IFC has indicated that it considers the Project to be a category “A” project and as such an Environmental and Social Impact Assessment (ESIA) including an Environmental and Social Management Plan (ESMP) and a separate RAP are required.

The objectives of the ESIA are to:

- Identify potential negative and positive environmental impacts of the different alternatives considered;
- Provide technical information and recommendations to help select and design the best alternative, and;
- Prepare an environmental and social management plan (ESMP) which includes
    - a mitigation program
    - monitoring plan
    - program of technical assistance; and

- description of institutional arrangements for the preferred alternative.

The ESIA has been prepared in accordance with the requirements of the governments of the Democratic Republic of Congo and World Bank policies and procedures (refer to Chapter 2 on Policy, Legal and Administrative Framework for details).

In order to contribute towards sustainable development, an ESIA not only identifies and assesses the significance of environmental impacts, but also suggests ways to mitigate any negative impacts and optimise positive impacts. For the ESIA to contribute in this manner, its recommendations need to start being implemented in the early stages of project planning. This allows the environmental assessment to develop from a report to an actual process, and to become fully integrated with project planning. This philosophy has been used in this ESIA. This will help ensure that the social and environmental costs of the development are minimised, and that benefits are optimised.

1.6 Project Approach and Methodology

The methodologies for collecting baseline information for the Kalukundi Project have been formulated on the basis of:

- Relevant documents, including World Bank directives, guidelines and other documents;
- Relevant national legislation, regional and local legislation, policy papers and guidelines of the DRC land administration, resettlement, cultural and environment sectors;
- Available ecosystem survey plans, interviews with relevant environmental and social professionals, related reports and feasibility study; and
- Practical considerations including timeframes for ESIA, and the accessibility of the study area (given constraints imposed by the rainy season).

Wherever possible, the Envirolution team made use of available information for vegetation cover, topographical and geological maps, aerial photography and concession area surveys. The ESIA report also makes use of the socio-economic information collected for the RAP investigation.

The ESIA team conducted investigations to determine how various infrastructural developments of the Kalukundi Project will affect the various environmental parameters. The team focused the surveys on potential effects of the project on land degradation, fauna and flora, icthyofauna, the social and economic environment as well as water use demands by both animals and people in the concession area.

The following procedure was followed during the compilation of this ESIA:

- **Project Initiation**: communications were held with all the members of the ESIA team to pro-actively plan and share information that would help prepare for the subsequent project actions which included site visits and any requirements that would enable the production of the desired results;
- **Project Start up meeting**: A meeting held between Project managers and ARL and between the ESIA team and ARL while on site;
- **Review of all available information**;
- **Site visit**: included a five day visit to Kalukundi for a total of 11 specialists to undertake investigations for each of the specialist disciplines;
    - **Social Impact Assessment**: qualitative and quantitative social assessment methods were used and employment of multiple units of analysis to enrich the social assessment study;
    - **Botanical Assessment:** to determine the terrestrial flora within the study area and assess its conservation status and ecological importance;
    - **Terrestrial Fauna Assessment:** to determine the existing terrestrial fauna within the study area. An assessment of the site conservation status and ecological importance was undertaken in order to identify habitats of importance for terrestrial fauna;
    - **Icthyofauna (Fish) Assessment**: to determine the fish species found in water bodies (lakes, pans, streams and rivers) within the study area. Assessment of the conservation status and ecological importance of these fish species and the present ecological status of the aquatic habitats were also undertaken;
    - **Land Degradation Assessment**: an overview of the landforms and vegetation present, an assessment of surface erosion, the present ecological state of the vegetation (in collaboration with the botanist involved with the study) and an assessment of current and potential impacts on ecological processes;
- **Compilation of impact assessment** and mitigation measures for the project components;
- **ESMP**: Upon the completion of on site assessment by the specialist team, an ESMP was compiled based on the findings of the specialist assessment and the proposed mitigation measures thereto; and
- **ESIA Report Compilation and Submission**: this included submission of this ESIA Report and associated specialist studies.

2 PROJECT MOTIVATION

As a publicly listed company in Canada, ARL clearly has to deliver value to its shareholders and the exploitation of minerals resources such as the concession at Kalukundi provides the means for it to deliver this value. The exploitation of these resources will clearly benefit ARL and its shareholders financially, but apart from these direct benefits to the company, there are a number of direct and indirect benefits or positive impacts that the project could have on the Kalukundi environment and the broader regional environment in the DRC.

According to ESF Consulting (2008), the following benefits could be expected from the project:

2.1 Economic benefits

2.1.1 Macroeconomic benefits

The Kalukundi Project will represent a capital investment of US$ 250 million directly in the DRC economy. This capital cost is mainly associated with the development of the open pits, purchasing of the mine fleet, construction of the TSF, Waste Rock Dumps (WRDs), workshops and the processing plant, and ancillary infrastructure such as housing. The injection of this direct foreign investment will boost the economy of the country through foreign exchange and capital.

The project is expected to generate economic benefits over the life time of the mine. These benefits will include payments to the Government through taxes and royalties of approximately US$ 200 million, dividends to Gécamines of approximately US$ 125 million and payments to suppliers and employees of US$ 800 million. These estimates have been based on long-term cobalt and copper price forecasts.

Based on taxation and national royalties for the project as specified by the DRC mining code, DRC government will retain a 2% royalty (revenue less selling expenses) as outlined in the Mining Code Article 241. Based on current estimates, this may translate to in the region of US$ 380,000,000 for the life of mine, at 2008 international market rates for copper and cobalt.

The project will also contribute to the DRC economic growth through primary taxes under the mining code, including income tax (30% of taxable profit) and import duties, which vary from 2% to 50% depending upon the article (under Article 234 of the Mining Code, title holders are exempt from customs duties and other taxes relating to exports in relation to the mining project.) The project will also have a cumulative impact on the general economy of the area, especially the once vibrant mining town of Kolwezi, which has started seeing increased investment after years of neglect due to the collapse of the mining industry. The spill over effects of the investment should be seen in improved infrastructure and services such as transport and communication.

The local transport industry will also benefit from the project through importation of supplies and exportation of the copper and cobalt that will be processed from the Kalukundi project.

2.1.2 Microeconomic benefits

The project will directly and indirectly inject US$ 800 million to the local economy of the area through supplies and salaries over the initial 10 years. However, due to lack of a strong rural economy and suppliers at the local level, initially most of the supplies will be sourced from outside the area. Thus, mainly the salary proportion of this expenditure will benefit the local population. This figure will spur the micro economy of the area by increasing cash flow which in turn will increase the purchasing power of the local population, boosting trade with the outside through supplies of goods and services. Increased cash flow will create more employment opportunities for the local inhabitants as well as in the regional economy.

Employment will result in increased purchasing power for the local community, with indirect benefits for small businesses and also for local government through increased tax collection. The project will inject more than US$ 100,000 a month into the economy through salaries to local employees.

The project is also expected to act as a catalyst for local procurement. Although the mine has specific equipment requirements that cannot be met easily by the local supply, there are still many goods and services that can be purchased locally. The community can supply food to the mining camp such as locally available fish from Lake Nzilo, and locally grown vegetables..

Some of the employees will be sourced from the villages, and some new employees, if not housed in ARL accommodation, will look for accommodation in the surrounding villages, giving the local population an opportunity to earn rental incomes. The local population can exploit these shortfalls and build houses for rent for ARL employees, or the employees themselves may rent houses creating sources of income and employment for the local population.

Although the artisanal mining sub sector generates income to the local economy, the sub sector is not stable as it depends on an individual's ability to deliver or mine minerals, the rudimentary technology to mine the ores and the inability of the miners to get access to good ore deposits affects their productivity, and the good-will of the buyers. On the other hand, large scale mining projects like ARL use modern technology and have access to international markets which provides the employees with assurance of a continuous stable income with other additional benefits including medical care, safe working environment, housing, equipment and social facilities.

2.2 Employment

Employment will be created during planning and preparation, construction and operational phases of the project. The Project is expected to create employment for between 500 and 600 people either directly or through contractors during the initial 18 months of preparation. During the mine operations, approximately 460 Congolese nationals and 72 expatriates will be employed directly by ARL. Additional jobs are expected to be generated in the service sector in Lubumbashi, Likasi and Kolwezi. Furthermore, more than 3000 people will benefit directly as a result of their relationship to the employees (based on an average of 8 people per household).

2.3 Improvement of roads and telecommunication infrastructure

Kalukundi project expects to invest in maintenance of local roads in the project area. Improvement and maintenance of local roads will not only facilitate speedy movement of materials for the project, but will also improve movement of goods, including agricultural produce. Road maintenance will enable public transport to resume and open up areas that were once inaccessible. Due to the presence of the project, there will be an increase in demand for cell phone connectivity in the area, and the density of cell phones will increase when the service provider installs a booster mast to improve coverage. For development to take place, a good transport and communication network is a must to support access to health care, agricultural produce markets, education and other socio-economic needs.

Though not as a result of the Kalukundi project, air travel was developed in the area due to the recent resumption of mining activities in the region. The Kalukundi project will, together with the other mining projects, assist in reducing the cost of air transport and improve the air transport capacity.

2.4 Skills development

The employees will benefit from training programmes that will be instituted by ARL to enable the local labour force to work in the different areas of mining operations. This training will build a critical mass of technicians, plant operators, electricians, and mechanics, among others that will not only benefit ARL but also the local population at large during and after the project life.

2.5 Improved standards of living

Employment opportunities created by the project are expected to improve the overall standard of living in the area. The villagers who will feel this impact immediately will be the residents of Kisanfu and Kisankala. With time, the larger area of Mutshatsha territory should start to benefit with improvement in health care, increased disposable income, increased trade in goods and services and improved education. Another aspect of improvement in standard of living will be through improvement in housing and sanitation when better permanent houses are constructed by ARL in the new Kisankala village.

2.6 Alternative livelihoods

Katanga has been the centre of artisanal mining, which is blamed for some of the negative social issues that face some mining towns in DRC, including low school enrolment, prostitution, child labour, hazardous working environment, alcoholism, drug addiction and the spread of STDs such as HIV/AIDS. The commencement of the Kalukundi Project will provide an alternative livelihood to some of these people who will be directly employed and provided with support services such as housing, food, health care, training, water and sanitation.

2.7 Development of community organisational capacity

Through engagement of community members in development initiatives such as Community Development Committees, the community organizational capacity will be developed. Already some of these organizational skills are being developed through the establishment of various sub-committees within the Kisankala Village Development Committee (KVDC).

2.8 Improved water supply

Supply of safe drinking water for the community has improved water supply especially in the village of Kisankala. This benefit will be transferred to the new village to be constructed by ARL.

2.9 Improvement of living and working conditions for women

Women have been marginalised by traditional attitudes and do not have access to well-paying and safe employment opportunities. Congolese women in the area, especially in Kisankala village, will get the opportunity to work in an environment on the mine where proper health and safety measures are in place. Employment opportunities in the mining project will provide a more sustainable and safer working environment for women.

2.10 Economic exposure and development

Implementation of the project will bring financial institutions as well as related economic facilities, infrastructure and services close to the people. This will expose and introduce the local population to factors of economic development including the banking system, financial services, and credit and investment schemes. The exposure will enable community members to invest their income and prevent dependency or living a life of “tomorrow will take care of itself” as is the case with the artisanal miners.

3 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

In accordance with the laws applicable to Kalukundi Project, the laws of the DRC and the Equator Principles (a set of environmental and social benchmarks, developed by private sector banks, for managing environmental and social issues in development project finance globally) apply to the planning, construction, operation and closure of the Kalukundi Project. The project will also be governed by applicable national and international guidelines for environmental resources, environmentally sensitive areas and culturally sensitive features. The environmental quality standards of the DRC 2002 New Mining Code and Annex IX of the Decree N°038/2003 of 26 March 2003 in the Mining Regulations were also applied in this ESIA analyses.

3.1 Applicable laws of the DRC

3.1.1 Registration of the exploitation permit

Records of the Mining Registry indicate that Swanmines is the holder of Kalukundi Exploitation Permit. The Kalukundi Exploitation Permit was issued by the Mining Registry (Cadastre Minier) further to an application by Swanmines to convert its old mining title (Concession No. 242) into an Exploitation Permit. Under the previous mining legislation of the DRC (Ordinance-Law No 81-013 of 2 April 1981), Swanmines was the holder of Concession No. 242 granted by Ministerial Decree No. 135/CAB.MINESP.

Following the enactment of Law No. 007/2002 of 11 July 2002 (the "Mining Code") and Decree No. 038/2003 of 26 March 2003 (the "Mining Regulations"), the holders of mining rights were required to validate their mining rights and to apply with the Mining Registry for the conversion of their existing mining right into one of the mining rights as recognised under the Mining Code and to adapt the shape of their mining perimeters to the new cadastral grid. According to the list of validated mining rights published in the official gazette on 15 April 2003, Swanmines has duly validated its right over Concession No. 242. Swanmines then converted Concession No. 242 into Exploitation Permit No. 591 once the shape of the mining perimeter that it covers had been adapted to the new cadastral grid.

3.1.2 The DRC Constitution

The Constitution of DRC aims at protecting the liberties and fundamental rights of Congolese citizens and, particularly, at defending those of women and children. Article 6 reiterates that the soil and subsoil are the property of the State, and that the conditions of their relinquishment are established by law, which must protect the interests of local populations. According to Article 34, the expropriation of assets for general interest or public utility purposes can only take place according to a law that provides for the prior payment of an equitable compensation.

3.1.3 Mining Code

The main piece of legislation governing mining activities is the Mining Code enacted by the Law No. 007/2002 of 11 July 2002. This core legislation includes environmental requirements applicable to mining activities. According to the code, the Directorate of Mines is responsible for inspecting and supervising mining activities with regard to safety, health, work practices, production, transport, sale and social matters. The code gives provisions to the State and ensures the development of the minerals it owns by privatisation.

According to the Mining Code, 25% and 15% of mining royalties, respectively, revert to the province and district/city impacted by the respective mining project. In this case the province and district that will benefit are Katanga and Kolwezi respectively. A portion of the mining royalties reverting to the communities is an important factor in demonstrating sustainable benefits to communities impacted by mining project, and forms an important increment to any communities and social activities voluntarily implemented by the mining companies. ARL will seek to help ensure that this aspect of the law is implemented with regards to the project, supported by capacity building at the provincial and district government levels.

Similarly, IFC considers the governance risks to the realisation of the project benefits to be reasonable. This view is based on the overall situation in the DRC and the range of benefits this project can bring to the local communities in addition to potential benefits at the national level. This is in addition to a project sponsor that is committed to governance and transparency, and supported by on-going sector reforms being established by the Government of the DRC and the World Bank.

The Mining Code also allows for artisanal mining rights through the provisions of Chapter 1, Article 109 on creation of artisanal mining areas. Artisanal mining areas are created pursuant to an order issued by the Minister after receiving an opinion from the Directorate of Mines and of the Governor of the province concerned. A mining perimeter covered by a valid mining title cannot be transformed into an artisanal mining area. According to the code such a perimeter is expressly excluded from the artisanal mining areas created in accordance with the provisions of this chapter. The creation of an artisanal mining area is notified to the Mining Registry, which proceeds to insert it in the registry survey map. As long as an artisanal mining area exists, no mining title can be granted over the area, except for an exploration license applied for by a group of artisanal miners who are working in the area. However, the Geology

Directorate may at any time proceed to prospecting and exploration work in the artisanal mining areas.

The code also provides for the Directorate of Mines to be in charge or responsible for inspecting and supervising mining activities with regard to safety, health, work practices, production, transport, sale and social matters.

3.1.4 Land Law

In terms of DRC land law (1973), the state owns all land including public land (such as land where public infrastructure is established, e.g. roads) and private property. These lands can be conceded to third parties according to defined modalities that are based on anticipated use. The 1973 Land Law recognises customary occupation of rural land and customary rights, but few details are provided on customary land management. In general, the law essentially addresses the regime applicable to concessions of urban land and of large pieces of rural land intended for intensive, mechanised crops.

3.1.5 Mining Regulations

The Mining Code is supported by the Mining Regulations enacted by the Decree No. 038/2003 of 26 March 2003. The Mining Regulations set out the organisation and operation of the Directorate of Mines to inspect and supervise mining activities with regards to safety, health, work procedures, production, transport, sale and social matters. The regulation also establishes Service d'Assistance et d'Encadrement de Small Scale Mining (SAESSCAM) as the department responsible for assistance and supervision of small-scale mining.

According to Article 405 of the mining regulations, the titleholder of the mining rights must develop and implement plans so as to avoid harm to the health and safety of the employees and communities.

Article 451 of the Regulation requires consultation with the public and the community in the area affected by a project. The consultation needs to be undertaken during the EIA process through active involvement of the local communities affected by the project. The public consultation programme has to provide for the presentation and explanation of the exploitation work programme, the negative and positive impacts resulting from the project and the mitigation and rehabilitation measures to the local communities affected and take note of their reactions, questions and concerns. The representative of the mining company responsible for public relations with the local communities is required to present this information timeously to the Administrator of the Territory and to the representatives of each community concerned.

ARL is required to establish a good relationship with the community directly affected by the project through establishing with the communities concerned, their main activities, their social and cultural values, informing the local communities of the exploration work programme and the negative and positive impacts of the exploration project, consulting with the communities affected when determining programmes for mitigation and rehabilitation and compensating the people affected by the exploration project.

The measures establish the basis for a relationship aimed at a good understanding between the mining company and the local communities affected by the project.

Whilst reaffirming ownership of the minerals of the national territory by the Congolese State, the Mining Code also emphasises the environmental constraints and the compensation of the land users paid by the mining industry. Article 42 of the Code requires mining licence applicants to prepare an ESIA and an ESMP to support the licence application.

3.1.6 Resettlement

The legislation that guides resettlement in the DRC is the Mining Code (Law No 007/2002 of July 11, 2002). This is also reiterated in Article 34 of the DRC Constitution which states that expropriation for general interest or public utility purposes can only take place according to a law that provides for the prior payment of equitable compensation.

Article 281 of the Mining Code states that any occupation of land or any modification that renders the land unfit for cultivation and or that deprives the owners of surface rights of the enjoyment of these rights, is subject to compensation. The holder or the lessee of the mining and/or carrier rights must, upon request of the parties entitled to the land, pay fair compensation amounting to either to rent or the value of the land at the time of its occupation, plus 50% (see Table 1).

Table 1: Domestic legislative provision for compensation

Article 281: Compensation for the occupants of the land
Any occupation of land depriving the rightful holders of enjoyment of the surface rights, any modification rendering the land unfit for cultivation, shall cause the holder or lessee of the mining and/or quarry rights, at the request of the rightful owners of surface rights, and at their convenience, to pay fair compensation, corresponding either to the rent or the value of the land at the time of its occupation, plus 50%. Land, as referred to in the above paragraph, means the ground on which the individuals have always carried out or are effectively carrying out any activity. Amicable settlement of the dispute may be made by any legitimate method other than resorting to the courts, especially by compromise, settlement, arbitration or before an Officer of the Judiciary

Police or an Officer of the Public Ministry.

In the absence of an amicable settlement between the parties within 3 months from the date on which the dispute arises, the compensation shall be determined by the competent court pursuant to the rules on judicial organisation and jurisdiction in force in the DRC.

However, the usual occupant of the land may, in agreement with the holder, continue to exercise his right to cultivate the land provided the work in the fields does not hinder the mining activities. The owner of the surface rights shall than no longer continue to construct buildings on it.

Lastly, simply passing through the land does not entitle to pay compensation if no damage results there from. The act of passing must take place with a view to best conserving the environment.

3.1.7 Administrative structures

The administrative governing structures in the DRC include the following:

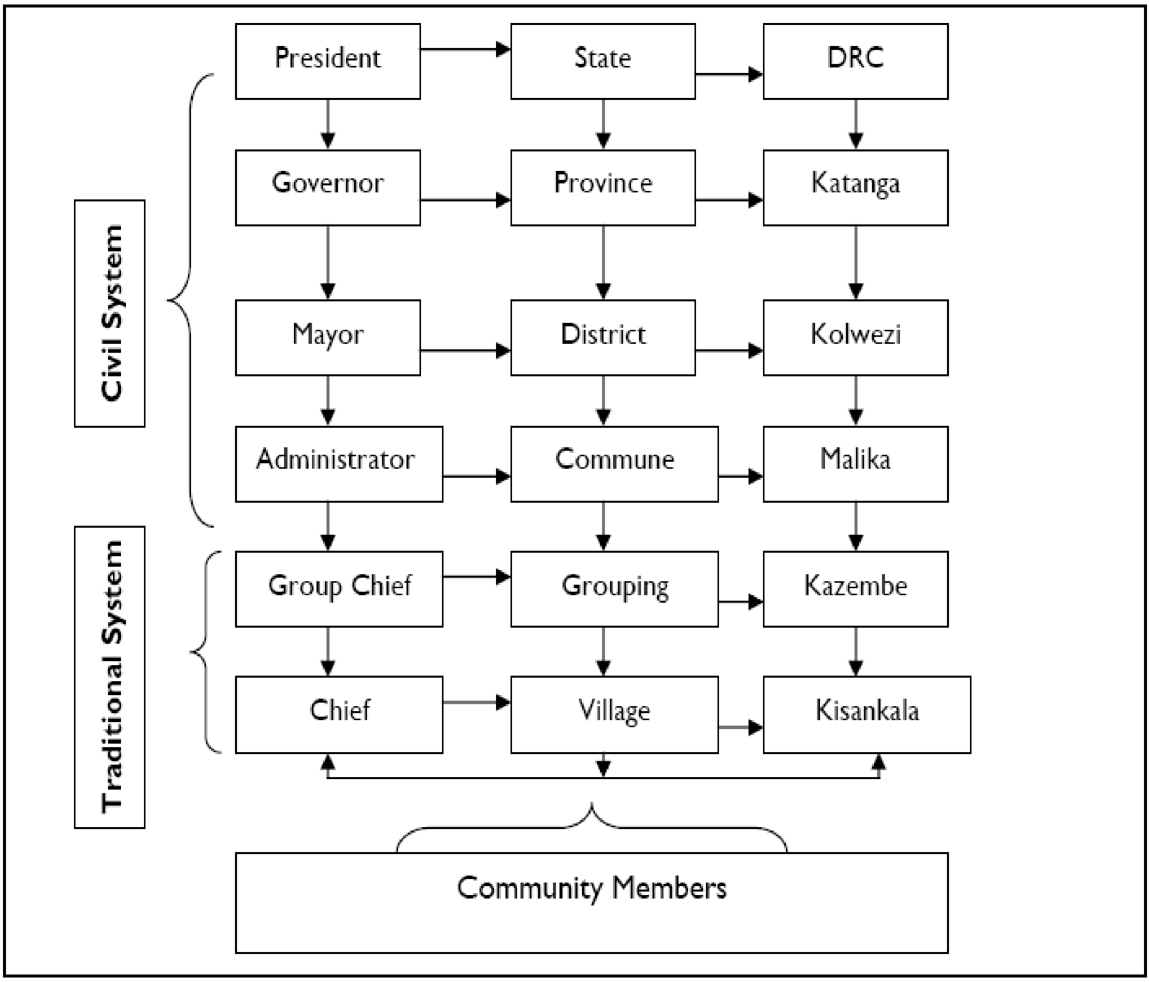

Figure 4: Administrative structure of the DRC from national to local level

3.2 Requirement and guidelines of funding agencies

ARL has elected to abide by the Equator Principles. The Equator Principles are a set of guidelines, developed by private financial institutions, for managing environmental and social issues related to project financing. These principles are aligned with the requirements of the International Finance Corporation (IFC), which has established a set of Performance Standards that govern environmental considerations of project financing. The IFC's Performance Standards have therefore been used as the yardstick against which to measure compliance with the Equator Principles. The Equator Principles are devised to promote environmental stewardship and responsible development in the context of project financing.

Projects are categorised based on the magnitude of the potential social or environmental impacts and risks of that project, in accordance with World Bank Group classification criteria. These categories are:

- **Category A:** Projects with potential significant adverse social or environmental impacts that are diverse, irreversible or unprecedented;

- **Category B:** Projects with limited adverse social or environmental impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures; and

- **Category C:** Projects with minimal or no social or environmental impacts.

Mining projects, by their extractive nature, tend to fall into Categories A or B, being high or medium risk. The Kalukundi Project falls under category A.

For Category A and B projects, the borrower must conduct a social and environmental assessment (i.e. this ESIA) to determine the social and environmental impacts and risks of the project, and to propose relevant and appropriate mitigation and management measures in respect of the project.

For projects located in emerging markets such as the DRC, the ESIA must refer to IFC Performance Standards and industry-specific environment, health and safety guidelines.

The impact of the Equator Principles on mining and metals finance in emerging markets and the World Bank's Pollution Prevention and Abatement Handbook will also apply generally to projects. The ESIA must establish the project's overall compliance with, or justified deviation from, the applicable standards and guidelines.

To satisfy the requirements of the performance standards, ARL must prepare an action plan that addresses the relevant findings and draws on the conclusions of the ESIA. The action plan should describe and prioritise the actions needed to implement mitigation measures, corrective actions and monitoring measures necessary to manage the impacts and risks identified in the ESIA. Furthermore, ARL must establish and maintain a social and environmental management system that addresses the management of the action plan.

Communities that could be affected by a project must be consulted in a structured and culturally appropriate manner to ensure their free, prior and informed consultation. Their informed participation must be facilitated as a means to establish whether a project has adequately incorporated the concerns of affected communities.

To accomplish this, the assessment documentation and action plan must be made available by ARL to the public for a reasonable minimum period, in the relevant local language. The borrower must also take account of and document the process and the results of the consultation.

To ensure consultation continues throughout construction and operation of the project, ARL must establish a grievance mechanism as part of its management system.

The IFC applies the Performance Standards (PS) to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. The IFC Performance Standards cover the following topics:

- PS1: Social and environmental assessment and management systems
- PS2: Labour and working conditions
- PS3: Pollution prevention and abatement
- PS4: Community health, safety and security
- PS5: Land acquisition and involuntary resettlement
- PS6: Biodiversity conservation and sustainable natural resource management
- PS7: Indigenous people and natural resource dependent communities
- PS8: Cultural heritage

The PS's are summarised below and the full text can be obtained from www.ifc.org

3.2.1 PS 1: Social and Environmental Assessment and Management Systems

PS 1 aims at managing social and environmental performance throughout the life of a project. An effective social and environmental management system is a dynamic, continuous process initiated by management and involving communication between the client, its workers, and the local communities directly affected by the project.

The objectives of the standard are summarised as:

- to identify and assess social and environmental impacts;
- to avoid, minimise, mitigate, or compensate for adverse impacts on workers, affected communities, and the environment;
- to ensure that affected communities are engaged; and
- to promote improved social and environment performance through the effective use of management systems.

PS 1 covers social and environmental management systems, social and environmental assessment, management programs, organizational capacity, training, community engagement, and monitoring and reporting.

3.2.2 PS 2: Labour and Working Conditions

PS 2 aims to establish, maintain and improve the worker-management relationship that promotes the fair treatment, non-discrimination and equal opportunity of workers, and compliance with national labour and employment laws. This standard also aims to protect the workforce by addressing child labour and forced labour and promoting safe and healthy working conditions, and to protect and promote the health of workers.

PS 2 covers human resources policy, working relationships, working conditions and terms of employment, workers organizations, non discrimination and equal opportunity, retrenchment and grievance mechanisms. Under ‘Protecting the Work Force’ it covers child labour and forced labour. Occupational health and safety, non-employee workers and supply chain are also discussed.

3.2.3 PS 3: Pollution Prevention and Abatement

PS 3 outlines a project approach to pollution prevention and abatement in line with internationally disseminated technologies and practices. The objective is to minimise adverse impacts on human health and the environment, and to reduce the emissions that contribute to climate change.

PS 3 covers pollution prevention, resource conservation, energy efficiency, wastes, hazardous materials, emergency preparedness and response, technical guidance, ambient considerations, greenhouse gas emissions, pesticide use and management.

3.2.4 PS 4: Community Health, Safety and Security

PS 4 addresses the proponent's responsibility to avoid or minimise the risks and impacts to community health, safety and security that may arise from project activities. The objective is to minimise risks and impacts on the health and safety of the local community, and to ensure the safeguarding of personnel and property.

PS 4 covers community health and safety requirements, infrastructure and equipment safety, hazardous materials safety, environmental and natural resources issues, community exposure to disease, and emergency preparedness and response.

3.2.5 PS 5: Land Acquisition and Involuntary Resettlement

Involuntary resettlement refers to both physical displacement (relocation or loss of shelter) and economic displacement (loss of assets or access to assets that leads to loss of income sources or means of livelihood) as a result of project-related land acquisition. Resettlement is considered involuntary when affected individuals or communities do not have the right to refuse land acquisition that result in displacement. The requirement to move Kisankala Village is classed under 'Involuntary Resettlement' and must be managed according to this PS.

The objective of PS 5 can be summarised as:

- To minimise involuntary resettlement;
- To mitigate adverse social and economic impacts;
- To improve or restore the livelihoods of displaced persons;
- To improve living conditions among displaced persons.

PS 5 covers project design, compensation and benefits for displaced persons, consultation, grievance mechanisms, resettlement planning and implementation, displacement (physical and economic), private sector responsibilities under government managed resettlement.

3.2.6 PS 6: Diversity Conservation and Sustainable Natural Resource Management

PS 6 addresses how clients can avoid or mitigate threats to biodiversity arising from their operations as well as sustainably manage renewable natural resources. The objective is to protect and conserve biodiversity and to promote sustainable management and use of natural resources.

PS 6 covers protection and conservation of biodiversity, habitat (modified, natural and critical), legally protected areas, invasive alien species, management and use of renewable natural resources, natural and plantation forests, and freshwater and marine systems.

3.2.7 PS 7: Indigenous Peoples

PS 7 recognises that indigenous peoples, as social groups with identities that are distinct from dominant groups in national societies, are often among the most marginalised and vulnerable segments of the population. The standard aims to protect the indigenous peoples as many a time economic, social and legal status often limits their capacity to defend their interests in, and rights to, lands and natural and cultural resources, and may restrict their ability to participate in and benefit from development.

There are no identified indigenous people at the Kalukundi concession, so this PS does not apply.

3.2.8 PS 8: Cultural Heritage

The aim of PS 8 is to protect irreplaceable cultural heritage and to guide proponents on protecting cultural heritage in the course of their business operations.

Cultural heritage refers to tangible forms of cultural heritage, such as property and sites having archaeological, palaeontological, historical, cultural, artistic, religious and unique natural value. Intangible forms of culture, such as cultural knowledge, innovations and practices of communities embodying traditional lifestyles, are also included.

The PS covers protection of cultural heritage in project design and execution, internationally recognised practices, chance find procedures, consultation, removal of cultural heritage, critical cultural heritage, and the project's use of cultural heritage

3.3 IFC Environmental, Health and Safety Guidelines for Mining

The IFC's Environmental, Health, and Safety (EHS) guidelines are technical references with general and industry-specific examples of good international industry practice. When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the General EHS Guidelines document, which provides guidance to users on common EHS issues potentially applicable in the mining sector. The EHS guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. The guidelines cover the following topics:

1. Environmental
    1.1 Air Emissions and Ambient Air Quality
    1.2 Energy Conservation
    1.3 Wastewater and Ambient Water Quality
    1.4 Water Conservation
    1.5 Hazardous Materials Management
    1.6 Waste Management
    1.7 Noise
    1.8 Contaminated Land

2. Occupational Health and Safety
    2.1 General Facility Design and Operation
    2.2 Communication and Training
    2.3 Physical Hazards
    2.4 Chemical Hazards
    2.5 Biological Hazards
    2.6 Radiological Hazards
    2.7 Personal Protective Equipment (PPE)
    2.8 Special Hazard Environments
    2.9 Monitoring

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

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

The IFC EHS guideline on mining and milling at open pit mines include information for tailings disposal, liquid effluents, ambient and workplace air quality, erosion and sediment control, mine reclamation, sewage sludge disposal, solid waste disposal, workplace noise, work in confined spaces, hazardous material handling and storage, general health and safety, training, and record keeping and reporting.

The guidelines require that safety hazards are identified based on job safety analysis or comprehensive hazard or risk assessment using established methodologies such as a hazard identification study (HAZID), hazard and operability study (HAZOP), or a quantitative risk assessment (QRA). In the approach, health and safety management planning should include the adoption of a systematic and structured approach for prevention and control of physical, chemical, biological, and radiological health and safety hazards.

3.4 International agreements

DRC has approved the following international conventions and protocols pertaining to the environment and which are of relevance to the Kalukundi Project:

- United Nations Framework Convention on Climate Change, 1992;
- Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal adopted on 22 March 1989;
- Bamako Convention on the Ban of the Import Into Africa and the Control of Trans-boundary Movement and Management of Hazardous Wastes within Africa, adopted 30 January 1991;
- Convention on Biological Diversity, 5 June 1992;
- United Nations Convention to Combat Desertification (UNCCD), adopted 1997;
- Convention on the Protection of World Cultural and Natural Heritage ratified 1975;
- Convention on the Means of Prohibiting and Preventing the Elicit, Import, Export and Transfer of Ownership of Cultural Property, ratified 2003;
- Montreal Protocol, 1985;
- Ramsar (wetlands) Convention; and
- The Kyoto Protocol.

The ratified treaties become part of the national laws and their provisions prevail in case of contradictions with the provisions of the national laws.

3.5 ARL Resources Policies

3.5.1 Environmental Policy

ARL has formally adopted an environmental policy that is endorsed by its CEO. This policy indicated that ARL is committed to developing and fostering a culture of environmental care, both within the company and in the community. As an international resource company, ARL is cognisant that its shareholders, employees and the community have a right to expect responsible environmental care.

As such, ARL states that it is committed to:

- Complying with environmental legislation and regulations as the baseline for environmental performance and striving to achieve best practice in every aspect.
- Managing operations to minimise or eliminate negative environmental impacts wherever practicable.
- Conducting business with service providers and contractors who have a similar commitment to the environment and who embrace ARL's environmental policy.
- Striving for the most efficient use of energy and water, the prevention of pollution and minimising waste by recycling wherever possible.

- Recognising that each generation is merely the custodian of the environment for the next and as such rehabilitating our sites to internationally accepted standards.

ARL states that it will embrace the principle of environmental care as part of its culture and will consider this principle in everything its does. This will underpin its success as a responsible resource company, without compromising the ability of future generations to meet their needs.

3.5.2 Community Relations Policy

As an international resource company, ARL understands it is a guest in all the countries in which it operates. As such, the company respects local culture and customs and aims to integrate into the surrounding community through its social development programs.

ARL's social programs are more then just 'a token gesture,' they are driven by ARL's values and in place so the community realises genuine and lasting benefits from ARL's presence in the area.

Where the required skills are available, ARL will recruit from the surrounding community. Similarly, where price and quality are acceptable, ARL's policy is to purchase locally, supporting the local economy.

In developing our Social Development Plan, ARL will utilise the process of 'Participatory Rural Appraisals' ensuring the community has full involvement and ownership of all projects in which ARL is a partner. ARL's considered areas of involvement will include health, education and agricultural projects.

3.5.3 Occupational Health and Safety Policy

ARL's Safety Vision is zero harm to their people, zero damage to equipment and a positive influence on all they come in contact with.

ARL is committed to providing a safe and healthy working environment for employees, contractors, consultants, visitors and any others who are impacted by ARL's activities; an environment where management and staff work co-operatively to protect the well being of each other.

The Company expects its management and employees to ensure no job is given such urgency or such importance, that personal well being or personal safety is compromised to achieve it.

Continuously improving occupational health and safety management and performance not only makes sound business sense but provides benefits to all employees through minimising the risk of injuries, illnesses and providing an enjoyable place to work.

ARL's Safety Policy is underpinned by the following obligations:

- **Responsibility** - Management is accountable for continuously ensuring a safe system of work. Each employee is responsible for always working within this system and for reporting and rectifying unsafe conditions.
- **Training** - Training is essential to improve safety awareness for employees and contractors. The Company will provide such training and engage the participation of every person in achieving a healthy and safe workplace.
- **Risks and Hazards** - ARL will have systems in place to identify risks and eliminate or control potential hazards in the workplace.

While the above obligations are necessary, everyone's participation and commitment is essential to ensure ARL's employees well being.

3.5.4 Human Resources Policy

ARL recognises that the pursuit of economic growth through employment creation and income generation should be balanced with protection for basic rights of workers. The workforce is a valuable asset, and a sound worker-management relationship is a key ingredient to the sustainability of the enterprise. Failure to establish and foster a sound worker-management relationship can undermine worker commitment and retention, and can jeopardize a project. Conversely, through a constructive worker-management relationship, and by treating the workers fairly and providing them with safe and healthy working conditions, ARL may create tangible benefits, such as enhancement of the efficiency and productivity of its operations.

The company has adopted this policy in accordance with the requirements of the **IFC's Performance Standards** and **Labour and Working Conditions**, which requires this policy to be appropriate to ARL's size and workforce and to set out ARL's approach to managing employees.

The objectives of the policy are as follows:

- To establish, maintain and improve the worker-management relationship;
- To promote fair treatment, non-discrimination and equal opportunity of workers, and compliance with national labour and employment laws;
- To abide by the company's Code of Ethics; and
- To promote safe and healthy working conditions, and to protect and promote the health of workers.

(a) Working Relationship

This policy is written so as to be clear and understandable to employees and it will be explained or made accessible to each employee upon taking employment.

ARL will document and communicate to all employees and workers directly contracted by the company their working conditions and terms of employment, including their entitlement to wages and benefits. ARL will provide employees with information regarding their rights under national labour and employment law.

(b) Working Conditions and Terms of Employment

Where ARL are a party to a collective bargaining agreement with a workers' organization, such agreement will be respected. Where such agreements do not exist, or do not address working conditions and terms of employment (such as wages and benefits, hours of work, overtime arrangements and overtime compensation, and leave for illness, maternity, vacation or holiday), ARL provide working conditions and terms of employment that, at a minimum, comply with national law.

(c) Workers' Organisations

ARL complies with the national law, which recognises workers rights to form and join workers organizations of their choosing without interference and to bargain collectively. The company will enable means for workers to express their grievances and protect their rights regarding working conditions and terms of employment.

(d) Non-Discrimination and Equal Opportunity

ARL will not make employment decisions on the basis of personal characteristics unrelated to inherent job requirements. The company will base the employment of Congolese staff on the principle of equal opportunity and fair treatment, and will not discriminate with respect to aspects of the employment relationship, including recruitment and hiring, compensation, working conditions and terms of employment, access to training, promotion, termination of employment or retirement, and discipline. ARL also comply with the national law, which provides for non-discrimination in employment. Special measures of protection or assistance to remedy past discrimination or selection for a particular job based on the inherent requirements of the job will not be deemed discrimination.

(e) Retrenchment

ARL will develop a plan to mitigate the adverse impacts of retrenchment on employees, if it anticipates the elimination of a significant number of jobs or a layoff of a significant number of employees. The plan will be based on the principle of non-discrimination and will reflect our consultation with employees, their organizations and, where appropriate, the government.

(f) Grievance Mechanism

ARL will provide a grievance mechanism for employees to raise reasonable workplace concerns. ARL will inform the employees of the grievance mechanism at the time of hire, and make it easily accessible to them. The mechanism will involve an appropriate level of management and address concerns promptly, using an understandable and transparent process that provides feedback to those concerned, without any retribution. The mechanism will not impede access to other judicial or administrative remedies that might be available under law or through existing arbitration procedures, or substitute for grievance mechanisms provided through collective agreements.

(g) Protecting the Work Force

<u>Child Labour</u>

Children below the age of 18 years will not be employed.

<u>Forced Labour</u>

ARL will not employ forced labour, which consists of any work or service not voluntarily performed that is exacted from an individual under threat of force or penalty. This covers any kind of involuntary or compulsory labour, such as indentured work, bonded labour or similar labour-contracting arrangements.

<u>Occupational Health and Safety</u>

The company will provide the workers with a safe and healthy work environment, taking into account inherent risks of its particular sector and specific classes of hazards in our work areas, including physical, chemical, biological, and radiological hazards. ARL will take steps to prevent accidents, injury, and disease arising from, associated with, or occurring in the course of work by minimizing, so far as reasonably practicable, the causes of hazards. In a manner consistent with good international industry practice, ARL will address areas including:

- the identification of potential hazards to workers, particularly those that may be life-threatening;
- provision of preventive and protective measures, including modification, substitution, or elimination of hazardous conditions or substances;
- training of workers;
- documentation and reporting of occupational accidents, diseases, and incidents; and
- emergency prevention, preparedness and response arrangements.

(h) Non-Employee Workers

"Non-employee workers" refers to workers who are:

- Directly contracted by ARL, or contracted through contractors or other intermediaries; and
- Performing work directly related to the core functions essential to ARL products or services for a substantial duration. When ARL contract non-employee workers directly, the company will use commercially reasonable efforts to apply the requirements of this policy.

With respect to contractors or other intermediaries procuring non-employee workers, ARL will use commercially reasonable efforts to:

- ascertain that these contractors or intermediaries are reputable and legitimate enterprises; and
- require that these contractors or intermediaries apply the requirements of this policy.

(i) Supply Chain

The adverse impacts associated with supply chains will be considered where low labour cost is a factor in the competitiveness of the item supplied. The company will inquire about and address child labour and forced labour in its supply chain.

ARL is an international company trading at the Toronto Stock Exchange (TSX), as such has a good rating in safeguarding human rights in areas where they work according to conditions set by their shareholders and the bourse in Canada. The company publishes its book of accounts annually for public scrutiny and has never been engaged in bribery or illegal activities. To ensure transparency to its undertakings in DRC, the company will publish its statement of account in the national media to show how much taxes the company pays to the government and how much profit it is making. The TSX is part of the Market Regulation Services (RS) Inc, a non-profit organization. The body, as part of its activities, regulates the activities of investment dealers in terms of both their capital adequacy and business conduct, and sets out the listing requirements for companies to be publicly traded.

4 PROJECT DESCRIPTION

4.1 Ore resources

The currently defined ore resources at Kalukundi occur within four individual pockets or "fragments". The fragments to be mined are known as the Anticline, Kii, Principal and Kalukundi fragments. The resources are predominantly composed of sulphides of copper and cobalt. However, the near-surface oxide resources are a significant component of the deposits and the current have defined exclusively oxide ore reserves for processing for the initial stages mine development, which will last for more than 10 years. A detailed geological study and drilling program has been carried out since 2004 (MDM 2006). The location of these deposits can be seen in
Figure **5**.

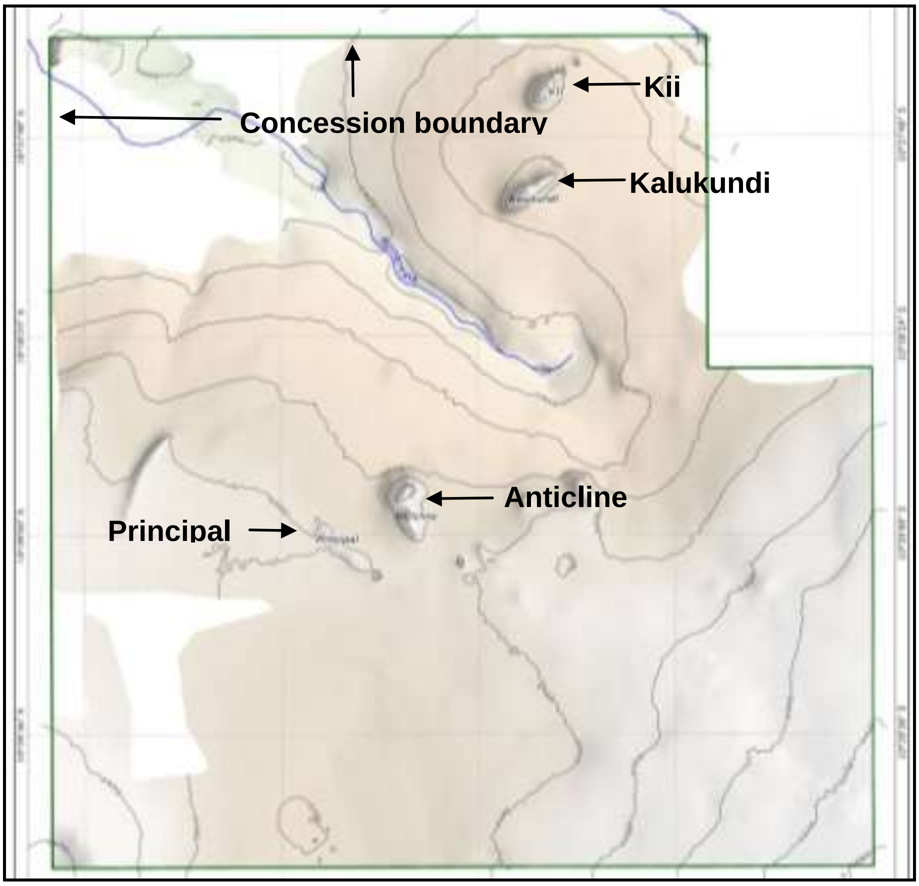

Figure 5: Location of the four ore fragments on the Kalukundi concession

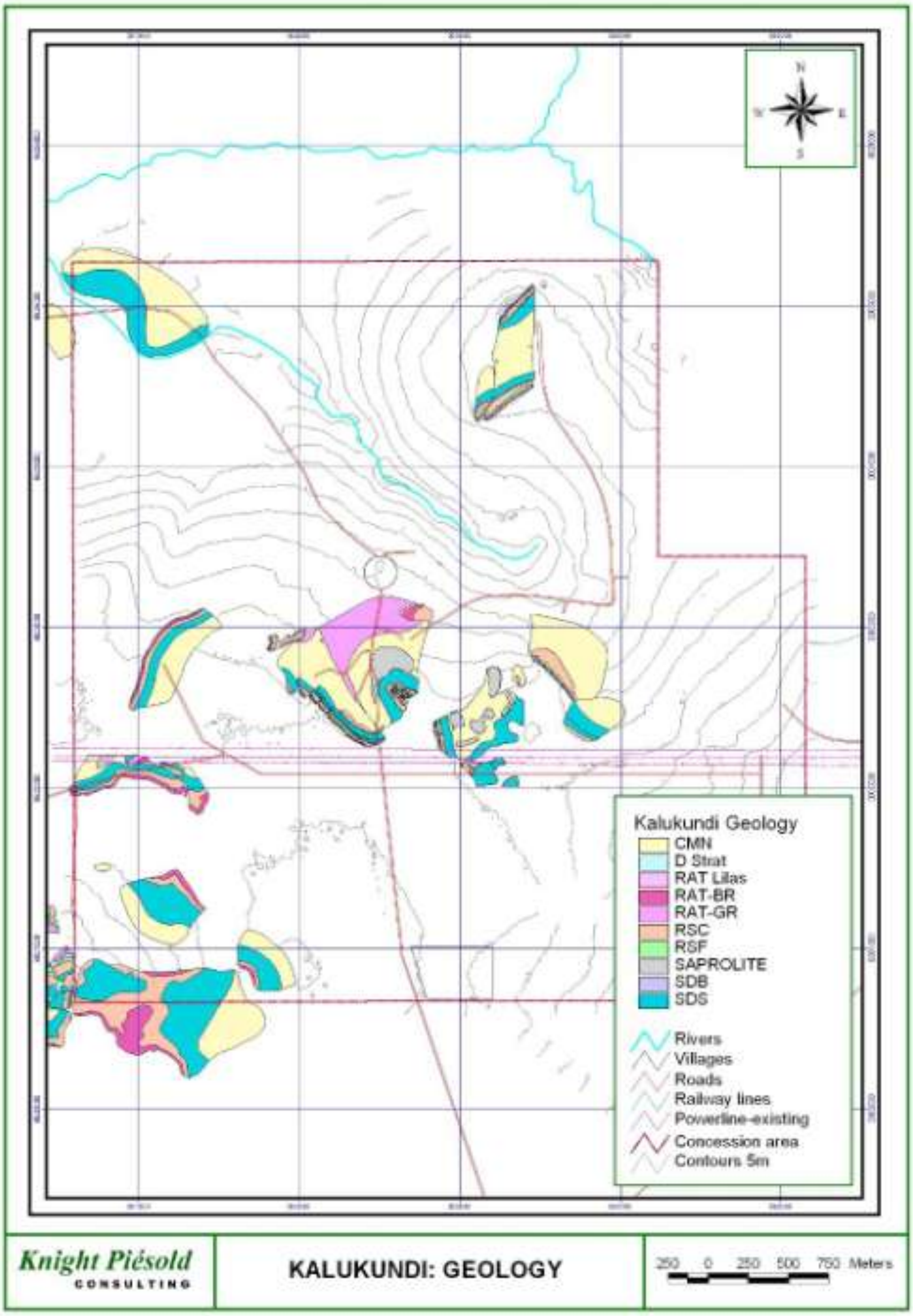

Figure 6: Geology of the Kalukundi concession[1]

[1] For an explanation of the codes used for the geological units, please refer to section 2.1.5 of Knight Piésold (2008)

Optimisation studies conducted by Metallurgical Design and Management (MDM) and RSG Global during the Feasibility Study indicate an optimum project life of 10 years based on mining of the above-mentioned four fragments. Investigations into mine scheduling and process plant design were based around the mining of these four fragments through open pits. The initial site development will occur prior to the pre-production year and during the mining operations new studies will focus on proving new ore resources, both oxides and sulphides, to lengthening the life of the mine. Any new oxide ores can be processed through the existing plant, hence adding to the life of mine. Metallurgical studies will be undertaken to evaluate the extraction of copper and cobalt from sulphide ores and feasibility studies will be required to design and construct a new plant to process the sulphide ores.

4.2 Mineralogy of the Kalukundi ore deposit

Dr Ted Thatcher of Microsearch has conducted detailed mineralogical analysis of drill core rock samples selected specifically for mineral identification purposes. He used microscope evaluation techniques on both thin sections and polished sections and confirmed his identifications with XRD analyses and selected microprobe analyses. Mintek undertook minor mineralogical studies on tailings samples by using a combination of microprobe and x-ray fluorescence techniques (MDM 2006). The oxide and sulphide mineralogy of the Kalukundi deposit is described in Table **2**.

Table 2: Mineralogy of the Oxide and Sulphide Ore at Kalukundi

Ore Type	**Major**	**Subordinate**	**Trace**
Oxide			
Copper	Malachite	Cobaltiferous Malachite Kolwezite Chrysocolla	Chalcanthite Libenthinite Tenorite Cuprite Native Copper
Cobalt	Heterogenite		Mg-Spherocobalite
Sulphide			
Copper	Chalcocite Digenite	Bornite Chalcopyrite	Covellite
Cobalt	Carrolite		Linaeite (Siegenite) Cobaltite

Note that the deeper sulphide ores have not as yet been assessed. It is likely that these will contain bornite and chalcopyrite as major ore minerals, with less chalcocite and digenite.

4.3 Mining programme

There will be an initial 6 months pre-strip of the Principal and Kii open pits. The following 6 months will involve mining from the Kii and Principal pits to a total material movement of approximately 3.12 Mt, which will comprise of 2.55 Mt of waste and 0.57 Mt of ore. This will comprise the pre-production year of operations. This ore will be stockpiled on the run of mine (ROM) pad to allow for blending in Year 1 of the mine schedule. Only ore from the Kii and Principal pits will be mined during the pre-production Year and Year 1 of the mine schedule. In the 4th quarter of Year 2, mining will be initiated in the Anticline and Kalukundi open pits. The pre-production year will be used to establish haul roads from the open pits to the ROM pad and WRDs, provide waste for the construction of the ROM pad and build stockpiles equivalent to the feed for the plant for a week and have enough ore exposed in the Kii and Principal open pits to provide continuous ore production at start-up. The full mining fleet will be required from start-up. Approximately half of the waste removed during the pre-production phase will be required to construct the ROM pad. The operating ramps and initial benches will also be produced during this phase. In the initial year the mining rate will be 7.3 Mt/a and then 6.3 Mt/a in the second year. The mining rate will then steadily decrease after Year 2 until Year 11 due to decreasing strip ratios planned in the pits.

Approximately 39.3 Mt of material will be removed during the Kalukundi project. 31.5 Mt of this material will be waste and 7.8 Mt of this material will be ore. The process plant will process 800,000 Mt/a. Detailed design work will be carried out up to a few months before mobilisation to site. The Kalukundi project construction will begin in late 2008 / early 2009, depending on IFC approval of the ESIA. Fabrication, erection and commissioning of the process plant will take approximately 18 months. The pre-production year would commence in 2009 and processing would commence in 2010.

4.4 Project phases

The project will consist of four phases, which are:

- Phase 1: Site Preparations and Pre-Production (Year 0);
- Phase 2: Mine Production (Year 1 until Year 10);
- Phase 3: Future expansion; and
- Phase 4: Decommissioning and Closure (Year +21)

It is important to note that this ESIA considers only phases 1, 2 and 4 and does not assess any possible future expansions under phase 3. Any such future expansion will have to be subject to its own EIA procedure and is outside the scope of this ESIA.

4.4.1 Phase 1: Site Preparation

Site preparations will begin as soon as the necessary financing and approvals have been obtained.

Erection of the construction camp and improvement of the road systems will be the first priorities, followed by preparations for the new Kisankala village, and the permanent mine site village.

The access road to site will be levelled and maintained throughout the mine life. During the initial year of site preparation works, pre-strip of the Principal and Kii open pits will be carried out in the first 6 months. Then a 6-month campaign of initial mining will be carried out in these two open pits to provide the initial ore to generate a stockpile for the process plant before commissioning in Year 1 and the waste material for the construction of the ROM pad.

(a) Clearing

Areas earmarked for infrastructure development will be cleared only as necessary to minimise and where possible to prevent dust and erosion problems. Topsoil will be stripped and stored for future rehabilitation of the mine site. Trees and large bushes that have been cleared from the site will be made available to local people and the people of the relocated village for use as construction materials or fuel. These will be stockpiled in a convenient location for collection. Deforestation and cutting of trees will only be carried out where absolutely necessary and re-vegetation schemes during mining and post-closure will aim to return the vegetation cover to its pre-mining state or alternative acceptable sustainable land use.

(b) Relocation of Village

ARL proposes to relocate the residents of Kisankala Village to the 'New Kisankala Village' to be constructed on the southern boundary of the concession. IFC performance standards will be applied to minimise social disruption and to ensure that the relocation is carried out as humanely and as sensitively as possible.

(c) Blasting

There will be a minimal amount of blasting on site during pre-mining site preparation. The surrounding land is flat and there is a deep soil cover. Levelling will be carried out primarily by bulldozers and graders. Blasting may occur in the Kii and Principal open pits in order to allow for the material production in the pre-production phase. This ore will be stockpiled and waste material will be used to construct the ROM pad.

(d) Infrastructure

Mining infrastructure that will be built during the construction phase will be a cobalt and copper process plant, workshops, offices, two WRDs, four open pits, a tailings storage facility (TSF), mine camp, tracks, roads, piping/drainage around the site and a relocated Kisankala Village.

4.4.2 Phase 2: Operations

On completion of the site preparation works, mining operations will commence and are planned to continue for 10 years.

Processing will be carried out through leaching, counter current decantation (CCD), solvent extraction (SX) and electrowinning (EX) circuits to produce copper and cobalt cathodes. These will be sold on the international markets. The copper will be of London Metal Exchange (LME) grade.

4.4.3 Phase 3: Future expansion

It is anticipated that upon reaching year 10 in the life of the Kalukundi mine, that new oxide resources will have been defined. This will enable oxide mining and processing operations to proceed for a number of years beyond year 10. Prior to year 10, deep exploration drilling will identify and define sulphide ore resources. Based on these results a new study will be necessary to evaluate the sulphide ore recoveries and plant design.

4.4.4 Phase 4: Decommissioning and Closure

Rehabilitation and re-vegetation of WRDs and TSFs will occur progressively over the life of the mine as the surfaces become available, in order to reduce the amount of rehabilitation required at mine closure, and to ensure rehabilitation success. After the completion of operations, the decommissioning and closure plan outlined in the Environmental and Social Management Plan (Appendix 2) will be put into effect with the rehabilitation of the project area. Rehabilitation measures will include:

- The removal of surface infrastructure (such as buildings, pipelines, power line extensions);
- Re-vegetation of outstanding areas of the WRDs, TSF, process plant area and mine camp;
- Post closure environmental monitoring and inspection; and
- Continuation of the sustainable development plan.

These actions should result in the rehabilitation of most of the cleared land with the only permanent features being the open pits and the changes in landscape due to the WRDs and TSF. Sustainable development plans will include options for final end use of the open pits, which will become a valuable resource for the community.

A more detailed closure plan with costs will be produced during the detailed design and construction phase. This closure plan will be reviewed and updated every 6 months. The preliminary and final closure plans will satisfy the requirements of the DRC Environmental Regulations and World Bank procedures and guidelines where appropriate. The overall objectives of the mine Decommissioning and Closure plan are to:

- Protect future health and safety;
- Minimise or prevent environmental degradation, either physical or chemical;
- Return the land to the pre-mining land use (sustainable woodland) or an acceptable alternative; and
- Minimise any adverse socio-economic impacts.

4.4.5 Project capital costs and employment

The Kalukundi Project will require US$ 250 million of capital investment. This capital cost is mainly associated with the development of the open pits, purchasing of the mine fleet, construction of the TSF, WRDs, workshops and the process plant, and ancillary infrastructure such as housing. The project will be financed by ARL. Initial capital expenditure will commence 6 months prior to the start of the 6 months pre-production mining. The Project is a medium-scale mining operation. It is estimated that between 500 and 600 people will be employed either directly by ARL, or indirectly through contractors during the 18-month mine construction phase. During the mine operational phase, approximately 460 Congolese nationals and 72 expatriates will be employed directly by ARL. Additional jobs are expected to be generated in the service sector in Lubumbashi, Likasi and Kolwezi.

4.5 Extraction of ores

4.5.1 Nominal capacity

The best method of processing the oxide ore in order to extract copper and cobalt economically is through acid leaching of the ore to render the copper and cobalt soluble, solvent extraction (SX) and electrowinning (EW) that will produce copper and cobalt cathodes. Annual production of copper and cobalt cathodes will be 16,400 t and 3,800 t respectively (MDM 2006).

The extraction rate of the copper and cobalt oxide ores from the open pits varies with the mining schedule due to the need to maintain a fairly constant grade feed to the plant over the 10-year mine life. The process plant throughput is 800,000 t/a and to maintain a consistent feed grade, blending of high and low grade ores must be carefully managed. This process of grade control must also be monitored closely with the carbonate content of the ore, which, in places, is an acid consumer. In addition, a steady decrease in mining extraction rate will be employed due to the fact that the ore to waste ratio decreases with increasing depth. The mining extraction rate of material in Year 1 is 7.3 Mt/a, in Year 2 is 6.3 Mt/a and steadily decreases until end of mining in Year 10.

4.5.2 Mining methods

Mining will be carried out by open cast mining techniques. An open pit will be created for each of the four fragments mentioned above. Conventional open pit selective mining methods will be used and a mining contractor will be employed.

The planned maximum mined depth below surface is variable within the pits and dependant on the depth to which oxidized weathering occurs. The depth of oxidation from the land surface is variable for each of the fragments as follows:

- Kalukundi fragment = 40m (to a maximum of 70m)
- Principal fragment = 150m
- Kii fragment = 140m
- Anticline fragment = 120m

Backhoe excavators and rigid frame dump trucks will be used to selectively mine and haul ore from the open pits. The multiple pits, multiple cut back mining philosophy will be employed and the timely and correct scheduling of mining will be essential to ensure continuity of a consistent blended ore feed, timely pre-stripping of future ore releasing areas and other factors such as geo-technical stability, infrastructure provision, environmental constraints, production costs and cash flow.

The height of the mining benches is usually determined according to physical characteristics of the mineralisation. It is envisaged that a 5 m working bench height will be maintained with free dig or blasted material excavated in two discrete "flitches" (levels), each nominally of 2.5 m height to minimise dilution and to maximise ore recovery. It is expected that blast heave in the primary material will mean the effective flitch height for mining will be 2.5 - 3 m. The mining schedule indicates a total material movement of 39.3 Mt over the 10 year mine life, made up of 31.5 Mt of waste and 7.8 Mt of ore, giving an average stripping ratio (overburden/ore) of 4:1.

Stripping ratios in the individual pits will be variable due to the need to maintain feed grade. Ore will be removed from the open pits by truck, and dumped into the ROM ore stockpiles. Approximately 2% of the total material that is being conveyed to the crusher has been assumed as floor stocks in the pits and will be exposed and made ready to mine to ensure that there is material available to aid with blending. A blending and stockpile approach will be followed.

The majority of blending will be carried out in the open pits to maximise direct truck dumping into the primary crusher. However, there will be a 50,000 t capacity ore stockpile at the ROM pad (3 weeks supply), which will aid with the hourly fluctuations in grade feed to the process plant. There will potentially be other stockpiles of high grade ore. Front-end loaders will be responsible for the maintenance of the ROM stockpiles. Blended ore will then be tipped into the ROM feed bin. A low-grade ore stockpile will be generated near the ROM pad to contain low-grade ore from the open pits for potential future processing options.

Knight Piésold conducted geo-technical studies to determine stability and seismic hazard. They concluded that the seismic hazard at the Kalukundi site was sufficiently low such that seismic loading in the slope design was not necessary.

These slope angles are considered to be conservative and are based on the engineering performance of current pit slopes in the Kolwezi Region and the relatively shallow depth of the pits. The current design assumes that pit dewatering is carried out by a pit sump dewatering system and storm water control alone. There has not been any allowance for potential slope depressurising by a series of vertical dewatering wells but this will be carried out in future studies and may allow for slope angles to be less conservative. The reason for this assumption is that no hydrological drilling was undertaken in time for finalisation of the 2006 feasibility study. This work has now been finalised and it will be possible to modify the pit slop angles. This will only be possible once additional geo-technical drilling has been undertaken in areas defined by the current geo-technical study results. Hence there is a strong potential to decrease the pit slope angles and thereby reduce the ore: waste ratio and hence the amount of waste to be removed.

Mining design parameters for the individual pits and the general pit designs are shown in Table 3 and Table 4 The haul roads will be dual lane and be designed for all weather traffic ability. The minimum width of all the haul roads, excluding drains and bunds on the road, will be 15 m.

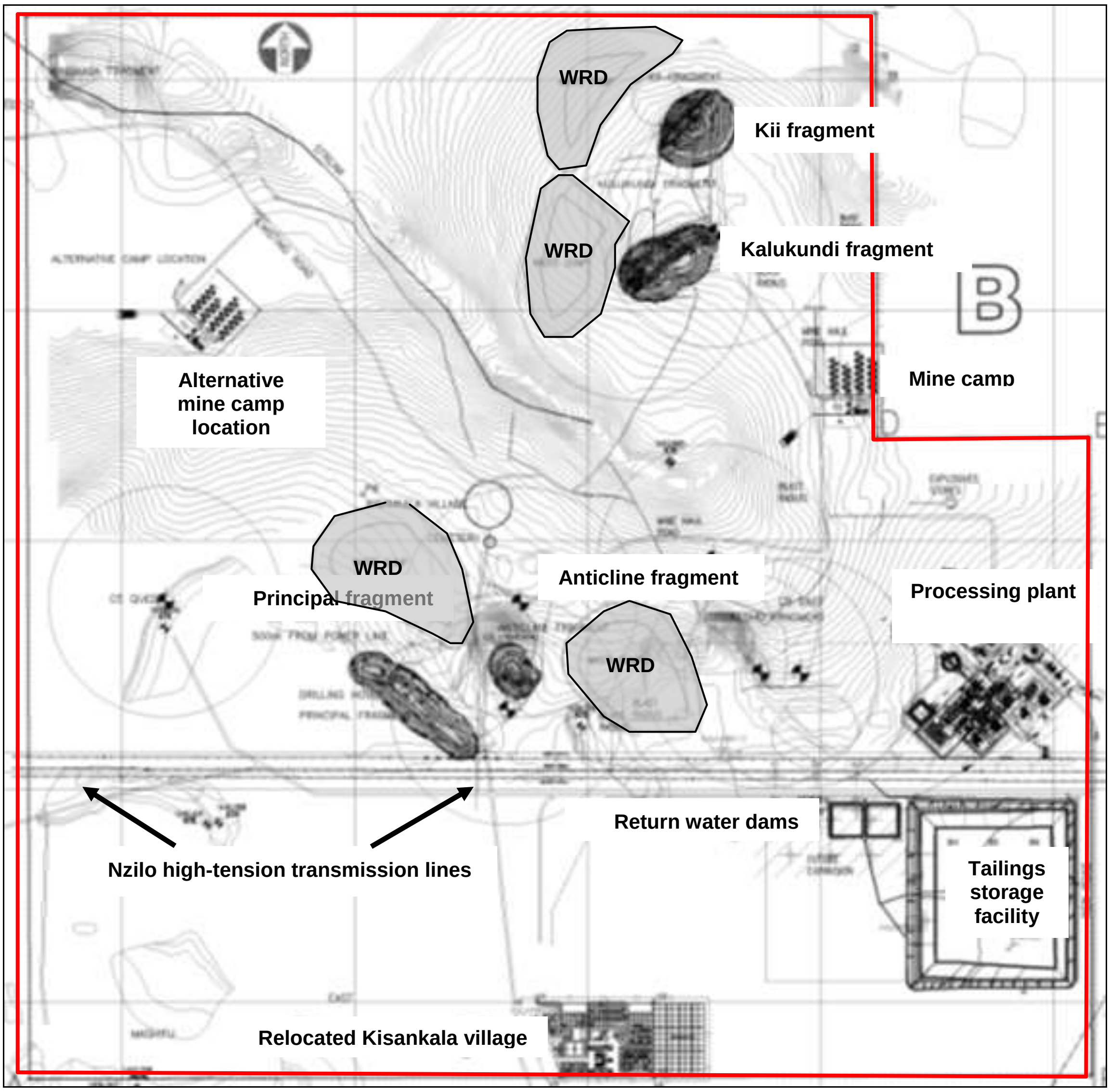

Figure 7: Kalukundi mine layout

(Not to scale)

Storm water cut-off drains will be constructed alongside profiled pit perimeter haul roads to prevent surface run-off flowing into the pit. Further studies will be carried out to determine the viability and necessity of slope depressurisation. Safe mining practices will be the norm and when further studies have described the hydro-geological character of the site, revisions can be made to the dewatering system in the open pits. These revisions are now in progress. A drilling plan is currently awaiting implementation, whereby 15 drill holes are planned to facilitate dewatering via vertical boreholes surrounding the rim of the open pits. This will reduce groundwater inflow volumes to a minimum, but pumping of water from the pit will still be required on a much smaller scale.

Table **3**: Pit Specific Design Parameters

Pit Slope	**Elevation (m asl)**	**Overall Angle (toe to crest)**	**Benches (m)**	**Bench Batter Angle**	**Berm Width (m)**
Principal Fragment					
SW (footwall)	1340-1355	56	3	75	3.05
	1355-1440	24	16-17	60	8.9
	1340-1370	45	6	60	2.54
NE (hanging wall)		25m wide berm as step out at 1370 m asl			
	1370-1390			60	6.42
	1390-1435			60	6.5
Kalukundi Fragment					
NW (footwall)	1330-1395	45	13	75	3.97
	1395-1435	33	8	60	5.5
SE (hanging wall)	1330-1390	45	12	75	3.99
	1390-1425	33	7	60	5.61
Kii Fragment					
NW (footwall)	1330-1355	51	5	60	1.45
	1355-1400	51	9	60	1.31
	1400-1430	33	6	60	5.78
SE (hanging wall)	1330-1430	22	20	60	9.99
Anticline Fragment					
SW (footwall)	1345-1375	35	6	75	6.96
	1375-1405	40	6	60	3.69
	1405-1430	33	5	60	6.02
	1345-1380	46	7	60	2.27
NE (hanging wall)		25m wide berm as step out at 1380 m asl			
	1380-1435	27	11	60	7.62

Table **4**: General Pit Design Parameters

Pit Design	Parameter
Haul road design	
Width	15m
Gradient	10%
Min. radius of turning circle	19m
Working widths	
Min. pit base width	30m
Min. cutback width	25m
Operational Design Criteria	
Bench height for drill and blast	5m ore and waste
Face height for excavators	2.5-3.0m

The sump water in all the pits will be pumped to surface via a pipeline. The sump pumps will be mounted on a floating raft. Flexible hoses will connect the pumps to the pipeline. Detailed design of the mine dewatering system will be carried out during final design study to proceed into mine development.

Mine drainage water will be directed to a sedimentation pond where solids will settle out. Clear water will be pumped to the raw water storage pond or discharged to surface waters. The discharge of significant mine drainage water, from surface runoff during the rainy season, to the Kisankala Stream is likely to occur. In the event of this occurring, the discharge will be carefully managed to minimise the effect of water surges on downstream infrastructure.

4.5.3 Equipment

The equipment that will be used to develop the Kalukundi open pits will be purchased new and imported into the DRC. A list of the major plant equipment is given in Table **5**.

Table **5**: Major Open Pit Equipment to be used at Kalukundi

Core Mining Fleet	Units Year 1	Total Units	Type	Capacity
Blast Hole Drill	3	3	IR DM 45E	150 - 200 mm
Hydraulic / Electric Shovel	2	2	Liebherr 994B	300 t
Front End Loader	1	1	Cat 992	12 m3
Haul Trucks	8	15	Komatsu HD	1500 150 t
Tracked Dozers	2	2	Cat D10	
Wheel Dozer 500	1	1	Komatsu WD	
Graders	2	2	Cat 16H	
Water Trucks	2	2	Cat 773	50 kL
Fork – Crane	1	1		10 t
Lighting Plants	5	5		
Truck (with Crane)	1	1		10 t
Fuel - Lube Truck	1	1		20 kL
Service Truck	1	1		
Welding Truck	1	1		
Compressor				
De-watering pumps	4	6		
IT 38 Tyre Handler 1 1	1	1		

The explosive types and detonators to be used are:

- P100 Bulk Emulsion Explosive;
- High Explosion Pentolite Boosters;
- Benchmaster Shock Tube Assembly; and
- Handimaster Timeline Delay Shock Tube.

AEL explosives will be hired as a contractor to supply explosives to site during mining operations. Explosives will be stored in two emulsion silos and two magazines; one for explosives and the other for the initiating systems. A SMRT trailer and Toyota Landcruiser will be used for mobilisation of the explosives to the blast site. The magazines will be fenced and locked and security will be provided by a registered Congolese company.

4.5.4 Waste rock dumps

The total amount of waste rock that will be removed from the open pits is 31.5 Mt (3.1 Mt from the Kalukundi pit, 10.6 Mt from the Kii pit, 3.1 Mt from the Anticline pit and 14.7 Mt from the Principal pit). Each open pit will have a WRD to reduce trucking distances and improve mining efficiency.

Although the location of the WRDs is shown in Figure **7**, they are likely to be modified. For example the WRDs for Kii and Kalukundi fragments will be located to the west of the pits and not the east. For the Principal and Anticline fragments the positions will be close to those represented on the plan, but will be adjusted for new infrastructure developments. The WRDs have been designed according to standard industry practice with an overall slope angle of 18°. The maximum height of the WRDs will be 25 m. The WRDs will be designed to store all of the scheduled waste rock that will be mined from each of their respective open pits. A 20% swell factor for the dump material has been taken into account and it is not scheduled that there will be any in-pit or exhausted pit backfilling being undertaken.

The waste rock is coarse and is not prone to erosion. During the life of the project, surface and slope run-off from the WRDs will be intercepted by perimeter drains and directed through silt traps before being discharged to the surrounding areas. The top of all of the WRDs will be engineered during the final lift of dumping such that all surface runoff from the WRDs will flow to the open pits nearby. This will prevent the contamination of local streams with contaminated surface water or sediment loading.

4.5.5 Water balance

A detailed study on the hydro-geological nature of the area (Knight Piésold 2008) has been carried out. According to this study, static water level in the project area is an average of 38 m below the ground surface. Therefore, there is no need for the dewatering process to commence during the construction phase. The dewatering process will commence at the end of the construction phase or, at the latest, at the beginning of the mining (operational) phase and will continue for the life of the opencast mining operations. The locations of the aquifer characterisation boreholes that were created for the study are indicated in Figure 8 below.

(a) Dewatering

Fifteen boreholes are proposed for the dewatering of the pits, and they will pump at different rates during the life of mine. Six of these boreholes are existing characterisation boreholes, while nine new boreholes must be drilled. All the existing dewatering boreholes are 120 m deep. However, the new dewatering boreholes to be drilled will be 160 m deep (20 m below the depth of the Kii and Principal Pits at their deepest stage). A total dewatering rate of some 29,000 m^3/d will be needed to keep the pits free of hydrostatic pressure throughout the life of mine.

It is clear the mine dewatering will provide far more water than is needed by the mine and the communities and there will be a net discharge to the streams. Excess water will be released into the Kisankala Stream. The exact location of this point will be finalised with the detailed design of the on site water system.

Decommissioning of the dewatering process will only occur once opencast mining has stopped. Certain boreholes will be used for water supply and their water level is expected to decrease as the dewatering of the pits proceeds and recover after the decommissioning of the dewatering process.

A VISUAL MOD FLOW numerical model has been developed to simulate dewatering rates that will be needed to keep pits dry as they increase in size and depth (Knight Piésold, 2008). The dewatering rates are chosen in such a way that the water level at each pit will be more than 20 m below the bottom of the pits at all times during the operational phase. A portion of the dewatered water will be used for the process plant, mine usage and water consumption of the mine employees and communities in the vicinity of the mine. The time at which each open pit reaches 30, 60, 100 and 140 m below the ground surface is provided in Table **6**.

Table **6**: Estimated Time for each Pit to Reach 30, 60, 100 and 140 m Deep

Months	Days	Kii Pit depth (m)	Kalukundi Pit depth (m)	Principal Pit depth (m)	Anticline Pit depth (m)
0	0	Start of Mining		Start of Mining	
12	365				Start of Mining
22	669	30			
24	730			30	
44	1338	60			
48	1460		Start of Mining		
60	1825			60	
65	1977				
72	2190	100		100	
73	2220				30
82	2494				60
86	2615		30		
92	2798				
96	2920		60		100
104	3163				
108	3285	140	100	140	

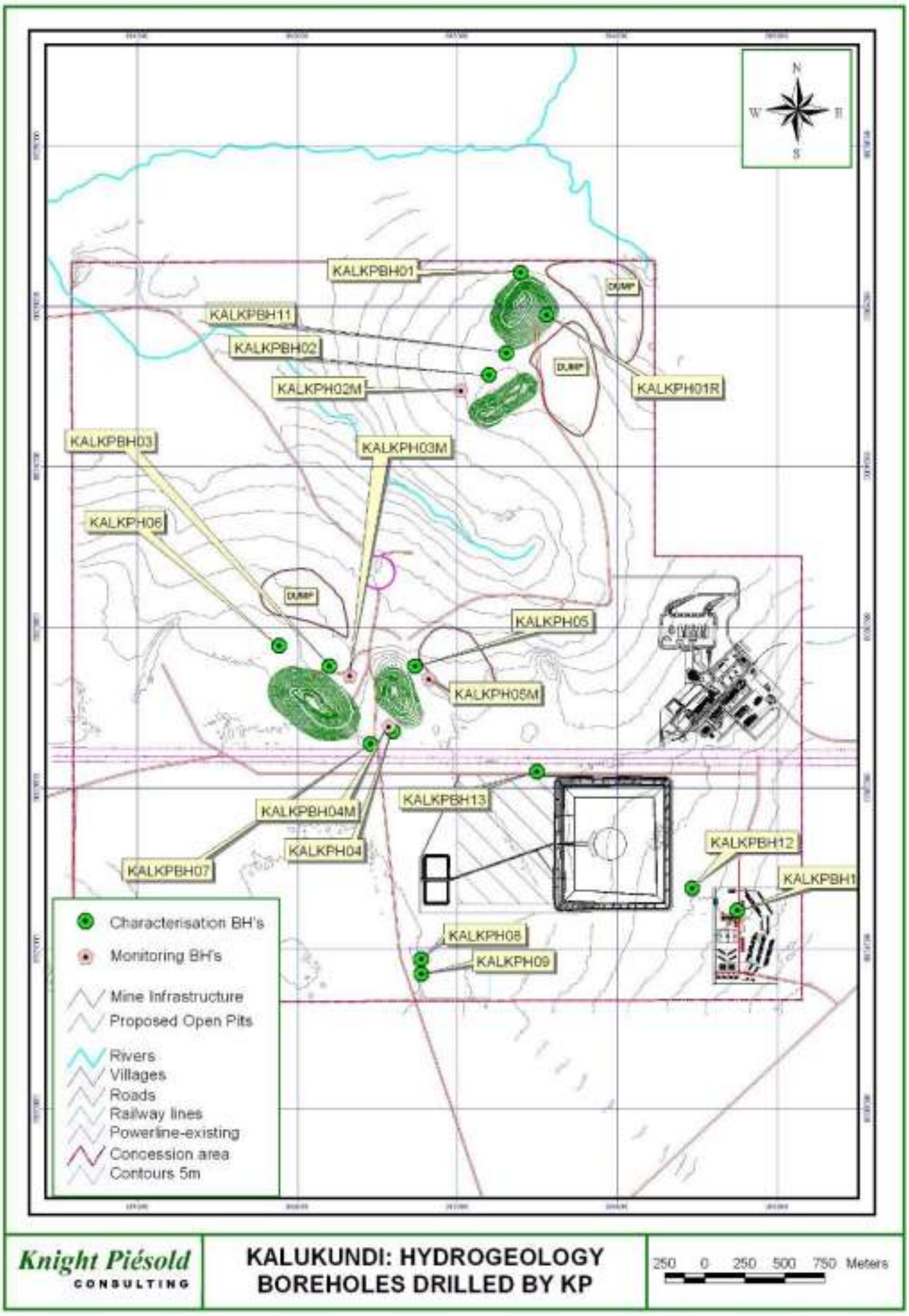

Figure 8: Location of the aquifer characterisation and monitoring boreholes (Not to scale)

The dewatering of the pits will be conducted at a rate of 334.1 l/s (1,202.7 m^3/h) throughout the life of mine. This will be achieved by 15 dewatering boreholes discharging at rates varying between 11 and 60 l/s (Table **7**). Six of the boreholes are the available boreholes drilled by Eastern Drilling and managed by Knight Piésold but the remaining nine are still to be drilled.

After programming of the dewatering rates and design, an evaluation of site hydrogeology, a numerical model was developed to predict the dewatering rate in the proposed open pits as listed in Table **7**. The dewatering process is recommended to commence in advance of the start up of the mining operations and to end at the closure phase.

In summary, the Kii and Kalukundi Pits will be dewatered at a rate of 123.1 l/s and the Principal and Anticline Pits will be dewatered at a rate of 211 l/s.

Table **7**: Dewatering Rates and Durations Needed for the Kalukundi Project Area

Pit	Life of Pit (months)	Life of dewatering (months)	Dewatering design	Number of Bore-holes	Total dewater-ing rate (l/s)	Dewatered volume (m^3) X10^6
Kii	0 - 108	0 - 108	KALKPBH01R at 12 l/s	1	12	3.41
			KALKPBH11 at 11.6 l/s	1	11.6	3.29
			KALKPBH02 at 14.5 l/s	1	14.5	4.12
			New boreholes at 20 l/s each	2	40	11.4
			New boreholes at 15 l/s each	1	15	4.26
Kalukundi	48 - 108	0 - 108	New boreholes at 15 l/s each	2	30	8.51
Principal	0 - 109	0 - 108	KALKPBH03 at 60 l/s each	1	60	17.0
			KALKPBH07 at 60 l/s each	1	60	17.0
			New boreholes at 20 l/s each	3	60	17.0
Anticline	12 - 96	0 - 108	KALKPBH05 at 11 l/s	1	11	3.12
			New boreholes at 20 l/s each	1	20	5.68
Total					**334.1**	**94.8**

(b) Measures to limit dewatering

The main measure to limit pumping of groundwater to dewater the mine is the volume that is necessary to ensure safe mining practices in the open pits. Mining activities will only be carried out to a mineable depth and dewatering activities will cease once mining operations are complete.

(c) Cone of depression

Dewatering of the open pits will cause a localised depression in the natural groundwater levels, known as the ‘cone of depression’. As seen in Figure 9, Geo-hydrological modelling has indicated that the cone of depression will expand out of the concession area within 9 years of the commencement of dewatering (Knight Piésold, 2008).

(d) Use of the dewatering water

The amount of water that will be dewatered during the life of mine is equal to 9.48 x $10^7 m^3$. This means the abstraction rate will be 334.1 l/s (29,000 m^3/d). The processing plant will use an estimated 7,000 m^3/d and an estimated 5.8 l/s (500 m^3/d) will be used for water consumption by the mine employees and communities in the vicinity of the mine.

(e) Physical and chemical characteristics of mine water

The aquifer test results indicated the very high-yielding capacity of the dolomitic aquifers underlying the project area. Water samples were collected in 1 litre plastic sample bottles. No preservatives were added to the samples due to the relatively short period between collection and delivery to the laboratory. Chemical analysis for all of the samples was conducted at a South African National Accreditation System (SANAS)-accredited testing laboratory complying with ISO/IEC 17025:2005. The positions from which the samples were taken were plotted and analysed by making use of the WISH software (Windows Interpretation System for Hydrogeologists). According to the geo-hydrological study conducted it was found that groundwater is generally of excellent quality due to the fact that the concentrations of most chemical constituents fall well within the maximum limits as set out by the WHO. Only two boreholes (KALKPBH07 and KALKBH01R) exceeded the maximum recommended pH slightly. The overall results measured against South African Water Quality Guidelines and World Health Organisation standards are presented in Table **8** and Table **9** and respectively.

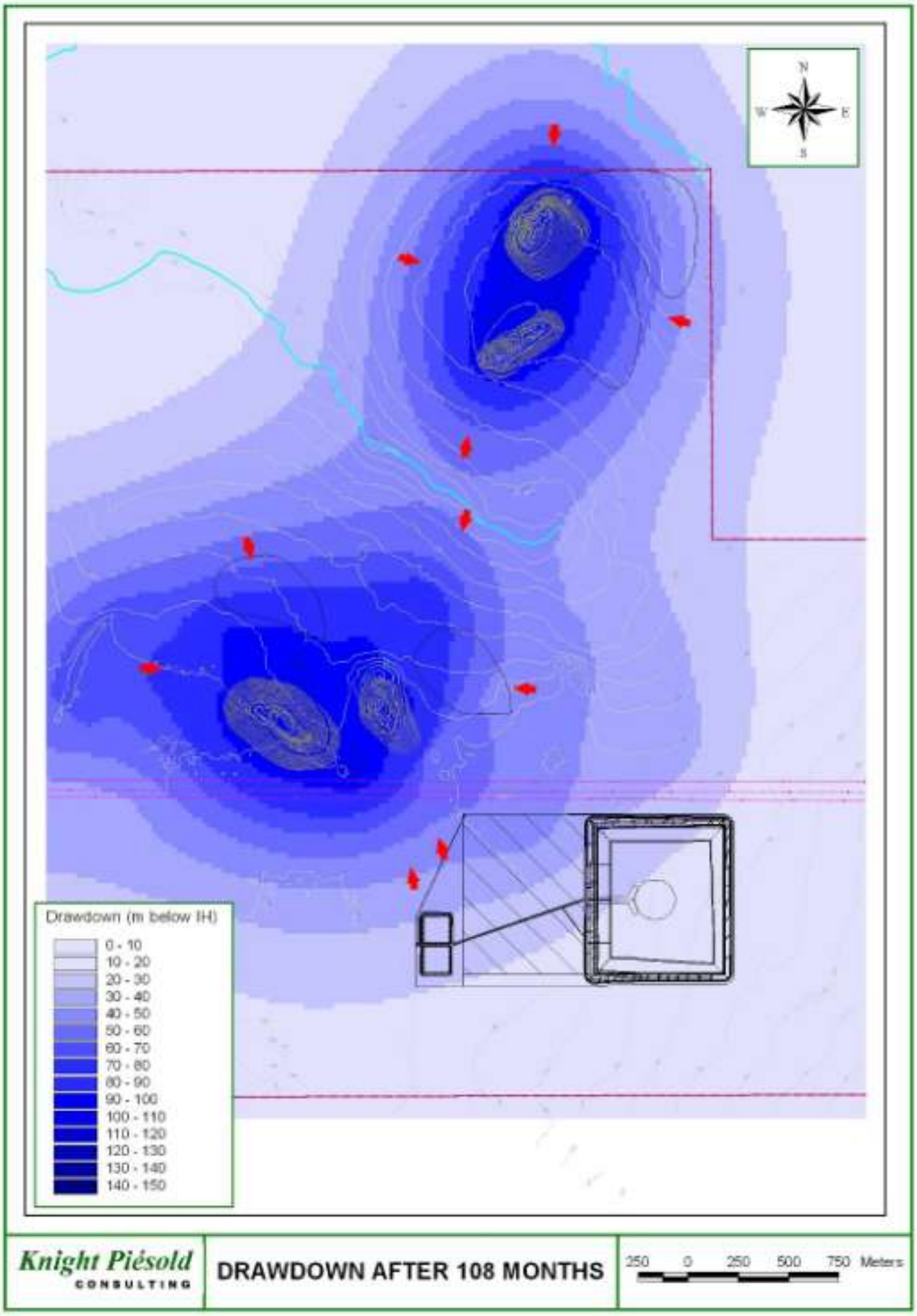

Figure 9: Cone of depression after 108 months of dewatering (Contours in metres)

Table 8: The Results of the chemical analyses compared to SAWQG for Human Consumption (NS=No Standard)

(Shaded cells indicate samples exceed standard)

Parameter	SAWQG Human Consumption	KALK PBH 05	KALK PBH 09	KALK PBH 02	KALK PBH 04M	KALK PBH 07	KALK PBH 12	KALK PBH 11	KALK PBH 13	KALK PBH 03	KALK PBH 01R
pH	6-9.0	6.77	8	7.97	8.43	7.83	8.47	8.67	6.4	8	8.7
EC (mS/m)	0-70.0	21.1	26.5	33.7	21.5	13.07	26.5	34.9	2.26	30.5	34.1
TDS (mg/l)	0-450.0	308	340	249	284	108	343	333	82	298	336
Ca (mg/l)	0-32.0	27	21.5	41	23	13.33	22.33	44	2.6	35	48
Mg (mg/l)	0-30.0	21.3	30.5	31.3	28	17.33	33.6	37.3	1.9	30	31
Na (mg/l)	0-100.0	0.93	1.3	3.17	0.4	0.77	0.47	1.13	0.4	0.4	0.7
K (mg/l)	0-50.0	0.73	0.25	0.67	0.03	<0.1	0.17	0.9	1.1	0.4	1.4
Cl mg/l)	0-100.0	3.57	5.2	18.63	14.5	17.17	14.5	15.2	8.3	14.9	23
SO_4 (mg/l)	0-200.0	1.27	3.7	1.47	0.4	<0.2	<0.2	0.8	<0.2	0.6	1
NO_3 (N) (mg/l)	0-26 (0-6.0)	0.03	1.3	0.03	0.5	0.43	0.87	<0.1	<0.1	0.2	1.9
F (mg/l)	0-0.1	0.03	0.1	0.2	<0.1	0	0.13	0.2	<0.1	0.1	0.2
Al (mg/l)	0-0.15	0	0.01	0	0.06	0.02	0.06	0.03	0.06	<0.009	<0.009
Fe (mg/l)	0-0.1	0.01	0	0.03	0	0.01	0.01	0	0.13	0.01	<0.001
Mn (mg/l)	0-0.05	0.03	0	0.01	0.01	0.01	0.11	0.01	0.28	0	0
NH_3 (mg/l)	0-1.0	0.1		1.6	0.5	21.1	0.1	0.8	0.1	0.1	0.1
As (mg/l)	0-0.01	0.01	0.03	0.02	0.01	0.05	<0.003	0.01	<0.02	<0.02	<0.02
Cd (mg/l)	0-5.0	0	0	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ni (mg/l)	NS	<0.329[2]	0	0.51	0	0.03	0.01	<0.002	<0.003	0.01	<0.003

[2] Figures for Ni could not be confirmed with the laboratory.

Table 9: The Results of the Chemical Analyses Compared to WHO Standards (NS=No Standard)

(Shaded cells indicate samples exceed standard)

Parameter	WHO	KALK PBH 05	KALK PBH 09	KALK PBH 02	KALK PBH 04M	KALK PBH 07	KALK PBH 12	KALK PBH 11	KALK PBH 13	KALK PBH 03	KALK PBH 01R
pH	6.5-8.5	6.77	8.00	7.97	8.43	7.83	8.47	8.67	6.40	8.00	8.7
EC (mS/m)	NS	21.1	26.5	33.7	21.5	13.0	26.5	34.9	2.26	30.5	34.1
TDS (mg/l)	NS	308	340	249	284	108	343	333	82.0	298	336
Ca (mg/l)	NS	27	21	41	23	13	22	44.0	2.6	35	48
Mg (mg/l)	NS	21.3	30.5	31.3	28.0	17.3	33.6	37.3	1.9	30.0	31.0
Na (mg/l)	NS	0.93	1.30	3.17	0.40	0.77	0.47	1.13	0.40	0.40	0.70
K (mg/l)	NS	0.73	0.25	0.67	0.03	<0.1	0.17	0.90	1.10	0.40	1.40
Cl (mg/l)	250	3.57	5.20	18.63	14.50	17.17	14.50	15.20	8.30	14.90	23.00
SO4 (mg/l)	250	1.27	3.70	1.47	0.40	<0.2	<0.2	0.80	<0.2	0.60	1.00
NO3 (N) (mg/l)	11	0.03	1.30	0.03	0.50	0.43	0.87	<0.1	<0.1	0.20	1.90
F (mg/l)	1.5	0.03	0.10	0.20	<0.1	0.00	0.13	0.20	<0.1	0.10	0.20
Dissolved oxygen	NS	3.03	2.80	<1	1.43	1.50	4.20	3.40	<1	3.90	7.60
As (mg/l)	10	0.01	0.03	0.02	0.01	0.05	<0.003	0.01	<0.02	<0.02	<0.02
Al (mg/l)	0.2	0.00	0.01	0.00	0.06	0.02	0.06	0.03	0.06	<0.009	<0.009
Ni (mg/l)	20	<0.329[3]	0.00	0.51	0.00	0.03	0.01	<0.002	<0.003	0.01	<0.003
Mn (mg/l)	0.4	0.03	0.00	0.01	0.01	0.01	0.11	0.01	0.28	0.00	0.00
Fe (mg/l)	0.3	0.01	0.00	0.03	0.00	0.01	0.01	0.00	0.13	0.01	<0.001
Zn (mg/l)	3	0.02	0.01	0.02	<1	0.01	<1	<1	<1	<0.005	<0.005
Pb (mg/l)	10	0.02	0.01	0.06	0.13	<0.01	0.13	0.15	0.06	<0.01	<0.01
Co (mg/l)	NS	<1	<1	<1	<1	<1	<1	<1	<1		
Cu (mg/l)	1	0.01	0.00	0.53	0.01	0.04	<0.002	<0.002	0.05	0.01	0.00
Cr (mg/l)	50	0.00	0.00	0.00	<0.003	<0.0007	0.00	<0.003	<0.003	<0.003	<0.003
Cd (mg/l)	3	0.00	0.00	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ba (mg/l)	0.7	0.05	0.03	0.08	0.01	0.04	0.03	0.09	0.03	0.01	0.04

[3] Figures for Ni could not be confirmed with the laboratory.

(f) Process plant make up water

The process plant will require approximately 22,400 m^3 of process water per day. It is important to note that a large proportion of this will be re-circulated within the plant circuit. **The net make-up water demand is in the range of 2,544 to 3,840 m^3/d** (See Figure 10). In addition, approximately 3,000 m^3/d will be used for the safety showers, reagent make up, potable water and general use.

(g) Discharge of excess water

The remaining volume of approximately 22,000 m^3/d not used in the above processes will be discharged to the Kii and Kisankala streams to minimise the impact of dewatering on the ecosystem and to ensure water supply to the communities that rely on the streams. Multiple discharge points will be necessary to mimic the natural stream flows and prevent erosion of the stream banks. It will also be necessary to discharge into the streams some distance from the source to limit re-circulation of ground water.

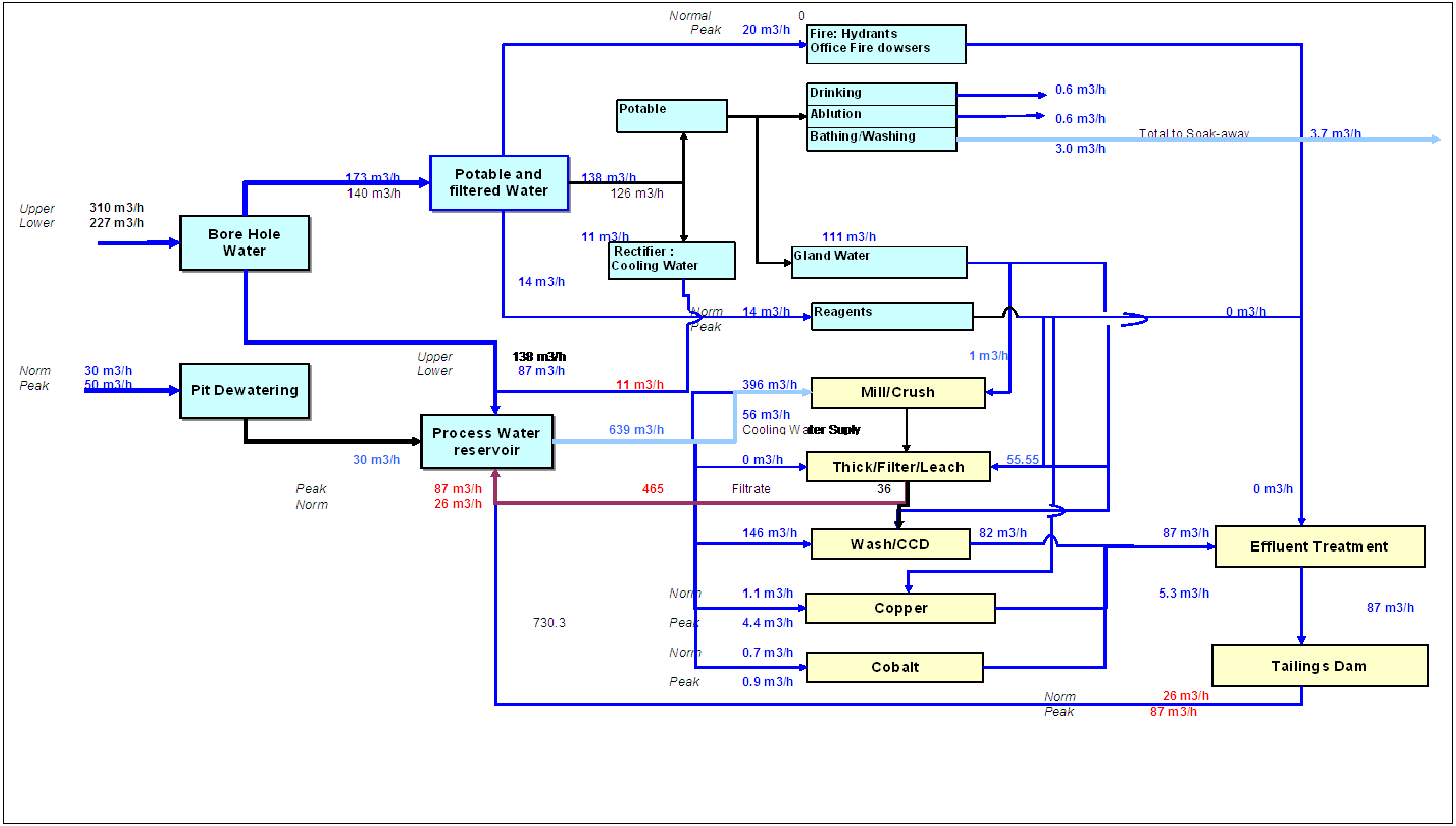

Figure 10: Kalukundi process water balance

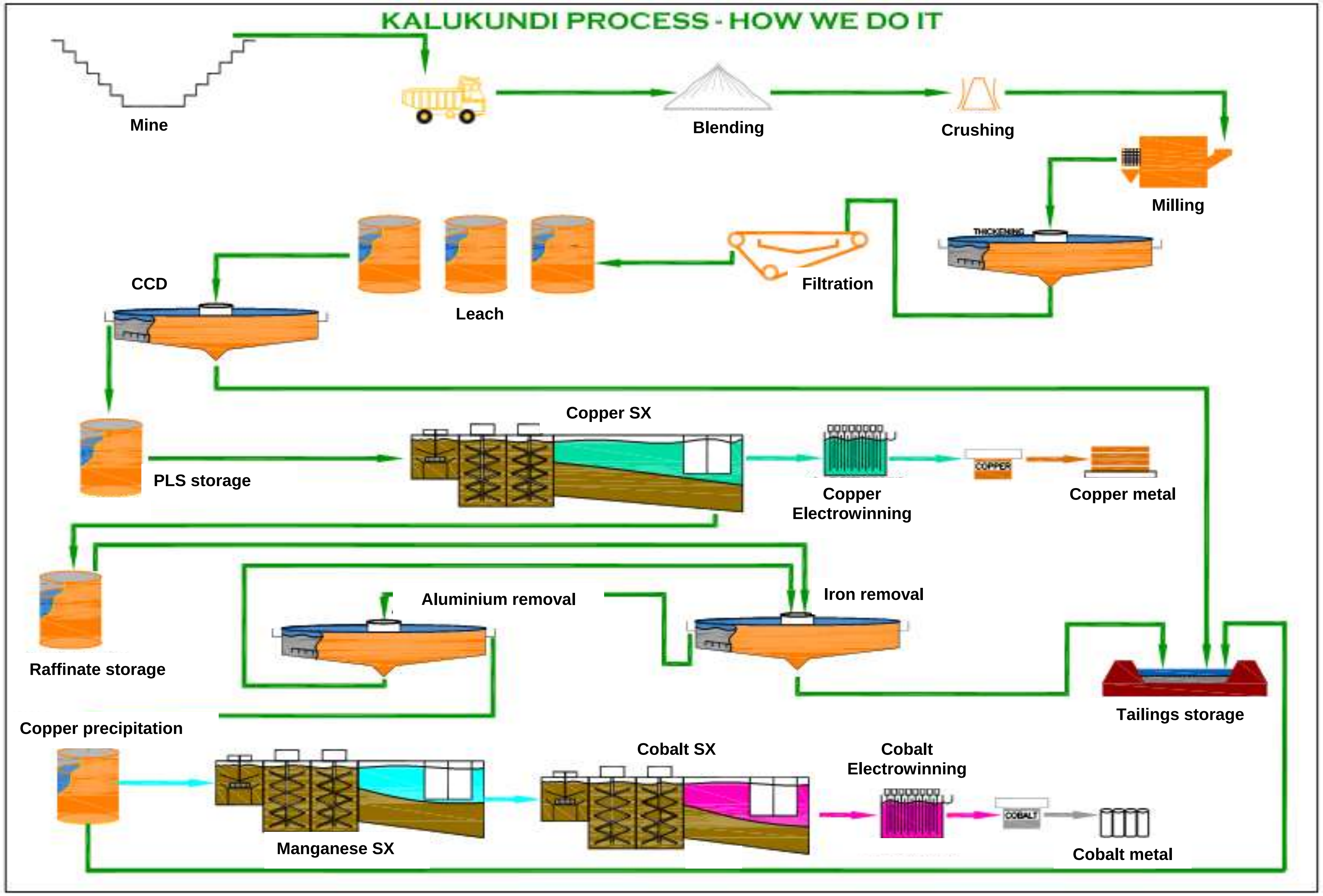

Figure 11: Kalukundi mining process

4.6 Ore processing

The Kalukundi plant is designed to recover copper and cobalt from a copper/cobalt ore body at a treatment rate of 800,000 t/y and an average feed grade of 2.37% Copper and 0.69% Cobalt. The hydrometallurgical process plant includes leaching, solvent extraction and electrowinning sections to produce 16,400 t of copper (99.999% Cu) cathode and 3,800 t of cobalt cathode (99.3% Co) per annum.

The flowchart of the processes described below is illustrated conceptually in Figure 11. The layout of the processing plant is shown in Appendix 1.

(a) Location of the process plant and processing capacity

The process plant is proposed to be located 1.5 km to the east of the Anticline Fragment, as shown in
Figure 7. This location was chosen primarily because of the shallow depth to bedrock for plant foundation construction, the presence of non-mineralised rocks and the central receiving location for ore from all of the open pits due to shortest trucking distances.

(b) Process plant flow diagram

Figure 11 is a simplified process flow diagram for the proposed Kalukundi process plant. The process was designed by MDM in South Africa and was based on metallurgical pilot plant test work carried out by Mintek (South Africa) in 2004 and 2005.

(c) Plant components

Major sections of the plant comprise of crushing, grinding, thickening and filtration, leaching, counter current decantation, Cu solvent extraction and electrowinning, Co purification, solvent extraction and electrowinning and tailing treatment and storage facilities (See Appendix 1).

(d) Crushing

Ore from the pits is delivered to the ROM pad where blending will take place to ensure equalised feed to the plant. Ore from the ROM pad is sent to a single stage crushing circuit to generate a crushed product that passes 160 mm. The crushed product is stockpiled before being fed to milling plant. The crushing plant is designed to have 85% operating utilisation out of an eight-hour shift per day basis. The remaining time each day will be available for maintenance, offering up to 16 h/d for scheduled maintenance purposes.

(e) Grinding

The stockpiled ore is reclaimed using apron feeders and fed to the milling plant at a steady rate of 106 t/h. The ore is ground down to 75% passing 75 µm utilising an open circuit SAG mill followed by a closed circuit ball mill. The milling plant is designed to operate at 106 t/h and have 91% operating utilisation, which includes 8 hours per week for scheduled maintenance purposes.

(f) Thickening and filtration

The milled ore feeds the thickener where excess water is removed. A 150 m^2 horizontal belt filter is used for the filtration of the thickener underflow and filtrate is returned to the thickener. Filter cake is mixed with raffinate before being sent to leaching. The dewatering steps are used to reduce the water consumption in the plant and also to prepare the leach feed with raffinate in the re-pulping tank.

(g) Leaching

The leach circuit consists of four leach tanks per stage for a total residence time of 12 hours. Most of the copper is leached during the time in the first two tanks where Sulphuric Acid (H_2SO_4) is added, while the cobalt is leached in the latter tanks. Sulphur Dioxide (SO_2) is added to the last two tanks to help the cobalt leach process. The leach product flows to the first of six CCD thickeners.

(h) Counter-current decantation

Raffinate from the Cobalt Solvent Extraction area is added to the last CCD thickener as washing liquor. The overall wash ratio in the CCD area is approximately 1.3. This ratio minimises the entrained losses during washing while still achieving the required pregnant liquor solution (PLS) grades for copper and cobalt. In the CCD thickener circuit the slurry is pumped downstream from CCD 1 whilst the liquor is pumped upstream from CCD 6. The PLS from CCD 1 is pumped to the Pinned Bed Clarifier whilst the Underflow is pumped from CCD6 to the tailings treatment tank. The pinned bed clarifier is utilised to ensure no solids enter the solvent extraction (SX) phase of the process.

(i) Copper solvent extraction

The pinned bed clarifier overflow is pumped to the primary copper SX where copper is extracted from the PLS and loaded onto an organic LIX984N before being stripped of the organic by a 200 g/l H_2SO_4 strip solution. The stripped organic is re-used whilst the loaded aqueous stream or advance electrolyte is pumped to the copper electrowinning plant. The cobalt rich, copper stripped, raffinate is pumped to the raffinate storage tank from where it is pumped to the filtration and leach areas as make-up solution whilst a bleed stream is sent to the cobalt recovery section of the plant.

(j) Cobalt purification

In the cobalt recovery section it is imperative that the electrolyte sent to cobalt electrowinning is cleaned of all metals that could co-deposit and reduce the grade of cobalt metal. The PLS flows through 2 stage thickeners, the first to remove iron, which is oxidised to the ferric form and precipitated out using lime, while overflows flows into the second thickener, which precipitates out aluminium using lime. The first stage precipitation is done at a pH of 4.7 whilst the pH is adjusted to 5.2 for the second stage. The first stage thickener underflow is pumped to the tailings treatment tank whilst the underflow from the second stage thickener is returned to the iron precipitation section.

The overflow from aluminium precipitation thickener flows into the copper precipitation circuit. Sodium Hydrogen Sulphide is used to precipitate the remaining copper out of the Cobalt PLS. The precipitate is sent to tailings whilst the clarified PLS is pumped to the Mn/Zn SX plant.

In the Mn/Zn SX plant, the manganese and zinc is extracted from the PLS using di-2-ethyl hexylphosphoric acid (DEHPA). The manganese and zinc is then stripped from the DEPHA using a 150 g/l H_2SO_4 strip solution. The manganese and zinc rich aqueous phase is then pumped to tailings and effluent treatment. The clarified PLS is pumped to the cobalt SX plant.

(k) Cobalt solvent extraction

In the cobalt SX plant cobalt is extracted in three extraction stages using Cyanex 272 as the organic phase. The raffinate from the cobalt SX phase is returned to the CCD area. The loaded organic is pumped to the cobalt SX circuit where the cobalt is stripped from the organic. The stripped organic is returned to the extraction phase whilst the cobalt rich advance solution is pumped to the cobalt electrowinning section.

(l) Electrowinning

In both the copper and cobalt electrowinning areas the advance liquor is heated through heat exchangers. Guar is added to the pregnant electrolyte as a smoothing agent for the cathodes. Copper electrolyte is pumped to the copper tank house, which consists of 112 cells each with 43 anodes and 42 cathodes of 1.15 m, by 1.0 m in size. Copper is plated on the cathode and the cathodes are periodically removed for stripping. Cobalt electrolyte is pumped to 52 cells consisting of 37 anodes and 36 cathodes of 0.75 m by 1.0 m in size. Cobalt is plated on the cathodes and the cathodes are periodically removed for stripping.

Copper and cobalt cathodes will be stored in a locked storage area. The copper cathodes will be baled awaiting transport offsite for sale, whereas the cobalt cathodes will be stored in drums due to their breakable nature.

4.6.2 Tailings disposal

All the discard streams in the plant will be pumped to the tailings and effluent treatment tank where lime is added to neutralise the slurry before it is pumped to the TSF. Return water from the TSF is pumped back to the plant and is used as part of the plant water requirements. In order to best utilise the limited water available in the area, water is re-circulated and retained in process where possible. The only water leaving the process will be in the tailings stream.

4.6.3 Chemicals and reagents

The process plant will be sealed and fully bunded so all spillages can be contained and returned to the process.

During the life of mine, due to the dewatering process, the migration of possible contaminants generated by the TSF and WRDs will be towards the pits due to the hydraulic gradient caused by the dewatering regime. After the decommissioning of the dewatering process, there is the potential for the contaminants to migrate towards the Kisankala Stream.

Reagents that are used in the process plant include lime, flocculent, steel balls, acids and organics. Water is also added to the process plant. Diesel, lubricating oils and greases will also be used for all machinery and working parts. The chemicals/reagents and other additions are listed below:

- No additions are made in the crushing section;
- SAG mill - water and steel balls;
- Ball mill - water, steel balls and collectors;
- Filtration – HBF filter aid to speed up and increase efficiency of filtration;
- Leaching Circuit – Sulphuric Acid (H_2SO_4) in the copper leach tanks and sulphur dioxide (SO_2) in the cobalt leach tanks;
- CCD - flocculant added to remove solids from the PLS;
- Copper Solvent Extraction – organic (LIX984N) used to extract the copper from solution, H_2SO_4 is used to strip copper from the organic;
- Cobalt Clarification – Lime is added to remove iron and aluminium, di-2-ethyl hexylphosphoric acid (DEHPA) is added to remove manganese and zinc, H_2SO_4 is used to strip the manganese and zinc from DEHPA;
- Copper Precipitation Plant – Sodium Hydrogen Sulphide is used to precipitate the remaining copper out of the Cobalt PLS;
- Cobalt Solvent Extraction – Cyanex 272 is added to remove cobalt from solution (3-stages), scrubbing and stripping produces the Cyanex 272 which is recycled in the plant;
- Copper and Cobalt Electrowinning – Guar added to the pregnant electrolyte as a smoothing agent; and

- Tailings and Effluent Treatment – lime added to neutralise the tailings slurry, water added to facilitate transport to the TSF.

(a) Radioactive Rejects

According to the classification of rejects in Annex XI of the Mine Code, 2003 there will not be any radioactive waste generated onsite.

(b) Cyanex

Cyanex is used in the processing of cobalt oxide ore to produce a cobalt cathode. Cyanex is phosphinic acid, which is classified as hazardous only in certain circumstances. In the case of Kalukundi, it will report to the TSF in a highly dilute form which is non hazardous. Cyanex is not related to cyanide, a reagent used in gold processing.

4.6.4 Chemical inputs

The chemicals that will be used in the process plant are shown in Table **10**, along with the annual consumption rates of the Kalukundi process plant.

Table 10: Chemicals to be used in the process plant

Product	Estimated consumption (t/month)	State	Hazard	Use
Purchased chemicals				
Sulphur	1744	Solid	Non toxic mild irritant	Sulphur Manufacture of sulphuric acid
LIX984N (organic) Phenolic Oxime Derivative Mixture/Petroleum Distillate, a mixture of 5-nonylsalicylaldoxime and 2-hydroxy-5-nonylacetophenone oxime in hydrocarbon diluent	15	Liquid	Organic Mild irritant	Extractant for Cu
Naptha (petroleum), hydrotreated light, special boiling point spirit	29	Liquid	Organic, moderate irritant	Solvent used in extraction process
Guar	0.1	Liquid	Slightly irritant	Smoothing agent for cathodes in electrowinning
Lime Quick-Calcium Oxide CaO	1417	Solid	Severe irritation and burns	pH control
Lime : Hydrated Ca(OH)2	1417	Solid	Medium irritation	pH control
S950 (Purolite Resin), functionlised styrene/divinylbenzene copolymer	1.7	Solid	Mildly irritating	Absorbing metal
DEHPA (di-2-ethyl hexylphosphoric acid)	1	Liquid	Medium	Extractant for Mn & Zn
Cyanex 272 (Bis (2,4,4-Trimethylpentyl) Phosphinic Acid	1.3	Liquid	Medium	Extractant for Co
CCD Flocculant	12	Solution	No	Flocculant
HBF Filter Aid (flocculant)	14	Solution	No	Flocculant

Product	Estimated consumption (t/month)	State	Hazard	Use
Pre-keach Thickener Flocculant	5	Solution	No	Flocculant
Hydrochloric Acid (33-35%)	45	Liquid	Yes	pH control
Sodium Hydroxide (40 – 45 %)	358	Liquid	Yes	pH control
SSX 210 Diluent for Dehpa and Cynanex, normal aliphatic hydrocarbon blend	4.9	Liquid	No	Stripping diluent
Chemicals manufactured on site				
Sulphuric Acid		Liquid	Yes	Leaching of Cu and stripping solution
Sulphur dioxide		Gas	Toxic	Leaching of Co

4.6.5 Storage of chemicals and reagents

Chemicals will be stored in a way that complies with all hazardous chemical reagent laws and guidelines, including separation of incompatible chemicals, correct storage, locks, spillage bunds, roofed enclosures to minimise potential for spillage of chemicals to enter the environment.

Apart from bulk chemicals, chemical reagents will be stored in an enclosed storage building. This storage area will have 24 hour security. Reagent storage areas will be equipped with bund walls and provided with drain pumps to ensure spills are properly contained. Safety showers will be provided at all reagent storage areas to ensure employee safety. Plans and layouts for this building will be finalised in the final mine design.

4.6.6 Preventative and emergency measures

Surface runoff (uncontaminated) will be kept separate from contaminated plant runoff and process water. Clean run-off from the process plant will be collected in the perimeter storm drain and discharged to surface waters. All process spills and wash water will be returned to the process. Water from equipment wash bays at the workshop will be passed through oil sumps to remove oil and then sent to the process water storage pond.

Non-hazardous chemicals and reagents used in the process will be stored under roof or in a shed equipped with a concrete floor and containment wall to prevent any spillages causing soil, surface or groundwater contamination. There will be no releases of gases to the atmosphere but regular monitoring of air quality around and within the process plant will be carried out. All parameters will comply with Congolese air quality standards listed in Annex IX of the Mining Code 2003.

Air monitoring will be carried out to prevent build-up of gases, prevent releases of high levels of dust from the process plant and ensure a safe working environment. Safety breathing equipment will be located in all key areas where exposure to gases may occur. In the case of accidental spillages, the incident will be reported to the shift manager and the immediate remediation measures will be undertaken to neutralise the spill and prevent the spread of contamination. Contaminated soil or water will be disposed of appropriately according to methods detailed on the material safety data sheets (MSDSs).

Mine workers will be supplied with MSDSs to inform them about the chemicals they will be in contact with and the appropriate handling and storage practices to prevent accidents. Equipment cut-off switches will be inserted on key machinery (such as conveyors) where necessary to shut down equipment in the case of an emergency. Fire fighting equipment will be available in key areas and extinguishers and signs placed in strategic areas of the process plant, offices and workshop areas. Only fully trained personnel will be operating each section and in the handling of reagents.

4.6.7 Elimination of mine waste

The treatment of all streams of waste from the mine will be detailed in the comprehensive Waste Management Procedure. The aim will be to re-use and recycle as much as possible, and ensure the rest of the waste is disposed of according to international standard practices.

Some of the methods to be use for industrial wastes are:

- Scrap metals and used tyres will be sold to vendors or used in community projects.
- Wood potentially may be sold or donated to local communities;
- Waste oil will be collected from site by suppliers and disposed of / recycled according to safe environmental practices;
- Contaminated soils will be treated onsite;
- Medical waste from the mine clinic will be incinerated onsite in an enclosed and safe incineration unit; and
- Sewage waste and waste water from ablution blocks will be stored in septic tanks onsite, which will be emptied as required.

The final destination of mine waste will be:

- The WRDs (waste rock, sediment from the settling ponds);
- The TSF (residue tailings from the process plant);
- Onsite waste management areas (putrescible waste facility, industrial waste facility, oil contaminated soil treatment facility);
- A small scale medical waste incinerated on site (its use would be limited to medical waste of approximately one 10 l bucket per week);
- Hydrocarbon contaminated waste incinerated on site (fuel filters, oily rags); and
- Offsite recycling facilities (tyres, scrap metal, waste oil, paper, cartridges.).

4.7 Infrastructure and amenities

Surface infrastructure will include the process plant (previously discussed), mine offices, the mine camp, resettled Kisankala Village, the TSF, the four open pits and the four WRDs. Other infrastructure will be finalised prior to project implementation.

4.7.1 Extent of the elements of mine infrastructure

The extent or footprints of the various elements of infrastructure that are to be established for the mine are indicated in Table 11 below.

Table 11: Extent of elements of mine infrastructure

Infrastructure element	Footprint in m^2	Footprint in ha
TSF Initial cell - Toeline area	591312	59.1
TSF (Possible future expansion)	485328	48.5
TSF Return water dams toeline area	50253	5.0
WRD – Kii	212609	21.3
WRD – Kalukundi	197828	19.8
WRD – Principal	276540	27.7
WRD – Anticline	250820	25.1
Processing Plant-Fenced area	286882	28.7
Mine camp -Fenced area	84487	8.4
Kisankala village -Fenced area	273757	27.4
Kii pit	84766	8.5
Kalukundi pit	89043	8.9
Principal pit	105896	10.6
Anticline pit	34943	3.5
Total	**3024464**	**302.4**

4.7.2 Waste Water Treatment

The mine sewage and domestic wastewater will be stored in buried septic tanks at the location of offices and ablution blocks. These septic tanks will be regularly monitored and emptied. The effluent and tailings produced from the process plant and workshop areas will be directed to the tailings and effluent treatment tank, which will release tailings slurry to the TSF.

4.7.3 Workshops

All servicing of light vehicles will also be carried out at the mine workshop on impermeable and demarcated area. Drainage from plant maintenance and service areas and wash water from wash bays will be collected in silt and grease traps and treated prior to release to the site drainage system. The refuelling station will be located near the mine workshops. There will be two above ground diesel storage tanks with a capacity 1.5 million litres. The fuel storage area will be equipped with containment walls and impermeable concrete flooring with enough capacity to contain 125% of the volume of the diesel tanks. All diesel spills will be contained within the containment area and cleaned up in an appropriate manner.

4.7.4 Mine Piping Network

Dewatering water will be pumped to the mine process water storage tank from the pit sumps and pit dewatering bores. Bore water will provide water for the potable water systems onsite such as the fire water system, the drinking and ablutions network, the cooling water for the process plant and the gland water system. All releases will be pumped to the TSF.

Process water from the process water storage tank will supply the water needs to the process plant and make-up water for the reagents.

The discarded effluent and the tailings from the process plant are pumped to the TSF. The return water from the TSF is pumped to the process water storage tank. Wash water from the workshops will be collected in a closed circuit system, where oils are separated and sent to the waste hydrocarbon tank and clean water is recycled to the wash down pad.

4.7.5 Mine Drainage System

The Kisankala Stream flows from the centre of the permit and out through the northwest corner of PE 591. The Kii River flows to the north of PE 591 and joins the Kisankala Stream. The stream will be fed by excess mine dewatering water and surface runoff and this flow will prevent potential drying of the stream due to depression of the water table due to dewatering activities. No diversions or channel changes (canalisation, dredging) will be made to existing watercourses.

The on site drainage system will be designed so that run off from areas that are potentially contaminated (plant area, workshops, crusher, ROM pad) will be directed to internal settling ponds for reuse. Run off from ‘uncontaminated’ areas will be directed away to settlement ponds and then returned to the natural drainage lines.

4.7.6 Electrical Infrastructure

Power supply to the mine will be provided from the Kolwezi to Lubumbashi high-tension power lines that pass through the concession. These power lines provide power to Tenke Fungarume Project, Lubumbashi, and Zambia and the corridor runs across the southern end of the Principal Fragment. The location of the power line relative to the mine site is shown in
Figure **7**.

4.7.7 Raw water storage dam

The raw water storage dam will have a capacity of 10,000 m^3 and will be used to supply onsite fire fighting supply systems, cooling water for the process plant, potable water for the potable water storage tanks at the mine camp and make-up water for the process water storage tank.

4.7.8 Process water storage tank

The process water tank will have a storage capacity of 300 m^3 and will be fed from the dewatering of the open pits and make-up water from the raw water storage dam. Return water from the TSF will also feed into the process water storage tank. The process water will supply the process plant with all water requirements.

4.7.9 Proposed relocated Kisankala village

The relocated Kisankala village is proposed in the southern portion of the concession area, south of the Nzilo power line and adjacent (east of) to the main access road to the concession.

The layout of the village, as agreed with the residents of the current Kisankala village, is shown in
village, is shown in

Figure 12. The design of the houses that will be provided to those that will be relocated is indicated in
Figure 13 and Figure 14.

Figure 12: Layout of the proposed relocated Kisankala village (not to scale)

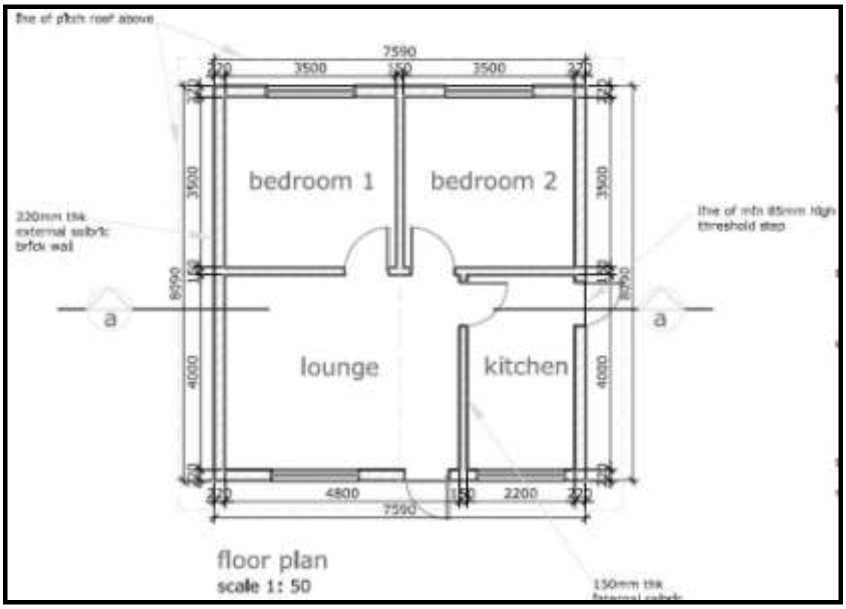

Figure 13: Four-room house design (not to scale)

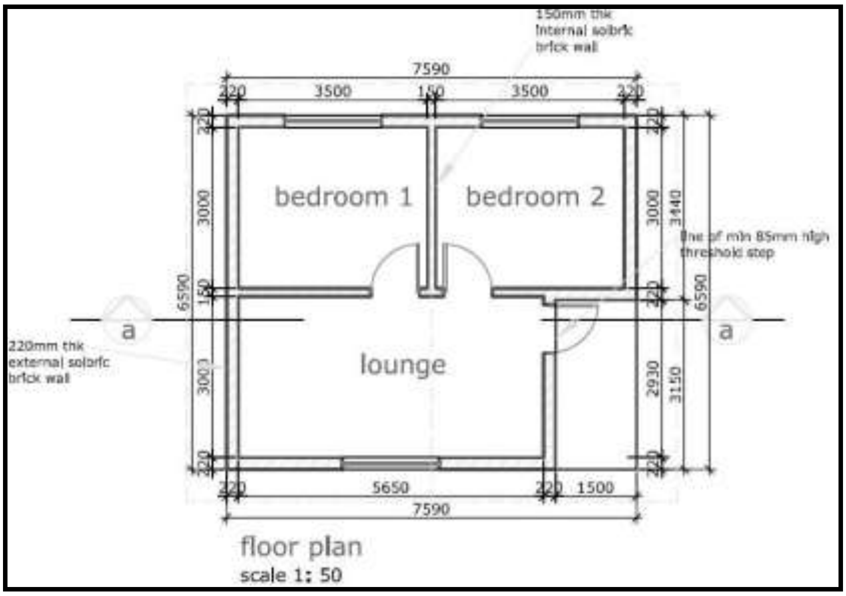

Figure 14: Three-room house design (not to scale)

4.8 Alternative locations of mine components

The location of the mine components and associated infrastructure is presented in the section below. Two different options for location of the TSF and the mine camp are also discussed.

Due to the small size of the concession, the placement of the TSF and processing plant has been carefully considered with regards to proximity to the new Kisankala village and to minimise potential environmental impact. Four locations were initially investigated for the project, with the two most favourable positions being considered in detail. This report will thus discuss social and environmental effects that could occur as a result of considering these two sites.

In **Proposal B** (See Appendix 1) the TSF is located in the southeast of the concession area against the eastern boundary, south of the power lines. The processing plant will be situated against the eastern boundary of the concession and north of the electricity transmission lines The TSF is located approximately 200 m from the plant.

In **Proposal C** (See Appendix 1), the processing plant and TSF will be located close to the north western corner of the concession, close to the point where the Kisankala Stream exits the concession area.

The implications of the different layout options are discussed in detail in Section 9.1.

4.9 Waste rock

4.9.1 Waste rock dumps

The waste rock will be stored on the WRDs. There are four WRDs and material from their corresponding open pits will be dumped in them. The combined storage capacity of the WRDs will be not more than 31.5 Mt (14.7 Mt in Principal, 10.6 Mt in the Kii, 3.1 Mt in Anticline and 3.1 Mt in Kalukundi) of waste rock over the 10-year project. Current design is conservative and further geo-technical work is likely to allow the pit slopes to be steepened, meaning less waste will be mined and dump sizes will be significantly reduced.

The proposed positions of the WRDs are shown in
Figure **7**.

4.9.2 Physical and chemical characteristics of the waste rock

Mintek Ltd carried out geo-chemical assessment of Kalukundi samples. The results of acid base testing are shown in Table 12.

Table 12: Acid-Base Analysis and Net-Acid Generation Results of the Waste Rock (Mintek, 2005)

Sample	pH	EC (u/cm)	Sulphide S^{2-}%	Carbonate (TC – TOC) %	NAG H_2SO_4 Kg/t*	NAG-pH	Conclusion
Waste rock	8.42	6.660	<0.1	0.16	2.98	6.89	PAF

Notes:

Notes:	PAF:	Potentially Acid Forming
	NAG:	Net Acid Generation
	NAG pH:	pH of solution at end of NAG assay
	TC – TOC	Total Carbonate – Total Organic Carbonate
	*	Reported as 'SO' but assumed to be 'H_2SO_4' – unable to be confirmed with the laboratory.

The sample of waste rock analysed was identified to be potentially acid forming. This may be due to the location of rock sampled. The production of ARD by the waste rock is not thought likely and mixing of the rocks can be carried out in the WRD to ensure that rock characterised by higher levels of carbonate materials will be mixed with rock of lower levels of carbonate, thereby neutralising the potential for acid generation.

Mild acid leaching test work was carried out using the US Environmental Protection Agency (EPA) 1310. The results in Table 13 indicate that the potential risk of release of heavy metals in solution from the mine waste rock into the environment is minimal. These small amounts comply with Congolese contaminant concentrations in final effluent the discharge point (Article 66), except for concentration of copper released, and the waste rock is considered to be low risk waste in terms of Annexe XI of the DRC Mine Code, 2003.

Table 13: Results of USEPA Mild Leach Extraction Procedure 1310 – A on Rock Sample (Mintek 2005)

Parameter	Concentration (ppm)	Parameter	Concentration (ppm)	Parameter	Concentration (ppm)
Chloride	2.03	Cu	0.18	Cd	<0.01
Fluoride	0.202	Zn	<0.01	Be	<0.01
Cr VI	<0.02	As	<0.01	Sn	<0.01
Ti	<0.01	Se	0.04	Sb	<0.01
V	<0.01	Sr	0.08	Ba	0.09
Cr	<0.01	Li	<0.01	B	0.02
Mn	1.42	Zr	<0.01	Hg	<0.01
Co	1.86	Mo	<0.01	Pb	0.06
Ni	0.25	Ag	0.19	Bi	<0.01
Th	<0.01	Fe	18.2	K	19.3
U	0.02	Mg	<0.10	Na	1320
Al	1.09	S	<0.10	S	10.5
Ca	8.97	P	0.18	Cd	<0.01

4.10 Tailings

4.10.1 Tailings storage facility

The tailings produced during the leaching of copper and cobalt oxide rocks and the SX and EW processing methods to produce copper and cobalt cathodes will be directed to the tailings and effluent treatment tank. The solution in this tank will be treated and neutralised and pumped to the TSF. The TSF will occupy an area of approximately 59 ha.

The conceptual design of the TSF has been done by Golder Associates Africa (Pty) Ltd in Johannesburg. Due to delays in project financing the detail design has not yet been commenced, but Knight Piésold, Johannesburg has been selected to undertake the work. The location of the TSF is shown in
Figure **7** and design drawings of the TSF are shown in Figure 15.

The TSF has been designed as a paddock-type containment facility with a perimeter compacted earth fill wall, compacted clayey fine tailings liner, decant system and perimeter toe drain. The tailings slurry will be neutralised in the tailings and effluent treatment tank at pH 6 to 8 and slurry will be pumped to the TSF.

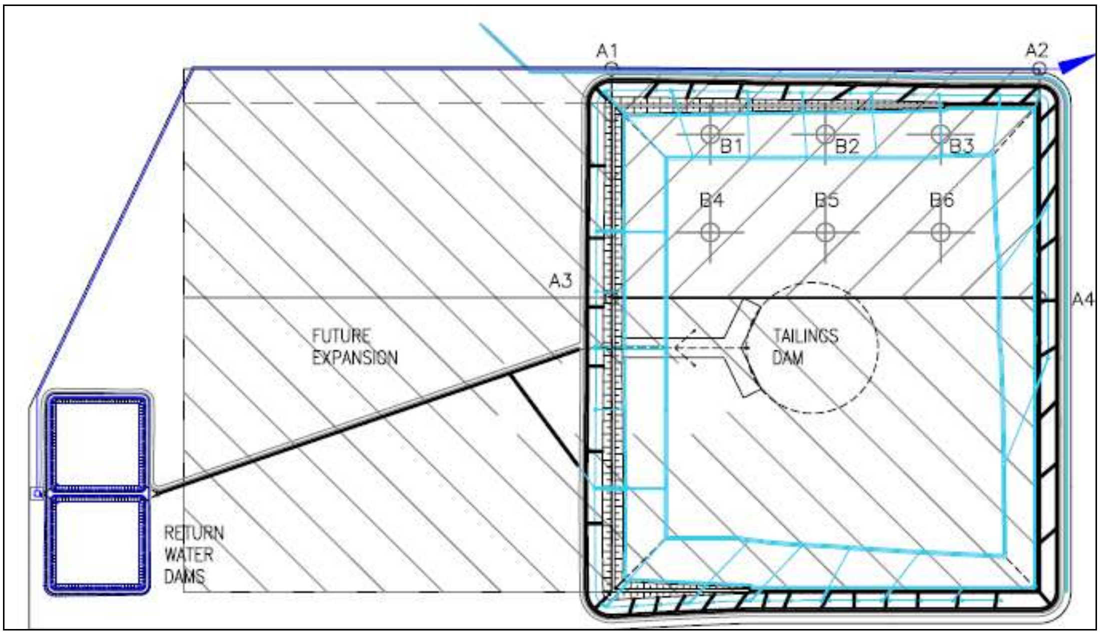

Figure 15: Conceptual design of the TSF (not to scale)

The current design is for a disposal facility (including future expansion) that can accommodate 12 Mt of tailings at a deposition rate of 60,000 t/month over a project life of 17 years. The detail design, when undertaken, will take into account the latest tonnages and production rates expected by the project team.

The area to the west of the facility will be available for future expansion. Initially deposition will be behind the earth fill wall, and future lifts will be constructed with coarse tailings borrowed from the head of the beach. Supernatant water will be returned to the process water tank at the processing plant by a submersible pontoon pump. There will be no gravity decant or piping through the TSF wall.

A toe drain and blanket rain will return seepage through a pipe and manhole network to a collector sump from where it will be returned to the TSF. Catchment paddocks along the perimeter of the TSF will collect silt and run-off from the sides of the TSF.

No stability problems are anticipated and research of seismic records for the region has shown that there are low levels of seismic risk in the area. The TSF will be designed to handle the 1 in 100 year storm event. There will be no discharge from inside the TSF direct to the mine site drainage system. Knight Piésold is carrying out detailed TSF design in Johannesburg (South Africa) to best industrial practices and taking into consideration local conditions.

4.10.2 Physical and chemical characteristics of the tailings

Test-work results in tailings showed that there is low sulphide content in the tailings, which indicates the deposited residue will be non-acid forming (NAF). The tailings are considered to be low risk with regard to acid rock drainage (ARD). The TSF will in any event be lined with a semi-impermeable layer of clay or fine tailings to prevent groundwater contamination.

Table 14: Acid-Base Analysis and Net Acid Generation Results of the Tailings (Mintek 2005)

Sample	pH	EC (u/cm)	Sulphide S^{2-}%	Carbonate (TC – TOC) %	NAG H_2SO_4 Kg/t*	NAG-pH	Conclusion
Tailings	5.92	1.795	0.25	0.87	0.67	3.74	NAF

Notes:

NAF:	Non Acid Forming
NAG:	Net Acid Generation
NAG pH:	pH of solution at end of NAG assay
TC – TOC	Total Carbonate – Total Organic Carbonate
*	Reported as 'SO' but assumed to be 'H_2SO_4'

Mild acid leach test work was carried out using the US EPA 1310 "An Extraction Procedure for risk assessment of waste materials to determine the constituents of a leached solution". The results (Table 15) indicate that the potential risk of release of heavy metals in solution from the tailings solids into the environment is minimal; however there are small amounts of copper leached. The concentration of copper in solution released is not compliant with the final effluent quality standards in Article 66 of Annexe IX of the DRC Mining Code 2002. The tailings solution sent to the TSF will be neutralised to pH between 6 and 8 and acidic conditions will be minimised. It is therefore not anticipated that there will be leaching of metals. The expected chemical composition of the tailings supernatant solution in the TSF will be investigated during the initial project implementation and Year 1 of the project life.

Table 15: Results of USEPA Mild Leach Extraction Procedure 1310-A on Tailings Sample (Mintek, 2005)

Parameter	Concentration (ppm)	Parameter	Concentration (ppm)	Parameter	Concentration (ppm)
Chloride	0.19	Cu	6.21	Cd	<0.01
Fluoride	0.873	Zn	0.18	Be	<0.01
Cr VI	<0.02	As	<0.01	Sn	<0.01
Ti	0.02	Se	<0.01	Sb	<0.01
V	<0.01	Sr	0.38	Ba	0.07
Cr	<0.01	Li	<0.01	B	<0.01
Mn	0.31	Zr	<0.01	Hg	<0.01
Co	1.73	Mo	<0.01	Pb	0.04
Ni	0.14	Ag	<0.01	Bi	<0.01

Parameter	Concentration (ppm)	Parameter	Concentration (ppm)	Parameter	Concentration (ppm)
Th	<0.01	Fe	<0.10	K	1.06
U	0.01	Mg	7.57	Na	5640
Al	0.33	S	726	Si	3.9
Ca	819	P	<0.10		

Table 16: Comparison of Kalukundi Tailings USEPA 1310 – A leachate test work results with Annexe XI of the DRC mining code

Parameter	Low Risk Waste Leachate Limit (mg/l)	Tailings Solids Leachate (mg/l)
Arsenic	1.0	<0.01
Cadmium	0.10	<0.01
Chromium (Hexavalent)	0.05	<0.02
Chromium (total)	1.0	<0.01
Copper	0.30	6.21*
Cyanide (Free) #	0.10	<0.10
Cyanide (total)	1.0	#
Iron	2.0	<0.01
Lead	0.60	0.04
Mercury	0.002	<0.01
Nickel	0.50	0.14
Zinc	1.0	0.18

* Exceeds the copper standard indicated in Annexe XI of DRC Mining Code

\# Values for these will be determined during project life, but not expected due to the fact that no cyanide is used in the process

The tailings are classified as low risk in terms of Annexe XI of the Mining Code, except for the concentration of copper (2.1 mg/l) that can be leached under mildly acidic conditions. However, the tailings are non-acid forming and any localised leaching would be quickly neutralised with precipitation of metals.

Table **16** shows a comparison between the maximum concentrations allowable to classify waste as low risk (Annex XI of the DRC Mining Code) and the results from the US EPA 1310-A “Extraction Procedure for risk assessment of waste materials to determine the constituents of a leached solution, undertaken on the final tailings”.

5 DESCRIPTION OF THE EXISTING ENVIRONMENT

This chapter provides a description of the current pre-mining environment, including natural and social elements of the environment. The descriptions of the environment have been obtained from a number of specialist assessments that were undertaken. This chapter provides an overview of the characteristics of the existing environment so as to provide a background to the impact assessment section that is to follow. Further detailed information can be obtained from the specialist assessments in Appendices 2 to 7.

5.1 Geology

The Kalukundi deposit is located within the Copperbelt region of the Democratic Republic of Congo. The Kalukundi copper and cobalt deposits forms part of the Lufilian Arc, which extends 700km from Luanshya (Zambia) in the southeast and through to Kolwezi in the northwest. The Lufilian Arc comprises folded and thrust faulted sediments of the neo-Proterozoic Katanga Super Group, particularly the Upper and Lower Roan Groups (750-850 million years old) and the Kundelungu Group (500-750 million years old). The Kalukundi deposits consist of a number of large individual fragments “floating” within the lithologies of the younger Kundelungu rocks. In all there are 12 major fragments within the boundaries of the concession, of which four are planned to be mined (see Section 4.1).

5.2 Topography and landforms

Elevations in the concession range from a low in the northwest, between the 1375 m and 1400 m contour intervals, to a high in the southeast, between the 1475 m and 1500 m contour intervals. Elevations in the incomplete 1 m-contour interval data set obtained from the client, range from a low of 1373 m in the extreme northwest to a high of 1482 m in the extreme southeast.

Relief within the concession is low, with the exception of the small hills associated with some of the metalliferous outcrops (the latter known colloquially as fragments). The relief of these hills can be in stark contrast to the low relief of the surrounding landscape. Notable examples include the Anticline, Kalukundi, Kii and Kinshasa fragments. Moderate (5 – 8 %) and steep slopes (> 8 %) are often associated with the hills or drainage lines.

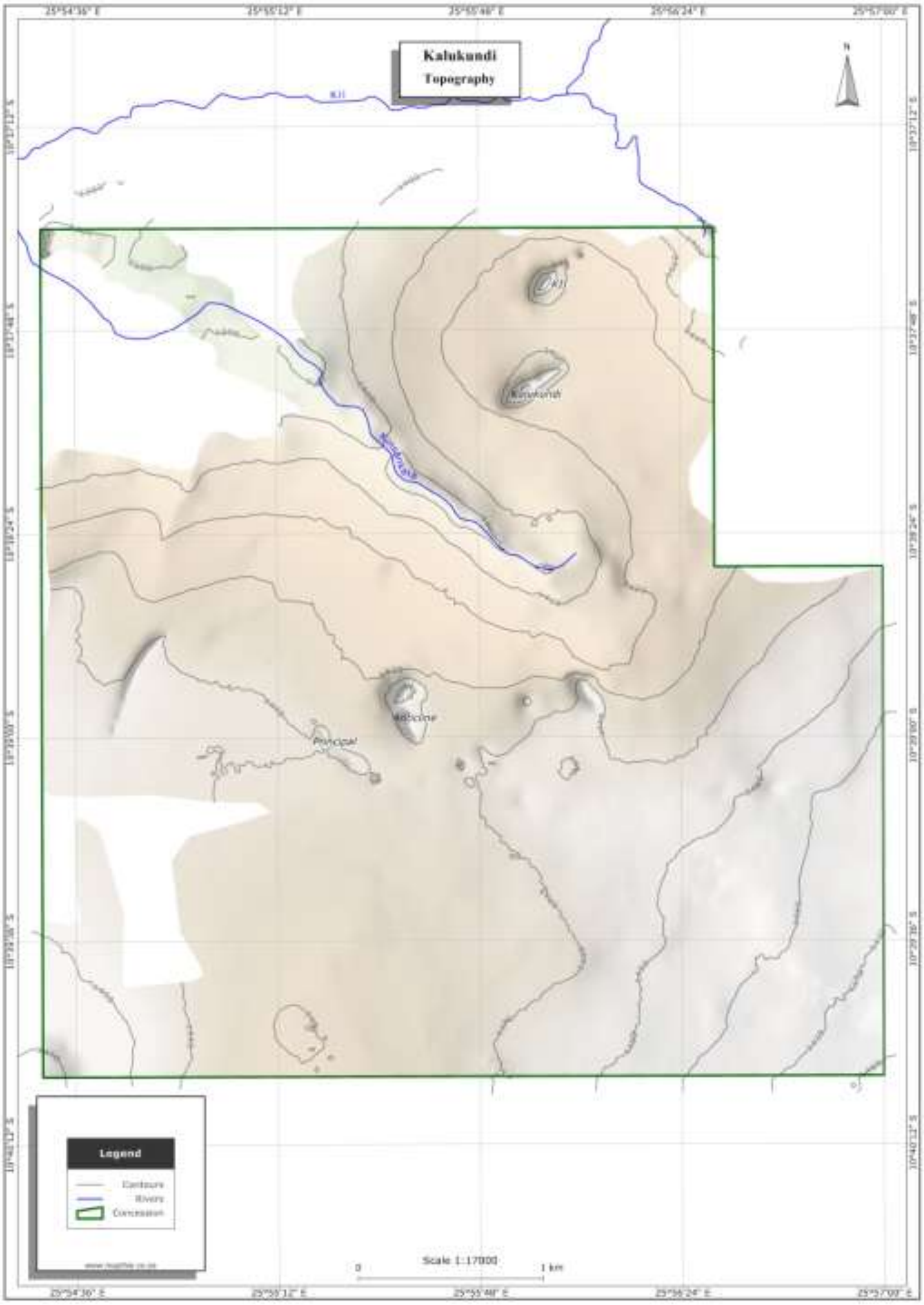

Figure 16: Kalukundi concession relief map

Most of the land surface in the concession slopes gently towards the Kisankala River, which in turn flows in a northwesterly direction towards its confluence with the Kii River. The confluence of these two rivers lies just outside the northwestern corner of the concession.

The intensity of sheet erosion is regarded as slight across virtually the entire concession. Based on ad hoc observations made in the field, a similar state could be assigned to channel incision in the concession. As a broad generalization, both the Kisankala and Kii rivers could be regarded as slightly incised. Significant sediment accumulation has occurred at localities where ore washing has taken place or is believed to have taken place (Illgner 2008).

5.3 Hydrology and aquatic systems

5.3.1 General hydrology

The Kii and Kisankala rivers (or streams) both originate within the Kalukundi Mining concession area and are fed by artesian springs downstream of grassy dambos, i.e. wetland areas within shallow valleys without a defined river channel. Base flows in both these streams are thus largely dependent on groundwater levels.

The Kisankala River flows northwest across the centre of the study area into the Kii River just outside the northwestern boundary of the concession area. The source of the Kii River is in the northeastern corner of the mining concession. The Kii River flows west to join the Bona River, which enters Lake Nzilo on the Lualaba River some 25 km west of the study area. The Lualaba is the main river in the region and flows north for over 1000 km before entering the Congo River.

The flat topography of this area ensures that both rivers have gentle gradients, which together with the densely vegetated catchment, allows fine sediment and decaying organic matter to accumulate in the river channel, rather than being flushed downstream after high rainfall events.

Knight Piésold (2008) reported stream-flows in late January 2007 (wet season) at the source of the Kii and Kisankala rivers as 6.33 l/s and 5.05 l/s, respectively. In January 2008, the flows in the lower Kisankala were estimated to be less than 10 l/s, but much higher flows were witnessed in the lower Kii River just downstream of the northwestern boundary of the mining concession area.

5.3.2 Habitat integrity and water quality

Habitat integrity was assessed using a rapid assessment method developed by Kleynhans (1996). The criteria assessed are those considered to reflect the habitat integrity of the river, with the instream and riparian habitats being assessed separately. The habitat integrity of the instream and riparian aquatic systems differs greatly between different parts of the concession area. On a scale from A (unmodified, natural) to E (extensive loss of natural habitat, biota and basic ecosystem functions), scores for the watercourses on the site range from A to D. Details on criteria that have been used to assess habitat integrity and assign scores are contained in the specialist icthyofauna (fish) assessment report (Appendix 3).

The upper Kii River has largely natural instream and slightly modified riparian habitats and its ecosystem functioning is essentially unchanged. The current impacts are related to the small-scale crop growing activities near the riverbank, which cause increased sediment and nutrient input.

The riparian habitats of the upper Kisankala are moderately modified with the instream habitat being largely natural. The current main impacts are related to the close proximity to the Kisankala Village, with activities such as access roads and footpaths (sediment run-off), clearing of riparian vegetation, washing using soap powders and pollution from faecal wastes. The lower Kisankala River was found to be moderately to largely modified. The impacts associated with this habitat are largely associated with washing of copper-cobalt ore (heterogenite) in the Kisankala River by artisanal miners. Excessive sedimentation and water turbidity caused by this practice has resulted in a large loss of natural habitat and aquatic biota and a significant disruption of basic ecosystem functioning.

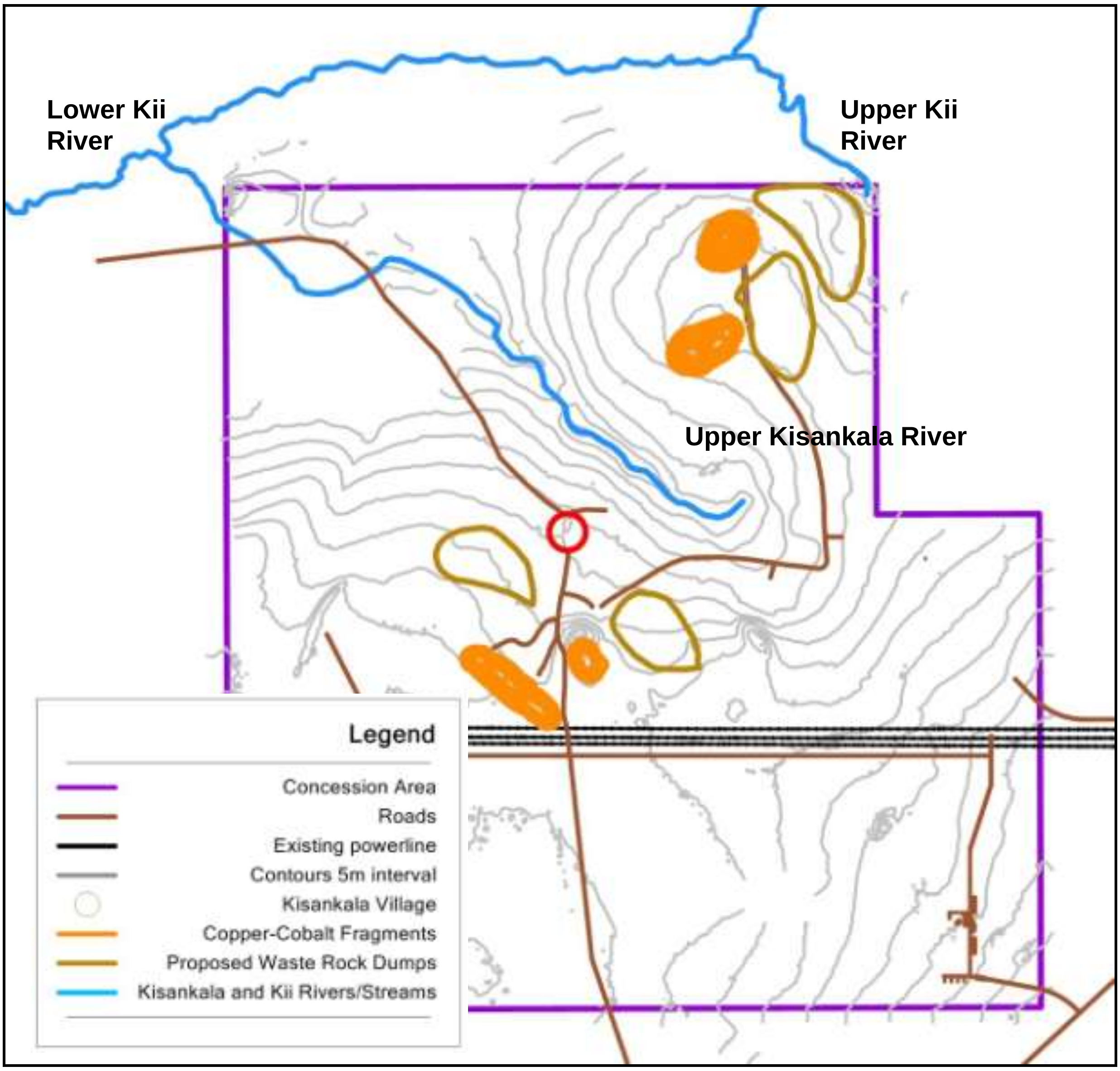

Figure 17: Map of the mining concession showing the watercourses (Not to scale)

Figure 18: Clear spring water at a fountain along the lower portion of the Kii River

Figure 19: Accumulations of sediment from ore washing in the lower reaches of the Kii River, upstream of the confluence with the Kisankala River (outside the boundary of the Kalukundi concession)

Water quality data taken from previous studies by African Mining Consultants (2006) indicated generally good water quality in the very upper Kii and Kisankala rivers just downstream of their sources. However, significant anthropogenic impacts on water quality, particularly high turbidity levels and elevated metal concentrations, were found in the lower reaches of both rivers. The increased sediment loads resulting in increased turbidity and elevated metal concentrations, are considered to be due to the widespread practice by artisanal miners of washing heterogenite in the lower Kisankala and Kii rivers. Of particular concern for aquatic biota are the high concentrations of the metals aluminium, cobalt, copper and iron in the water. Water quality data for the lower Kisankala reported by African Mining Consultants (2007), show that at times these four metals are present at levels well above those recommended as the upper limit for aquatic biota, including fish.

5.4 Climate

According to AMC (2007), the climate data derived from a number of weather stations in the Katanga Province indicates that the average annual rainfall of the region is between 1220 and 1320mm per year. Figure 20 is a climate graph for Lubumbashi. Rainfall is strongly seasonal, mainly occurring in thunderstorms during summer (November to March). These storms typical produce between 10mm and 40mm of rain per precipitation event.

According to AMC (2007), average annual temperatures in the region vary between 20ºC and 28ºC throughout the year. Minimum temperatures occur during the cold season months of June and July with temperatures varying between a minimum of 4ºC and a maximum of 25ºC. Maximum temperatures occur in the month preceding the onset of the rains (October) with minimum and maximum temperatures during the October of 18ºC and 32ºC respectively.

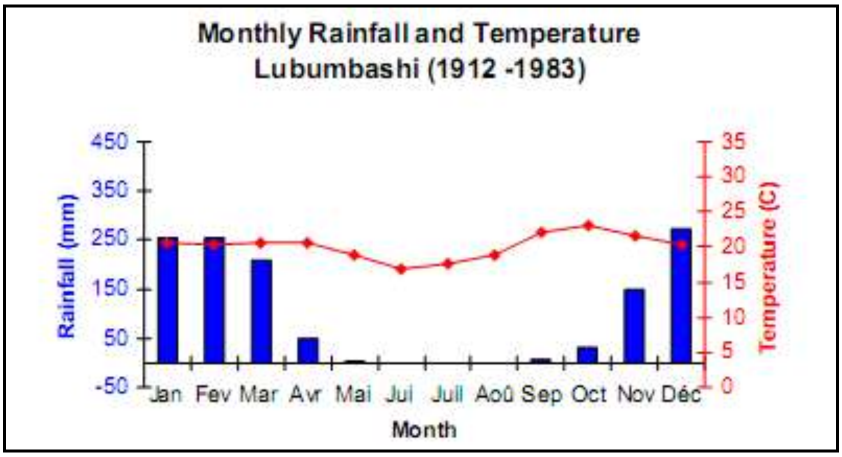

Figure 20: Climate graph for Lubumbashi

There is a scarcity of long-term monitoring data from the area around the Kalukundi Project. The two graphs below are based on data collected at an exploration project adjacent to Kalukundi (15 km south), but reflect data collected over a period of less than two years.

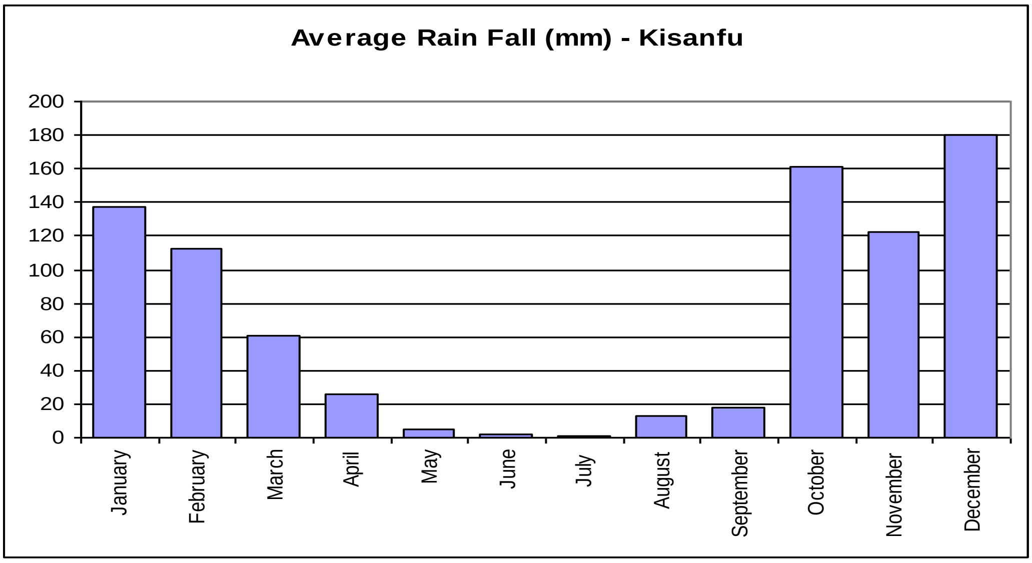

Figure 21: Rainfall graph for a mine at Kisanfu
(based on data from November 2005 to February 2007)

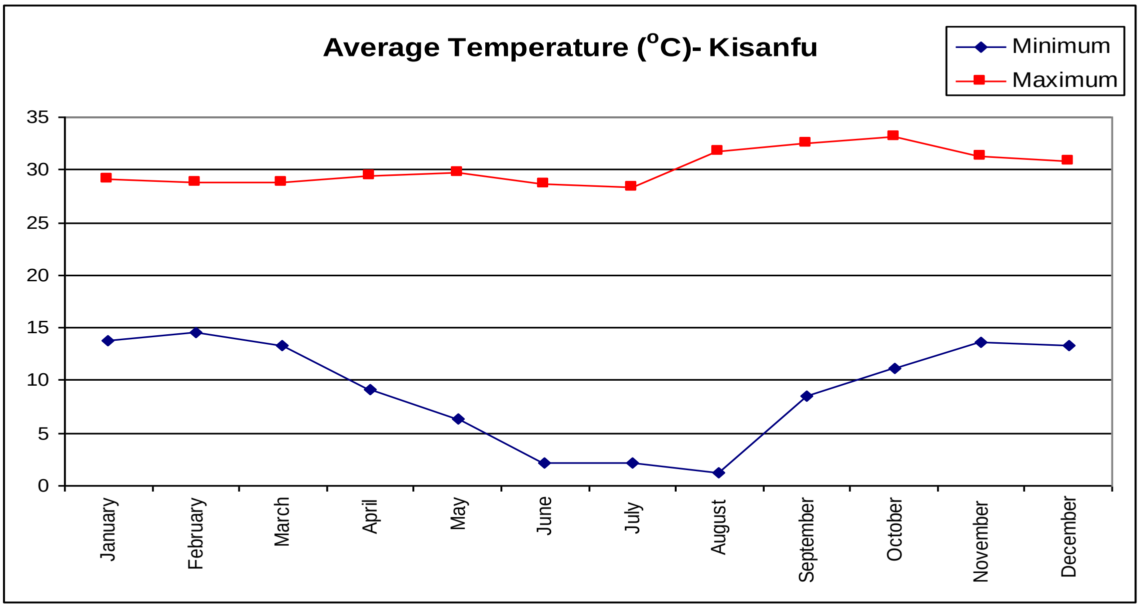

Figure 22: Temperature graph for a mine at Kisanfu
(based on data from November 2005 to February 2007)

Average annual rainfall at Kisanfu according to this data is approximately 877 mm per annum. This is very low compared to the annual long-term average for the region (more than 1200 mm per annum), probably due to the short period over which data has been collected.

5.5 Flora

On a regional level, the study area is situated within the Miombo woodland belt of central Africa. Regionally, 475 vascular plants have been identified within this vegetation community. Based on the literature, many more species have the potential to exist in the region. However, the local area is relatively fragmented and modified by human activity, reducing the numbers of species that exist. Broadly speaking four vegetation communities occurs within the concession area:

- Miombo woodland;
- Copper-cobalt outcrop associated vegetation;
- Dambo Wetland; and
- Gallery forest.

A total of 266 plant species have been identified within the mine concession. In addition, 11 species, which were not identifiable to family or genus level (due to lack of flowering material), occur within the study area. Miombo woodland was found to be the most diverse with 183 species recorded, copper outcrops with 69 species; riparian communities with 35 species; dambo with 24 and disturbed areas recorded approximately 17 species.

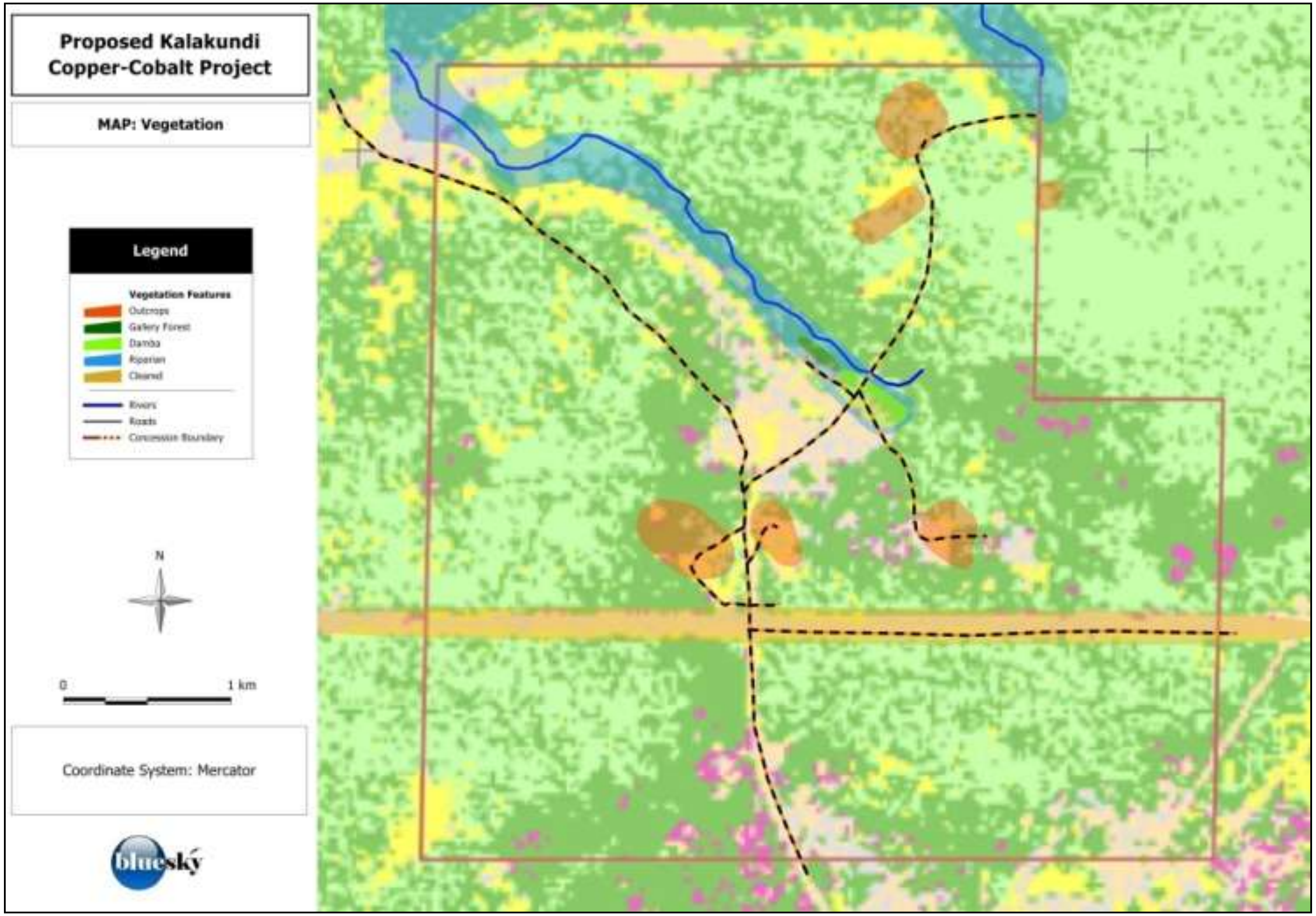

Figure 23: Vegetation of the Kalukundi concession

5.5.1 Miombo woodland

(a) Description

This is the most prevalent vegetation unit, covering vast areas around the concession area in the southeastern DRC. Typical Miombo species dominate this vegetation unit, with a distinct grass layer covering the understory. Canopy cover, influenced by anthropogenic clearing of vegetation for timber, charcoal crop production, varies from area to area. Where there was no evidence of vegetation removal the canopy tends to be medium dense (50 – 75% cover), but this is reduced depending on the extent of tree removal. Termiteria are common, often associated with distinct species including species such as *Azanza garckeana, Allophylus africanus, Combretum molle, Erythrina abyssinica, Mystroxylon aethiopicum, Carissa edulis, Markhamia obtusifolia* and *Premna senensis.*

Numerous herb shrub and grass species are also present, as well as various fungi, which are an important component of the Miombo. Weedy species were present in disturbed areas (including road verges and along pathways), but none appear to be highly invasive or problematic.

(b) Current state of the community

More than 50% of the Miombo Woodland within the concession is still fully or partially intact, with a range of disturbances from large areas relatively undisturbed (intact structure, function and composition) through to large areas that are highly disturbed with high levels of vegetation clearing and cultivation (structure, function and composition highly modified). The most important sources of disturbance within this vegetation community are:

- Anthropogenic clearing of vegetation for habitation, charcoal, timber and crop cultivation;
- Livestock grazing; and
- Seasonal burning during winter.

The level of degradation differs from low to high depending on the area of the concession. Areas adjacent to Kisankala village, roads, pathways and commonly used routes (such as to artisanal mine areas and fields near rivers) tend to be more degraded than areas far from Kisankala village.

Figure 24: View over Miombo woodland from the Kalukundi fragment

Figure 25: View of Miombo woodland with undisturbed understory

5.5.2 Copper-cobalt outcrop associated vegetation

(a) Description

A number of plant communities can be distinguished in mineralised sites associated with copper-cobalt outcrops. They contain a number of endemic and non-endemic species known as metalliferous flora, which are able to grow on sites where the soil has high copper/cobalt content. Several different floristic communities were identified within the copper-cobalt outcrops, including:

- ***Shrubby Savannah*** belt on the lower slopes of the outcrops;
- ***Copper-Cobalt steppe-savannah*** on the lower slopes of the copper cobalt hills, this grass-dominated vegetation occurs on soils derived from the copper cobalt outcrop and tends to be restricted to the aspect where the outcrop is exposed.
- ***Stone-Packed Steppe*** dominated by *Xerophyta* spp.
- ***Crevice vegetation***: contains a wide variety of copper endemics particularly belonging to the *Lamiaceae, Scrophulariaceae and Pteridophyta* (ferns). Large boulders provide habitat for numerous species that tend to grow from small crevices and depressions in the rocks.

Figure 26: View of lower slopes of Copper-cobalt outcrop vegetation on the Kii fragment

(b) Current state of the community

Less than 50% of the outcrops within the concession are still fully or partially intact, with a range of disturbances from large areas relatively undisturbed (intact structure, function and composition) through to large areas that are highly disturbed with high levels of excavation from artisanal mining, prospecting and commercial mining (structure, function and composition highly modified).

Disturbances to these communities include:

- Anthropogenic disturbances relating to mining activities (artisanal mining and prospecting activities;
- Principal Fragment– almost 100% transformed, with some small outcrops still almost completely undisturbed to the north;
- Anticline Fragment – mostly transformed, on top of portion where camp is located and mined section to the south;
- Kalukundi Fragment – Intact on the northern side and top with some artisanal pits; main workings on the eastern side with some trenching on the south;
- Kii Fragment – largely undisturbed on the northern side and top; major workings on the eastern side from artisanal mining;
- Kesho Fragment - mostly transformed, especially where original ARL activities occurred; some portions of some communities still intact.

The level of degradation is low to very high depending on area. Areas that have been heavily mined tend to be completely transformed with vegetation of a secondary nature, but original habitat is still present, although patchy.

5.5.3 Dambo wetland

(a) Description

In general Dambos (Figure 27) are characterised by grasses, rushes and sedges, contrasting with surrounding Miombo woodland. They are substantially dry at the end of the dry season, revealing grey soils or black clays, but unlike flooded grasslands, they retain wet lines of drainage through the dry season. They are inundated (waterlogged) in the wet season but not generally above the height of the vegetation. Any open water surface is usually confined to streams, rivers and small ponds or lagoons at the lowest point, generally near the centre. Dambos are defined as seasonally waterlogged, predominantly grass covered, depressions bordering headwater drainage lines. However distinction can be made between ‘hydromorphic/phreatic’ Dambos (associated with headwaters) and ‘fluvial’ Dambos (associated with rivers).

In terms of the habitat on site, a moderate sized, intact Dambo is present at the upper reach of the Kisankala stream, feeding into the stream via a natural spring, which is surrounded by a small pocket of Gallery Forest. The Dambo is predominantly intact with an un-surfaced road running at right angles through its centre. Siltation of the Dambo is currently occurring during heavy rainfall from runoff from the road network and the nearby Kisankala village.

The upper catchment of the Kii River is likely to historically have had a small Dambo present, but is disturbed through agricultural activities, although it was not being heavily cultivated during the site visit. Similar to the Kisankala stream, the spring feeding the Kii stream is surrounded by a small pocket of gallery forest.

The portions of the river downstream of the spring tend to be vegetated with a mix of Dambo (having characteristic sedges and reeds present), Gallery Forest (dominated by trees rather than sedges), and cultivated or agricultural areas (disturbed/transformed), making it difficult to determine the original composition.

Figure 27: View of Dambo vegetation (foreground) and gallery forest (on the left) along the Kisankala stream

(b) Current state of the community

More than 50% of the riparian areas within the concession are still fully or partially intact, with a range of disturbances from large areas relatively undisturbed (intact structure, function and composition) through to large areas that are highly disturbed with high levels of disturbance (structure, function and composition highly modified).

Sources of disturbance include:
- Anthropogenic clearing of vegetation for crop cultivation along river banks with localised disturbances to riparian vegetation due to activities such as ore washing, bathing, laundry, mud quarrying for building; digging of small wells for drinking water;
- Some ad hoc livestock grazing present (goats, pigs and chickens);
- Seasonal burning during dry winter months; and

- Existing road passes directly through the Dambo with excessive runoff and high levels of sedimentation (silt accumulation);

The level of degradation in this community differs from low to high depending on the area. Areas adjacent to Kisankala village, roads, pathways and commonly used routes tend to be more degraded than outlying parts relative to the Kisankala village. Outlying areas tend to be favoured for crop cultivation.

5.5.4 Gallery forest

(a) Description

Gallery forest is found along the margins of the rivers and streams, consisting of a dense canopy of trees. Typical tree species include *Raphia farinera*, *Ilex mitis* and various lianas. Gallery forest tends to be scant along the Kii and Kisankala rivers isolated to pockets along the edges of the streams. This is partly due to vegetation removal along the river margins to make way for agricultural activities (crop cultivation) and for use as timber; as well as the Dambo wetland being present. Without having historical information regarding composition of Dambo and gallery forest, it is difficult to determine the original distribution thereof, but it can safely be assumed that gallery forest has been substantially reduced in extent. Some pockets are found along the river margins.

(b) Current state of the community

Some pockets of Gallery Forest are still fully or partially intact along the river course, with a range of disturbances from some patches relatively undisturbed (intact structure, function and composition) through to patches that are highly disturbed with high levels of vegetation clearing and/or disturbance (structure, function and composition highly modified).

Sources of disturbance to gallery forest include:

- Anthropogenic clearing of vegetation for crop cultivation along river banks with localised disturbances to riparian vegetation due to activities such as ore washing, bathing, laundry, mud quarrying for building; digging of small wells for drinking water; and
- Existing ore washing area below Kisankala village with excessive runoff and very high levels of sedimentation (silt accumulation).

The level of degradation in this community differs from low to high depending on the area. Areas adjacent to Kisankala village, roads, pathways and commonly used routes tend to be more degraded than outlying parts relative to the Kisankala village. Outlying areas tend to be favoured for crop cultivation.

Figure 28: View of Gallery Forest at the Kisankala spring

5.5.5 Threats to vegetation

Of all vegetation types, the Miombo woodland has the greatest flora species diversity. Miombo woodland is under pressure from human activities. These include clearing for agricultural purposes, charcoal and fuel wood collection, urbanization, infrastructure and industrial development, and thus reduce the size of the Miombo woodland community. The copper-cobalt habitat types also have high flora species diversity. Many of the species have a restricted distribution. Habitat classified as 'critical' under the guidelines of the World Conservation Union (IUCN) was identified on the copper-cobalt rocky outcrops and these were disturbed by artisanal mining.

All habitat types support numerous species of flora and are of some value regardless of the state of disturbance. However, it is notable that gallery forest and the two copper-cobalt habitats are rare and already under threat in baseline conditions.

Shifting agricultural practices are common and result in abandoning of sections of the land, likely due to the soil becoming too impoverished or perhaps because weed infestation was too high. Natural re-vegetation is generally re-establishing in these highly disturbed areas.

The Kisankala and Kii rivers can generally be regarded as degraded. This is mainly due to the extent of deforestation in the catchments, poor cropping activities inside riparian zones and artisanal washing in the stream. All of these activities cause extensive sedimentation in the rivers. However, a few areas along the margins of the rivers (Kisankala and Kii) still exist where the riparian forests are intact.

5.6 Terrestrial fauna

The mine region is located in an area of relatively uniform biotic complexity that has previously been poorly surveyed. It has high faunal species diversity, but no centres of endemism. The area has been settled for many centuries, and the large bird and large mammal faunas are impoverished due to overgrazing and other human-induced impacts.

5.6.1 Amphibians

Seventy eight species have been noted for the southern area of DRC, of which about 64 species may be present in Katanga. Despite this high regional diversity, the mine area falls in a region of relatively low amphibian diversity, with a predominance of burrowing species that are opportunistic breeders in association with sporadic summer rainfall. Thirteen amphibians were confirmed on the mine site during the field survey. Most are wide-ranging species, e.g. Guttural Toad (*Amietophrynus gutturalis*), Common Squeaker (*Arthroleptis stenodactylus*), Natal Puddle Frog (*Phrynobatrachus natalensis*), Common River Frog (*Amietia angolensis)*, Long-toed Running Frog (*Kassina senegalensis*) etc., but a few have marginal distributions in the region (e.g. *Breviceps poweri* and *Hyperolius kivuensis*). A further 18 species probably occur in the immediate region. No amphibians in Katanga, including the mine region, are known to have become extinct in historical times. No threatened amphibians occur in the mine region. A further 18 species probably occur in the immediate region. No amphibians in Katanga, including the mine region, are known to have become extinct in historical times. No threatened amphibians occur in the mine region.

Few endemic amphibian species are known from the Katanga region. Power's rain frog (*Breviceps poweri*, reaches the northern limit of its range in Kalukundi region. Two problematic frogs were collected: a small male Puddle Frog with affinities to *Phrynobatrachus natalensis*, and a very large Ornate Frog, with affinities to *Hildebrandti ornata (muerensis)*. Their taxonomic status requires further study.

Important habitats within the mine area for amphibian diversity include streams running through gallery forest, dambo grasslands, and temporary pools in Miombo woodland. The current spatial coverage of reserves in the area adequately protects amphibian species diversity. However, wetlands in general are poorly protected throughout the region.

Figure 29: Puddle frog (*Phrynobatrachus cf. natalenis*)

Figure 30: Ornate Frog (*Hildebrandti ornata cf. muerensis*)

5.6.2 Reptiles

Nearly 300 reptile species are recorded from DRC, of which 125 have been recorded from Katanga. Only a subset of these may occur within the greater mine area. Eighteen species were recorded in the field survey and a further 39 species probably occur in the region. Many of the species recorded are wide-ranging, e.g. snakes such as the puff adder and night adder, whilst others are tolerant of urban areas, e.g. striped skink and tropical house gecko.

Eighteen reptiles are endemic to Katanga province. Only one (a small thread snake *Leptotyphlops kafubi*) was recorded from the mine site. Another, the Katanga Thick-toed Gecko (*Pachydactylus katangensis*), may occur on the rock fragments. One problematic species (Variable skink, *Trachylepis varia* complex) was collected and may represent a novelty that requires further study. No threatened reptile species occur in the greater mine area. No alien reptile species are known to have been released, or have formed breeding populations within the DRC.

Important habitats within the mine area for reptile diversity include rock outcrops, gallery forest and dambo grasslands. The loss of rock outcrops will destroy habitat for rupicolous[4] reptiles.

Two of the common reptile species of the concession area are shown in Figure 31 and Figure 32 below. Other common reptiles include Spek's Hinged Tortoise, Walberg's snake-eyed skink, Striped skink and Striped Skaapsteker.

[4] Inhabiting rocky habitats

Figure 31: Marsh terrapin

Figure 32: Puff adder

5.6.3 Birds

The DRC has one of the richest bird faunas in Africa with nearly 1200 species recorded. Nearly 650 species may occur in Katanga, and 450 occur in the Dilolo and Kolwezi region. During the faunal survey 73 species were recorded, including most of the common resident species. Many species occurring in the Dilolo and Kolwezi region are, however, absent from the Kalukundi concession.

Katanga has high degree of bird endemism, but relatively few are threatened. No threatened or endemic birds were observed on the mine site. Subsistence hunting, targeting large species such as game birds, water birds, and raptors has also led to a general decline in populations of these groups. Only one alien bird species was noted in the area - in Kolwezi but not on the mine concession area. Important habits within the mine area for avian diversity include gallery forest, Miombo woodland and dambo grasslands.

5.6.4 Mammals

The DRC has the richest mammal fauna in Africa (over 425 species). It is likely that over 200 of these may occur in southern Katanga. A very large proportion of these are insectivores, particularly bats, which are numerous in the Kolwezi region (over 100 species). Most large mammals are locally extinct due to hunting. None were observed during the faunal survey. A small, very shy group of cercopithoid monkeys was observed along the Kii stream. In addition, tracks of a gerbil (*Tatera* sp.) were noted in the power line corridor and scats containing crab pieces, probably from a Cape clawless otter, were noted along the Kii Stream. Several endemic species probably occur in the region, including aquatic species in forest streams. None were recorded during the survey, although they may occur along both the Kisankala and Kii streams.

The only alien mammals in the region include feral domestic cats and dogs, and introduced urban rodent pests (house mouse, house rat and Norwegian rat).

Important habitats within the mine area for mammal diversity include gallery forest and forest streams.

5.7 Icthyofauna (fish)

Ten species of fish belonging to 7 families have been found in four sampling sites within the concession area.

Table 17: Aquatic sampling points

Site No & River	Co-ordinates		Description/Comments
	South	East	
Site 1 - Kii R.	10^0 37.586' (us)	25^0 56.442' (us)	The upper Kii R. from the source (us) to ca. 500m downstream (ds) – 5 open areas of about 5-10 m long
	10^0 37.468' (ds)	25^0 56.315 '(ds)	
Site 2 – Kisankala R.	10^0 38.406'	25^0 55.740'	Upper Kisankala R., at accessible spots from source to ca. 60 m downstream
Site 3 – Kisankala R.	10^0 37.260'	25^0 54.200'	Lower Kisankala R., ca. 60m upstream of junction with Kii R, at footpath crossing
Site 4 – Spring in Kii River	10^0 37' 34. 5"	25^0 54' 13.2"	Small tributary of ca. 50m long, originating from an Artesian spring on south bank of Kii R.

An unknown snoutfish (*Hippopotamyrus spp*.) and the unknown earfish (*Keneria spp*.) are of particular importance in terms of conservation, as both species are considered to be un-described (i.e. new to science) and requiring further investigation. Both species were only found in this study area in the relatively good aquatic habitat in the upper Kii Stream. This is significant, as both fish families are known to be sensitive to poor water quality and other human-induced impacts on aquatic habitats.

Figure 33: Snout fishes (*Hippopotamyus* spp.) and earfishes (*Kneria* spp.) caught in the upper Kii River

The elevated turbidity caused by ore washing in the river has disrupted the entire food chain, from reduced primary production (photosynthesis) by algae to visual predators being unable to capture sufficient food in the low-visibility water. The high sediment loads also have a host of direct impacts, such as smothering benthic food organisms and fish spawning habitats, and damaging fish gill filaments. In addition, the metal concentrations in both the water and sediments in the river have been recorded at levels that are lethal to most aquatic life, including fish.

5.8 Social conditions

5.8.1 Administration

The district of Kolwezi, within which the mining concession area is located, is headed by a mayor and deputy mayor. The district is further divided into two territories, namely Dilala and Mutshatsha, each headed by a Territory Administrator. The Kalukundi project location is within Mutshatsha Territory. Mutshatsha is further divided into sectors each headed by a Chief of Sector while the sectors are divided into groupings each headed by a Group Chief. The lowest administrative unit is a locality/village, which is headed by a Village Chief. Under this structure, the project is located within two villages, Kisankala and Kisanfu. These Villages are within Kineme Grouping of Lualaba Sector.

5.8.2 Settlements

The closest major town to the concession area is Kolwezi, and there are numerous villages surrounding the project. Kolwezi is a well-established mining town, with considerable existing infrastructure including a railway, power supply, and a small airport with international status. Kolwezi town has an estimated population of 418,000 people, including a small population of expatriates working in the mining industry. Kolwezi serves as a primary transportation center and market place for the region. Kolwezi town is about 50 km (56 km by road) from the project area and is accessible by mostly unsealed roads. Lubumbashi the capital city of Katanga Province is a 320 km drive by road from Kolwezi, which presently takes approximately six hours. The road between Lubumbashi and Kolwezi is in exceptionally poor condition.

The two closest permanent settlements to the project area are Kisanfu and Kisankala villages. Kisankala village is within the concession area while Kisanfu is 2.5 km south of the concession area boundary. Kisankala village covers an area of 0.75 km^2. The village was founded when the first settlers arrived in 1974. Artisanal miners arrived in the village after exploration work by Gécamines in 2000. According to a census conducted in January 2006, the population of Kisankala Village is 2361, making up 647 households (ESF, 2008).

Housing in the village is a combination of traditional structures (rectangular huts of clay bricks with one to four rooms, with thatched roofs) and temporary wooden structures covered in whatever material is available, such as bags and plastic sheeting. The majority in the village comprise of these temporary structures.

Figure 34: One of the few mud brick houses in Kisankala village

Figure 35: A typical temporary structure in Kisankala village

5.8.3 Population dynamics of Kisankala village

The population in the region is transient and there is a high degree of movement of the population into and out of the area. The artisanal miners' population makes up 75% of Kisankala Village, which is far greater than that of 'original' inhabitants. According to the Resettlement Action Plan of 2006, the village had a population of between 600 and 700 native inhabitants and more than 3000 artisanal miners and people carrying out related activities originating from outside the area. The presence of artisanal miners and their activities dominate most aspects of village life. The difference in population size between January 2005 and January 2006, when censuses of the village were done, was more than 100% (1064 to 2361). The transient nature of the population is also shown by the fact that 26 out of the 54 households that were surveyed indicated that they had been living in the area for less than five years.

Artisanal miners in the area originate throughout Katanga Province. Key feeder towns include Kamina, Luena and Kolwezi. Artisanal miners work six days a week, with a half-day on Saturday. Most stay in Kisankala Village over weekends, although those that have homes in Kolwezi sometimes return over weekends. Average length of stay in Kisankala is 6 years.

In the Kisankala Village, the traditional form of governance is still in practice. The community is governed by a chief, who is in charge of the local administrative and customary responsibility. The chief is assisted by a council of notables, including a secretary and a traditional judge.

Figure 36: View of the centre of Kisankala village showing trucks in the background that are used to collect ore from artisanal miners

Within the concession area the majority of the population speaks Swahili. Other languages spoken frequently are Chokwe, Lunda, and French.

5.8.4 Economic activity

Poverty within Katanga Province is rife. This is blamed mostly on the collapse of the state-owned Gécamines (La Générale des Carrières et des Mines), according to the Poverty Reduction Strategy Paper, an initiative of the DRC government supported by the World Bank. Immediately after Gécamines' production slumped in the early 1990's, Katanga Province underwent a profound socioeconomic transformation. The entire population of the Katanga mining region, which was dependent on this enterprise, was plunged into poverty and the loss of a number of services (e.g. provision of pesticides and fertilisers to farmers and maintenance of roads), which were provided by Gécamines. This led to a vast number of company employees who had no other sources of livelihood, but with experience in mining, to resort to artisanal mining.

It therefore comes as no surprise that artisanal mining is the most common means of livelihood in the area (53%) followed by vendors (19%) and agriculture (13%). Other economic activities in the area include subsistence farming, petty trade, charcoal burning and hunting and gathering of game meat and wild fruits and vegetables.

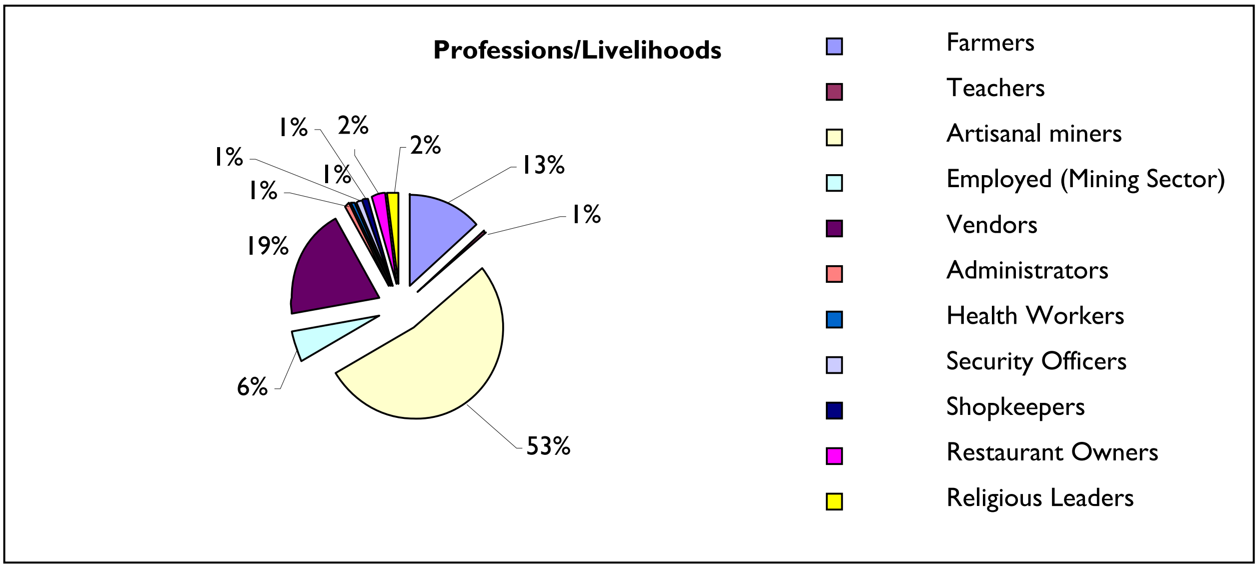

Figure 37: Livelihoods in the Kalukundi concession

Figure 38: Ore mined by artisanal miners being sorted in Kisankala village

Figure 39: Typical trader's shop in Kisankala village

Within and immediately around the Kalukundi concession, artisanal miners currently work around the Goma, Kinshasa and Kawama fragments. These three areas are approximately 7, 3 and 14 km respectively from Kisankala village. Of these mining areas, only Kawama is an artisanal miner's fragment demarcated as such by the government. Goma and Kinshasa fragments are the concessions of Rock Mining and ACX Corporation respectively and the artisanal miners either mine there illegally or they are employed and paid by the owners. Artisanal miners in the area are not organised in large groups. However, during mining they organise themselves in groups of 3-4 persons. This group of miners can produce 4-5 tonnes of copper and cobalt ore in a good week, which fetches them up to US$ 120. The artisanal miners normally sell to intermediaries (negotiators) who then sell to mineral merchants or mining companies including SOMIKA and BAZANO among others, who ferry the minerals to Lubumbashi, Zambia and other destinations.

The majority of the artisanal miners engage in other economic activities including selling of local beer, bhang (Cannabis), vending, fish mongering, farming (generally carried out by the wives), trading and photography among other petty trades. Despite the importance of the agricultural sector to the DRC on a national level, there is very little agricultural activity around Kisankala Village. Only six agricultural plots were identified within the Kalukundi concession, most of which were clustered along the Kisankala and Kii streams nearby. Residents reportedly used to be more active in agriculture prior to the collapse of Gécamines when the company and its agencies provided inputs such as fertiliser and pesticide.

Fish are an important source of food in Kisankala Village. Fishing is carried out on Lake Nzilo at Lualaba close to Kolwezi. This dam was created by the damming of the river for hydropower generation in the 1950's. Fish is brought from Lualaba by fishmongers who sell to the local community. Fishing is carried out by netting from traditional dug out canoes. The common fresh fish species caught is tilapia. Other fish species are brought in dried from other areas including Likasi.

Petty trade is common in the village due to the high number of artisanal miners, who are characterised by a consumer-based economy. Trade is carried out mostly by women who sell charcoal, cloths, local brew, food stuffs, processed goods, beer, cooking oil, maize meal, among other commodities. Women also are engaged in fish mongering and selling vegetables. Other petty trade includes tailoring, salons and selling of medicine.

Charcoal burning is also an important activity in the village as most of the households use charcoal for cooking and heating.

Figure 40: Fish for sale in Kisankala market

Figure 41: Charcoal burning in the Kalukundi

concession area

5.8.5 Education

There is very little educational infrastructure in and around the Kalukundi concession area. There are only three primary schools within the immediate area, including one in Kisankala village and two outside the concession area, including one in Kisanfu. The primary school in Kisankala village is a make shift school that also serves as a church. The school in Kisankala started in 2005 with two teachers and 75 pupils. At the time of writing the school had a total of approximately 230 pupils with six untrained teachers who are paid by the parents and subsidised by ARL.

5.8.6 Land tenure

The DRC has two recognised land tenure systems: the modern and the customary. Under the modern system, the government owns all land. The right to use land is thus assigned or allocated by the government. Under the customary land tenure system, land ownership is collective. Groups or clans hold land and the group assigns land for use to its members though its appointee.

The basic land tenure regime reflects the 1967 Bakajika Law and the 1973 Land Tenure Law. The former suppressed all forms of private land ownership, asserting to the State “full ownership rights over its domain and full sovereignty in conceding rights to land to up to 20 kilometers, forests and mines through the extent of its territory”. The 1973 Law allowed for certain types of ‘permanent private concession’, and also recognized that customary laws apply to user rights over ‘non-allocated lands in rural areas’ (Counsell 2006). However, according to the World Bank, “important implementation decrees of the 1973 law were not adopted and up to now, the Congolese land ownership legislative framework remains incomplete”.

Within the Kalukundi concession area, the customary land tenure system has been followed, since the chief delegates land to each family or household through traditional land rights. There are no title deed holders in the area. There is no record or evidence of land ownership or certificates allowing exploitation of natural resources within concession apart from traditional rights to land controlled by local authorities. Increasingly, however, the artisanal miners are overrunning the powers of the chief.

5.8.7 Health

Health services in the area around the proposed Kalukundi mine, as for the DRC as a whole, are poor. Thirty seven percent of the population in the DRC has no access to any kind of health care. The ratio of doctors to patients is 1: 83,000 in the area against the recommended ratio of 1:10000. Kolwezi district is divided into 8 health zones. The concession area falls under Lualaba Health Zone with the headquarters in Lualaba town. In this health zone there are 14 health facilities, with 6 privately run informal "clinics" in Kisankala village. These clinics are run by mostly untrained personnel, whose only form of qualification is having being an assistant or having worked in a health care establishment in an urban centre. However, the clinics are supervised by a primary health care supervisor who visits the area once a month. Within the broader area, the nearest health facility is a clinic in Kisanfu. Hospitals can also be found in Kolwezi and Likasi.

The common diseases reported are malaria, cholera, intestinal worms and dysentery According to the Zonal Health Officer, the zone is faced with cholera, malnutrition, HIV/AIDS, respiratory diseases, tetanus and polio. There was an outbreak of cholera in February 2008 and December 2007 in the region, although only one case was reported in Kisankala village. Poor sanitation is blamed for cholera, dysentery and diarrhoea.

Sexually transmitted diseases (STDs), including HIV/AIDS, are a major risk in the project area. The presence of large numbers of young male artisanal miners currently residing in Kisankala poses specific risks in relation to STDs, due to the associated presence of commercial sex workers.

The nearest formal clinic, which is run by the Congolese National Railways (Societe National de Chemins de fer Congolais or SNCC), is in Kisanfu. This clinic has three staff and has a women's ward with three beds, a maternity ward with two beds and a delivery room. There is also a well-equipped laboratory (according to the local standards) with a capacity to undertake malaria, HIV/AIDS, TB and dysentery diagnoses.

5.8.8 Water and sanitation

In 1999, UNICEF estimated that in the DRC as a whole only 45 percent of the population had access to potable water. However, in rural areas the percentage of the population that had access to potable water in 2001 was only 26 percent. There is no piped water to individual households in Kisankala. Currently, the primary source of drinking water is the set of communal taps that was installed by ARL on the outskirts of the village. These taps are fed from tanks that are supplied from a borehole. Prior to this system being installed, the population obtained water from the Kisankala River spring and from other springs in the area.

Figure 42: Communal taps in Kisankala village installed by ARL

There are a number of pit latrines in the village, but there are many households that have no access to latrines and most people simply relieve themselves in the bush. According to the Zonal Health Officer, the majority of the diseases in the area are related to poor sanitary conditions.

5.8.9 Energy

High voltage electricity lines bisect the southern side of the concession area. However, these lines do not supply any settlements within the concession area. Kisankala village has no source of electricity supply. However, a number of businesses and households have generators, which are used to supply themselves or other customers. All energy for heating and cooking in the village is obtained from charcoal, which is produced in the surrounding Miombo woodland and sold in the village by vendors.

5.8.10 Transport and telecommunications

The common means of transport in the area is by walking, bicycle, public mini bus and trucks transporting minerals. Air transport is used mainly by the mining companies through Kolwezi airport while there is a weekly train service stopping at Kisanfu train station, located 4.5 km south of Kisankala village.

Access to the project area by road from Kolwezi is via the degraded Likasi-Kolwezi road, which passes 1.5 km to the southern boundary of the concession area. The road network throughout the area is in a state of disrepair and access within the concession is difficult. The road network in the area is maintained by the mining companies but only on the roads that serve their areas. Buses cannot provide a reliable service due to poor road conditions that do not allow all weather travel.

There is no landline telephone connection to the project area. The mobile network connection is available only on high ground and in certain areas. Very few people have cell phones.

5.8.11 Vulnerable groups

Vulnerable people or groups in this study are those who by virtue of gender, ethnicity, age, physical or mental disability, economic disadvantage, or social status may be more adversely affected by the project than others and may be limited in their ability to claim or take advantage of resettlement assistance and related development benefits.

The vulnerable groups in the area are artisanal miners, women, children, the handicapped, orphaned children and widowed women. People living with HIV/AIDS also qualify to be categorised as a vulnerable group due to the stigma associated with the disease and discrimination, but due to lack of availability of data on them, they have not been included in this study.

(a) Artisanal miners

Economic collapse, social instability, and resource plunder have resulted in a proliferation of artisanal miners in the DRC. This was exacerbated by the collapse of GECAMINES, which employed and provided most of the services to the communities in the region. Many of the company employees without other sources of livelihood but with experience in mining resorted to artisanal mining.

In Kolwezi, it is estimated that there are close to 30,000 artisanal miners who earn an average of US$ 1-3 per day.

In Kisankala, many of the artisanal miners are demobilized soldiers and young people who know no other means of livelihood other than artisanal mining and combat. Artisanal miners are exceedingly vulnerable as they have been and continue to be victims of forced displacement, ill-treatment, harassment, extortion, violence and human rights abuses. Artisanal miners have the capacity to respond to displacement as they are accustomed to migration to new areas in search of ore deposits.

(b) Women

Women's vulnerability is due to cultural and financial barriers, the demanding role of being a wife, and raising children and other household responsibilities. They are therefore at a disadvantage when it comes to getting a job. Women are engaged in some aspects of artisanal mining (particularly processing) but due to their low status they are generally compelled to undertake the poorly paying ancillary activities such as sorting and washing.

(c) Children

In the DRC, children are vulnerable due to exposure to child labour in artisanal mining as a result of poverty in rural areas. The use of child soldiers in the civil war has also contributed to this problem. Child labour has proliferated as a result of the fact that child work is often considered part of the socialisation process by many rural people, the rising number of orphans (including many conflict and some AIDS orphans), the disintegration of the traditional extended family, the illegality and informal nature of much of the artisanal mining sector, the remoteness and isolation of many artisanal mining areas, the lack of opportunities or incentives to go to school or continue with education, lack of post primary education, the few job prospects, and lack of regular employment or livelihood choices.

According to UNICEF (2006), 28% of children in the DRC are engaged in child labour at ages of five to 14. Many children and adolescents are simply lured by the prospect of becoming rich while others are encouraged by their parents to help contribute to the family earnings. In Kisankala girls often get married at the age of 14 years and drop out of school or get pregnant, while boys are generally lured into artisanal mining activities before completing Class 5, the most advanced class at Kisankala School.

(d) Handicapped, Orphans and Widows

The number of disabled people, orphans and widows in the village of Kisankala is 52 (see

Table **18** below). The traditional practice of taking in family members who have been bereaved reduces the suffering of this category of persons in the village of Kisankala. Most of the orphaned children are not destitute as they have been taken in by relatives.

Table 18: Numbers of handicapped persons, orphans and widows in Kalukundi village

Vulnerable group	Number
Orphans	30
Widows	18
Mentally handicapped	1
Physically handicapped	1
Blind	2

6 ASSESSMENT METHODOLOGY

This section of the report assesses the significance of the environmental impacts that have been identified by the specialists that formed part of the team, which conducted the environmental impact assessment process.

Envirolution Consulting appointed a number of sub-consultants to undertake specialist studies for the ESIA. The specialist team consisted of the following members (Table 19):

Table 19: Environmental impact assessment team

Institution	Name of specialists	Field of specialisation
Bill Branch Faunal Studies	Dr Bill Branch	Reptiles and amphibians
Anton Bok Aquatic Consultants	Dr Anton Bok	Aquatic fauna (icthyofauna)
N.A.	Mr Jamie Pote	Vegetation
N.A.	Dr Peter Illgner	Land degradation
ESF Consultants	Mr Duncan Oyaro Mr James Kambo Mr Larry Asego	Social impact assessment
Digby Wells & Associates	Mr Ken Lyell	TSF design
Biotechnology & Environmental Specialist Consultancy	Ms Lee-Ann Proudfoot	ESIA review
USK Consulting	Mr Steve Kalule[5]	ESMP compilation & waste management
Strategic Environmental Focus (as sub-consultants to USK Consulting)	Mr Reuben Heydenrych[6]	ESMP & EIA compilation

The team members conducted literature reviews of available information related to the site conditions and with respect to similar mining operations prior to visiting the site. Most of the members of the team visited the Kalukundi site from 21 to 29 January 2008. The vegetation specialist Jamie Pote spent an additional three days at Lubumbashi University to identify plants and four days on site during March 2007. The team spent the time on site gathering information through field studies, including the gathering of samples for identification at their offices in South Africa. The combined site visit by all specialists assisted in integration of ideas and findings between the specialists. The Social impact assessment (SIA) team visited the site from 13 to 21 February 2008. The SIA team undertook a social survey through conducting interviews with a broad spectrum of community members.

[5] Did not attend site visit
[6] Attended site visit on behalf of USK Consulting

The role of each specialist was to collect sufficient data to assess the environmental impacts. In order to achieve this, the specialists assessed the environment as it existed at Kalukundi, and secondary data from published and unpublished sources.

6.1 Environmental impact rating scale

To ensure a direct comparison between various specialist studies, a standard assessment methodology was used to assess the significance[7] of the identified impacts. The criteria that were considered in the determination of the impact significance are:

- **Severity/Benefit**: the importance of the impact from a purely technical perspective;
- **Spatial scale**: extent or magnitude of the impact (the area that will be affected by the impact);
- **Temporal scale**: how long the impact will be felt:
- **Degree of certainty**: the degree of confidence in the prediction;
- **Likelihood**: an indication of the risk or chance of an impact taking place;

To ensure integration of social and ecological impacts, to facilitate specialist assessment of impact significance, and to reduce reliance on value judgments, the **severity** of the impact within the scientific field in which it takes place (e.g. vegetation, fauna) is assessed first. Thereafter, each impact is assessed within the context of time and space, and the degree of certainty in the prediction is indicated.

The impact is then assessed in the context of the whole environment to establish the "**significance**" of the impact. This assessment incorporates all social, cultural, historical, economic, political and ecological aspects of the impact.

Thus, the **severity** or benefit of an impact within a specialist discipline is first assessed before the **significance of the impact** is evaluated in a broader context. Consequently two rating scales are required, one to determine the **severity** or benefit, and one to determine environmental significance.

[7] The importance of the impact in the overall context of the affected system

6.2 Severity / benefit

Severity is based on the professional judgement of the various specialists to evaluate the extent to which negative impacts would change current conditions, or how beneficial positive impacts would be on a particular affected system (for ecological impacts) or a particular affected party (for social impacts).

Table 20: Severity rating scale

Negative impacts	Positive impacts
Very severe An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated. For example, change in topography resulting from a quarry.	***Very beneficial*** A permanent and very substantial benefit to the affected system(s) or party(ies), with no alternative to achieve this benefit. For example, the creation of a large number of long-term jobs.
Severe Long-term impacts on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming or some combination of these. For example, the clearing of forest vegetation	***Beneficial*** A long-term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these. For example, an increase in the local economy.
Moderately severe Medium- to long-term impact on the affected system(s) or party(ies), that could be mitigated. For example, constructing a narrow road through vegetation with a low conservation value.	***Moderately beneficial*** A medium- to long-term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising are equally difficult, expensive and time consuming (or a combination of these), as achieving them in this way. For example, a slight improvement in the (Kolwezi - Likasi) road(s).
Slight Medium- to short term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary. For example, a temporary fluctuation in the water table due to water abstraction.	***Slightly beneficial*** A short- to medium-term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these. For example, a slight increase in the amount of goods available for purchasing.
No effect The system(s) or party(ies) is not affected by the proposed development.	***Don't know/Can't know*** In certain cases it may not be possible to determine the severity of the impact.

The severity of impacts can be evaluated with and without mitigation order to demonstrate how serious the impact is when nothing is done about it. The word mitigation means not just “compensation”, but also ideas of containment and remedy. For beneficial impacts, optimisation means anything that can enhance the benefits. Mitigation or optimisation must be practical, technically feasible and economically viable.

6.3 Spatial scale

The *spatial scale* defines the extent or area over which the impact will take place.

Table 21: Spatial scale

Spatial scale	Explanation
Individual	Individuals in the area could be affected
Household	Households in the area could be affected
Localised	A few hectares in extent. The specific area to which this scale refers is defined for the impact to which it refers.
Mine pits	The area is as large as the footprint of the fragments that will be mined i.e. Principal, Anticline, Kii and Kalukundi fragments.
Study Area	Includes the entire Kalukundi concession area.
District	Includes are area around the concession area, including the administrative district of Kazembe
Regional	The impacts will be of such a nature that it may affect the Katanga Province.
National	The impacts will be of such a nature that it may affect the entire Democratic Republic of the Congo.
International	The impact would affect resources and processes outside the border of the DRC

6.4 Temporal scale

The temporal scale defines the times over which the impacts would continue to occur.

Table 22: Temporal scale

Temporal scale	Explanation
Short term	Less than 5 years.
Medium term	Between 5 and 20 years
Long term	Between 20 and 40 years, and from a human perspective essentially permanent
Permanent	More than 40 years, and resulting in a permanent and lasting change.

6.5 Degree of certainty

Each of the specialists also stated the degree of certainty or the confidence attached to their predictions. For this reason, a 'degree of certainty' scale has been used.

Table 23: Degree of certainty

Degree of certainty	Explanation
Definite	More than 90% sure of particular fact. To use this one will need to substantial supportive data
Probable	Between 70% and 90% sure of particular fact
Possible	Between 40% and 70% sure of particular fact
Unsure	Less than 40% sure of particular fact

6.6 Likelihood

The likelihood of impacts being manifested differs. There is no doubt that some impacts would occur if the project is executed as planned but certain other impacts are not as likely, and may or may not result from project activities. The specialists therefore stated their estimation of the likelihood of an impact occurring, using the following likelihood scale.

Table 24: Likelihood

Likelihood	Explanation
Very unlikely	The chance of these impacts occurring is extremely slim, e.g. natural forces destroying a dam wall.
Unlikely	The likelihood of these impacts occurring is slight.
May occur	The likelihood of these impacts occurring is more likely, although it is not definite. For example, impacts such as an increase in alcoholism and associated violence as a result of increase of wealth
Definite	The impact will definitely occur if the project is executed as planned, for example the clearance of vegetation ahead of mine construction.

6.7 Significance

Significance is an indication of the overall importance of the impact taking into account all the above mentioned assessment criteria. Significance was assessed in the relevant context, as an impact can be relevant to the ecological environment, the social environment or both. By ensuring that all specialists adhered to the abovementioned objective criteria, subjectivity was reduced as far as possible. There is, however, always an element of judgement that cannot be completely removed from the assessment of significance.

Significance of an impact is not always directly proportionate to severity, despite the fact that one would expect a direct relationship i.e. an impact with severe ***severity*** would be expected to be of ***high significance***. However, this is not always the case. For example, changes to the geology might be ***severe,*** but the significance is regarded as ***low,*** since the change in the environment is considered by society as being unimportant.

Table 25: Significance

Significance	Explanation	Examples
Very high	These impacts would be considered by society as constituting a major and usually permanent change to the natural and/or social environment, and usually result in severe or very severe effects, or beneficial to highly beneficial effects.	• The loss of species will be viewed by informed society as being VERY HIGH significance. • The establishment of a large amount of infrastructure in a rural area, which previously had few services, would be regarded by affected parties as resulting in benefits with VERY HIGH significance.
High	These impacts will usually result in long-term effects on the natural and/or social environment that will only be mitigated over very long periods of time.	• The loss of a diverse vegetation type, which is fairly common elsewhere, would have a significance rating of HIGH over the long term, as the area could be rehabilitated. • The change to soil conditions may have a severe impact on the natural system, and the impact on the affected parties (on the case of people harvesting natural herbs on the soil) would therefore also be HIGH. However, if no land available elsewhere, this impact could be rated as VERY HIGH.
Moderate	These impacts will usually result in medium to long-term effects on the natural and/or social environment. These impacts are real but not substantial, and usually result in moderately severe effects or moderately beneficial effects.	• The loss of a sparse, open vegetation type may be regarded as very severe by the specialist, but due to the nature of the vegetation and habitats, its significance could be regarded as only being of MODERATE significance. • The provision of an efficient health service in a rural area would be regarded as being moderately beneficial, and result in a benefit of MODERATE significance.
Low	These impacts will usually result in medium to short term effects on the natural and/or social environment. These impacts are considered to cause fairly unimportant and usually short term change to the (natural and/ or social) environment. These impacts are not substantial and are likely to have little real effect.	• The temporary change in the water table of a wetland would be rated as slight, as these systems are adapted to fluctuating water levels. The significance of this impact s therefore LOW. • The increased earning potential of people employed as a result of development would only be slightly beneficial to people who live some distance away, resulting in a benefit of LOW significance.
No significance	There are no primary or secondary effects at all that are important to scientists or the public.	• A loss of Species of Special Concern (SSC) will not take place, since none occur in the study area, resulting in NO significant impact.
Don't know	In certain cases it may not be possible to determine the significance of an impact. For example, the primary or secondary impacts on the social or natural environment given available information.	• The effect of a particular development on people's psychological perspective of the environment.

6.8 Absence of data

Specialists often have to assess impacts with limited data and information. An ideal situation where all possible information relevant to a decision is available is almost never the case. It may either be a case of information on some aspects of the environment not being available at all, or partial information being available. The respective specialists must indicate the degree to which such absence of data or incomplete data affects their ability to make accurate and reasonable judgements. They may decide to make certain assumptions to fill the gaps in information, or they may make predictions based on previous experience or in extreme cases where data is critical they may indicate that no assessment can be made at all. Any such limitations to the specialist studies related to an absence or lack of information have been indicated as such in the specialist studies.

American legislation (CEQ regulations at 40 CFR 1502.22) has considered these limitations, and makes the following recommendations: "When an agency evaluated reasonably foreseeable significant adverse effect on the human environment in an Environmental Impact Statement (EIS) and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking …(a) if the incomplete information… is essential to the reasoned choice among alternatives and (b) if the overall costs of obtaining the information are not exorbitant, the agency shall include the information in the EIS."

There are two acceptable procedures to follow when there are shortages of information:

- **It is more important to identify all likely environmental impacts than to precisely evaluate the more obvious impacts.** All specialists have tried to evaluate all significant impacts, recognising that precise evaluation is not always possible. It is better to have a *possible or unsure* level of certainty on important issues than to be *definite* about unimportant issues.
- **It is important to be on the conservative side in reporting likely environmental impacts.** Because of the fact that assessing impacts with a lack of data is more dependable on scientific judgment, the rating on the certainty scale cannot be too high. If the evidence for a potential type of impact scale cannot be ruled out with confidence, not that the impact is not proven.

It is for these reasons that a degree of certainty scale has been provided, as well as the categories DON'T KNOW OR CAN'T KNOW.

6.9 Mitigation

Specialists were requested to indicate what mitigation measures need to be applied to the negative impacts to either reduce them or avoid them completely. Key mitigation measures, as well as the time frames for their implementation, the responsible staff and measurable targets, have been incorporated in the Environmental and Social Management Plan (ESMP), which accompanies this ESIA. The ESMP has been written as a stand-alone document.

Mitigation measures have been written, where possible, to address the source of the impact rather than the after-effect (“end-of-pipe” solutions), since addressing the source is more efficient and effective than addressing the after-effect. The following hierarchy must be applied to the application of mitigation measures (from most preferred to least preferred):

- **Avoidance**: The impact is avoided in its totality by removing the source of the impact or reducing the source to such an extent that the impact becomes negligible in significance;
- **Reduction:** The impact cannot be avoid in totality, but it is reduced in magnitude and/or significance;
- **Rectification:** the impact is mitigated after it has occurred e.g. rehabilitation of areas that have been disturbed;
- **Compensation:** providing a substitute resource for a resource that has been lost because of the project e.g. “offset conservation areas” or resettlement of a village.
- **No action**

7 ASSUMPTIONS AND LIMITATIONS

This section of the report provides the assumptions and limitations under which the EIA study was conducted.

7.1 Assumptions

7.1.1 Assessment excludes possible expansions to the project

The assessment of impacts in this ESIA is expressly limited to the current proposals for mining the four ore fragments as described in the project proposal in section 4.4. Prospecting for further ore bodies is ongoing, and preliminary results indicate that further economically viable ore bodies exist and that these will lengthen the life of the mine and increase the footprint of the mine within the concession area. Such future expansions are, however, excluded from this assessment. Any possible cumulative impacts of such expansions are therefore not considered in this ESIA. Any future expansion of the Kalukundi mine will have to be assessed through an independent ESIA process.

7.1.2 Implementation of mitigation measures

It is assumed that mitigation measures as described in this report and in the ESMP will be strictly adhered to by ARL and that suitable systems (including a formal management system subject to regular and periodic environmental auditing) will be put in place to ensure that the mitigation measures are implemented. This system must be in line with the requirements of IFC Performance Standard 1. Without such a formal system, there is little assurance that the necessary monitoring will be in place to ensure that the recommended management of impacts is applied consistently throughout the lifetime of the project.

7.2 General limitations

7.2.1 Length of the site visit

The week long length of the site visit limited the ability of the results to represent all seasonal variations, as the results reflect only the faunal species that make use of the habitats during the rainy season. Repeated downpours during the site visit also limited the amount of time that specialists could spend in the field during this week.

7.2.2 Limited access to information on activities surrounding the concession

Very limited access was possible to the concessions surrounding the Kalukundi concession to compare conditions in the surrounding areas to the conditions on the concession. Assessment of the impacts of project activities has therefore been done in isolation, and there is little information on similar projects in adjacent areas. Unforeseen cumulative impacts resulting from similar project in the region may therefore occur. As a result, assumptions have been made regarding cumulative impacts of the project and a precautionary approach has been followed with regards to impact prediction. It may be that cumulative impacts are in fact not as serious as predicted by a precautionary approach, which tends to be based on a “worst case scenario”.

7.2.3 Decisions on project actions

Sites of some project actions e.g. road routes, remain un-finalised and may need to be re-assessed.

7.2.4 Limited access to existing information about the study area

Due to previous historical inaccessibility and subsequent civil unrest, studies in the region remain scattered, few and opportunistic. This constraint is relevant to social as well as natural data and information. There is a general lack of up to date information available for the DRC.

7.3 Limitations relevant to the vegetation assessment

- The time frame in which all the field survey was conducted was very limited and the floral survey was conducted during January and March 2008, whilst optimal flowering period is at the beginning and end of the rainy season (October/November and April). Many species do, however, flower sporadically throughout the year and this enabled successful identification of some species that do not flower during the abovementioned peak flowering periods. Species identification was completed as best possible within the limitations of these constraints and final identification of some species was not possible. Relevé sampling during the non-flowering season is time-consuming and a transect approach was favoured, which limits the quantitative value of the assessment.
- Fieldwork conducted during the rainy season resulted in at least three full days worth of time being lost because of very wet conditions during the planned fieldwork period, which was determined in the Terms of Reference for this study. A second trip was conducted for the botanical assessment to overcome this problem, but time constraints have imposed

some limitations on the report content. A detailed Riparian Vegetation Index was also not conducted (as per the original Terms of Reference) since accessible sites tended to be highly modified, which may have resulted in skewed results being obtained.

- No high-resolution satellite imagery was available during the compilation of the report due to almost permanent cloud cover during the rainy season (October through March). This has had limitations on the detailed mapping of vegetation (as per the Terms of Reference) within the concession area and also resulted in less detailed surveying of flora due to increased time pressures.

7.4 Limitations relevant to the faunal assessment

- Taxonomic knowledge of many inconspicuous or non-charismatic groups in Central Africa is poor and new taxa are still frequently discovered; e.g., and it is probable that many undescribed species remain to be described (see below).
- National and International assessment of threatened taxa is restricted to well-known groups, e.g. mammals and birds.
- Taxonomic knowledge of many inconspicuous or non-charismatic groups in Central Africa is poor and new taxa are still frequently discovered; e.g., and it is probable that many undescribed species remain to be described..
- National and International assessment of threatened taxa is restricted to well-known groups, e.g. mammals and birds.

7.5 Limitations relevant to the icthyofauna (fish) assessment

7.5.1 Information regarding stream hydrology

There is little information on the natural hydrology of the Kisankala and Kii rivers or the instream flow requirements of the aquatic biota. This lack of data will make effective mitigation of the dewatering of the mine pits and the release of large amounts of this water into the rivers problematic. Additional studies will be required in order to understand the hydrological dynamics of the stream systems of the Kisankala and Kii streams, so that mitigation can be designed to mimic the natural flow regime as closely as possible. This information will allow appropriate volumes of dewatered water to be fed back to the affected rivers so as to simulate natural flows in terms of volumes and seasonal variations.

In terms of mining operations, the development of a conceptual model of the proposed simultaneous dewatering and river re-charge program will facilitate management of any mitigation measures. In this regard, the fact that the dewatered water fed into the dry river channels will tend to recharge both the riverbed and banks (alluvial aquifer) and the deeper aquifer, will need to be taken into account.

8 STAKEHOLDER ENGAGEMENT

Stakeholder engagement and public consultation has been ongoing throughout the environmental assessment process and since the establishment of prospecting activities on the Kalukundi concession. Formal stakeholder engagement commenced during the initial EAP process during 2006.

Public consultation was critical in assisting the team understand the local conditions and use of Indigenous Knowledge Systems existing and inherent within the local communities and institutions in the project area. Consultation with the stakeholders also helped highlight the socio-economic and environmental concerns and impacts that could arise from the project and was instrumental in helping to come up with feasible mitigation measures.

The Social Impact Assessment for the ESIA included a stakeholder mapping exercise to identify Interested and Affected Parties. The exercise identified all the stakeholders in the area including the communities, artisanal miners, administration, civil societies, academia, and private sector organisations. Details of the stakeholders identified are indicated in Appendix B of the Social Impact Assessment.

8.1 Stakeholder engagement undertaken during the initial EAP process

Formal consultation with inhabitants of the concession area and surrounding areas started on the 24th of October 2006, when a meeting was held in Kisankala village .

Discussions with Chief Nsemba Kapaya Lubwe Timothe (Kisankala Village) were initiated early on during site visits by ARL and AMC and various relocation sites were investigated. During discussions with Chief Nsemba he highlighted the lack of a school and medical facilities in Kisankala Village. The new village will be supplied with potable water, a school and a clinic. The churches of Kisankala Village will be relocated to the new village and a house will be built and for all villagers who had a permanent house at the cut off date.

Census methods were used to identify the population of Kisankala Village, the number of households to be relocated, average incomes and numbers of people in each household. The first census was carried out in January 2005 and identified 1,069 people in the village. The census was updated in March 2006 and 2,361 people were identified. Many of these inhabitants of the village are artisanal miners. Chief Nsemba was approached to develop a list of the villagers who inhabited Kisankala village prior to artisanal activity in the area. This list was used to organise a meeting on 24th of October 2006 in Kisankala Village to consult with the villagers regarding the possibility of relocation. A voting session was carried out during this meeting to obtain the consensus of the village. The meeting voted in favour of relocating the village.

8.2 Stakeholder engagement undertaken during the ESIA process

A comprehensive Social Impact Assessment (SIA) (Environmentalistes Sans Frontieres 2008) was undertaken as part of the ESIA compilation process. This included detailed stakeholder engagement with the communities likely to be affected by the Kalukundi mining project. The following methods were used in this study:

8.2.1 Semi-structured interviews

A key informant survey was used to collect data from population units of intermediate size, such as communities and villages within a larger social milieu. This technique was used to gather information from subjects who are in a position to know key facts or able to interpret key characteristics about the population of interest. Subsequently individual, in-depth interviews were conducted with these identified people. These people included village elders, opinion leaders, church leaders, and respected members of the community, amongst others. The key informants were asked to characterise information about the community rather than to provide their own personal viewpoints or characteristics.

Interviews were also conducted with community representatives in the area to obtain information on socio-economic characteristics of the area.

8.2.2 Quantitative household survey

The objective of the quantitative household survey was to generate a baseline description of pertinent demographic and social characteristics of the concession area. The results of the survey were triangulated with information obtained by other means, including secondary data, interviews, focus group meetings and Participatory Rural Appraisal.

The interviewees for the quantitative household survey were selected randomly among the adult population in the area by picking households and respondents randomly in the villages of Kisankala and Kisanfu but ensuring that both men and women were selected. In order to obtain a representative sample of households in the mining project area, 54 households were selected and interviewed using a pre conceived questionnaire (see Appendix F of the Social Impact Assessment).

Basic descriptive statistics were generated for all variables assessed in the survey. In each case, data was disaggregated according to village.

8.2.3 Focus Group Discussions

During the field survey and in undertaking the specified tasks in the SIA, interactive Focus Group Discussions were held with the communities, leaders and a cross section of influential community members. Open ended questionnaires were used so as to give the interviewees a chance to have their say about the perceived impacts of the project and to ensure that they had an opportunity to express their opinions.

Focused Group Discussions were also held for other stakeholders including the civil societies, local authorities, private sector, public organizations, and local communities. The aim was to get information about their plans for socio-economic development and growth in the project area to identify possible synergies with ARL Community Development Programme.

8.3 Issues and Response Report

The Issues and Response Report records and categorises comments made by stakeholders. These comments were made in writing, telephonically, and verbally during focus group meetings, discussion sessions and one-on-one meetings. The report also includes the responses provided by members of the SIA team and ARL.

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
RESETTLEMENT AND HOUSING		
The planned housing scheme should take into consideration the number of members in a household because in some cases one man can house more than 10 people.	Ntambwe Yav	The DRC Mining Law requires that the replacement houses are equal or better than existing houses. The plan is for two bedrooms, a lounge and a kitchen for each house, although on the smallest houses the kitchens are outside.
When the whole process started we were few in this village and census was undertaken and census cards issued. The process has however dragged on for long and now there are more people than initially. What will happen to the new comers who do not have the census cards or were not initially counted?	Ntambwe Yav	There was a cut off date and this was communicated to all. Only those with permanent housing prior to the cut off date will be considered for new housing. Others will be compensated for the value of their building material.
WATER		
We appreciate that ARL took the initiative to improve our water supply. We used to use water of poor quality and now we have good water.	Ntambwe Yav	ARL is happy to partner with the community to improve the standard of living. Management of the system will however have to be the responsibility of the community now, and in future water projects in the new village.
Poor and irresponsible management of effluent from mining facilities as well as artisanal mining areas has resulted in great pollution of water resources hence affecting communities that rely on them. People have to go for longer distances in search of potable water.	World Vision	The environmental department is committed to educating artisanal miners about this and will assist where possible, and as much as possible to rehabilitate damage on ARL concession. ARL has an effluent management plan during life of mine and at closure

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
EDUCATION		
Education facilities are not sufficient. We currently have facilities for Primary 1 to Primary 5 and don't have facilities for Primary 6 as well as secondary facilities. What will they do for the purposes of particularly Primary 6. At present, the school is housed in the church building. They should be supported to construct these facilities so that their children don't have to go far from home (Kolwezi). Where the children fail or do not complete school, the young boys go to the mines and then marry the drop out girls (early marriages). Currently there are 230 pupils between Primary1 and 5 we are therefore requesting ARL to continue subsidising the 6 teachers' salaries so that this can continue.	Ilunga	The new village will have all the primary classes and will more than likely extend into secondary education facilities. Vocational training infrastructure developed with other partners is also a possibility into the future. There will be programmes to address youth issues, e.g. teenage pregnancies, the importance of education etc. Teachers will continue to be subsidised but emphasis will still be on ensuring that parents also assist in some way (payment of a nominal fee) to ensure sustainability of the school system after ARL has left. The long term vision is to hand over the school to government educational authorities.
We appreciate that ARL gave school children books to read and work on. We would like to ask that they also assist in providing teachers with the same so that it can improve the level of education particularly things like dictionaries and teaching aid to help them prepare for the lessons. The current fees stand at 800 Congolese francs per term per child. That is just under US$2.	Lubondo Chief's Secretary	ARL will continue to assist the school with materials for students and teachers. ARL has requested that KVDC fundraises to assist with 3 teachers desks/tables. Although the fees appear nominal, getting all the parents to pay is a challenge

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
ECONOMIC IMPACTS		
There has been a significant improvement in the economy since mining activities restarted. This has also positively affected transport and related infrastructure as well as increased opportunities for employment. More circulation of money has also supported growth in markets and service provision resulting in increased wealth creation. Mining has also promoted urbanization and industrial development in the district of Kolwezi.	World Vision	ARL intends to be another major contributor to the positive economic impact.
Market expansion and growth has been experienced as a result of mining activities in the region. This has been both in terms of demand as well as price.	GAPAT	This is a positive impact of mining industry in the area
LIVELIHOODS		
We need to be assisted with fertilizers, pesticides and seed in order to be able to farm more successfully. During the dry season it is very windy and cold conditions which cannot sustain vegetables such as tomatoes. One tomato can go up to 200 Congolese Francs.	Moshidi Kachongo	ARL will have agricultural projects as one of its key areas of focus in its community projects
Will our farms be affected and once we move will we be allowed to access our former farms? Will the new farms be favourable for livestock keeping?	Florence Kashela	The six farms that will be affected in the concession area have already been identified and compensation resources have already been set aside. There are agricultural plots planned as part of the new Kisankala village.
Will we get the same amount of land as that which we currently have?	Moshidi Kachongo	The data that has been collected clearly shows how many acres each person is farming and the KVDC committee will allocate new land to the farmers. All farmers will have their land replaced with an equal or greater area.
Due to concessions there is loss of agricultural land in the district. This has led to a deficit in the locally produced foods hence threat to food security.	ARTERI World Vision	Farming will be encouraged and supported by the ARL community sustainability initiatives.

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
Mining has resulted in increased wealth among a percentage of the local population though this is not even across the board.	ARDERI	ARL will operate under Human Resources policy which complies with the IFC performance standards on employment, to ensure fair wages and conditions across the board. Increase in wealth for individuals should flow across to other sectors as the individuals spend their wages in the community.
Benefits of mining are largely felt in the urban towns while the rural areas where the mining is taking places are left unattended.	GAPAT	With the construction of the new Kisankala village the standard of living will rise and there should be more economic activity in neighbouring villages as more money comes into circulation. ARL intends to house the senior and junior staff in purpose built accommodation within the community to encourage economic benefits to that community.
Due to poor control, access to markets and organization, artisanal mining has resulted in poverty due to exploitation by middlemen who buy the ore at very low prices and resell at very lucrative prices.	GAPAT	ARL is aware of the plight of the artisanal miners, but does not engage in artisanal mining so is not in a position to act on this issue. There is no artisanal mining on the ARL concession.
Many mining companies do not have community interests at heart. Many of them come with grand plans of what they intend to do for the communities where they work yet there is almost nothing to show as they rarely implement anything.	Kolwezi District Medical Office	ARL's commitment to the community is shown by the early engagement of an experienced Corporate and Community Relations Manager, and is already making a positive impact in the community with small projects, e.g. supply of drinking water to Kisankala Village, donation of wheelchairs to handicapped people in Lubumbashi, Kolwezi, Kisankala and Kinshasa, sanitation and hygiene activities, market gardening, community health projects and community capacity building. ARL has also signed a Memorandum of Understanding with the Ministry of Social Affairs in Kinshasa to support the community.
Rapid increase of population due to mining as well as increase in cash flow as significantly increased the cost of living affecting the poor.	Social Affairs Department, Kolwezi	Support for sustainable community businesses and education will be the focus of the ARL community relations effort, assisting the poor to develop alternative incomes so they can benefit from the general increase in living standards.

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
HEALTH		
Lack of health facilities around or near the village has forced villagers there to travel to Kolwezi having to walk (or be piggy-backed) for 4 km to Kisanfu and to board a bus to Kolwezi for 2,000 francs. In emergency cases, an ambulance from Kolwezi will cost them about 30,000 francs (USD 600). It would be good if ARL intervened to help in such occasions. ARL could provide a motor vehicle exclusively to the village and under the management of the village chief for their use during such and other emergencies.	Moshidi Kachongo	ARL will be building a clinic in the new village which will be able to handle a greater variety of medical cases than the current clinics. There will be a community health programme to improve the overall health of the population. Providing transport for villagers to Kolwezi is an issue for the KVDC or the clinics themselves, which would be run by the DRC government or NGO.
We had been promised that ARL would conduct HIV testing. We are still waiting for it to materialize	Georgette	ARL has worked on the initial phase of creating awareness of HIV/AIDS and STIs in collaboration with AMOCONGO. ARL is reviewing the logistics for the next phase of the programme which includes Voluntary Counselling and Testing Service as well as provision of resources, training and infrastructure for the programme. So ARL will set a date and inform you accordingly.
Some mining companies indiscriminately dump mining wastes and debris without concern of exposure of toxic chemicals to human populations thus causing health problems. This includes some road fillings that are being carried out with these materials, there are cases where uranium has been detected and the companies don't undertake prior tests to ascertain the rock chemical composition. Some of the deposits had up to 14% uranium content while the acceptable exposure level is 0.01%.	World Vision	ARL has a comprehensive environmental management plan and all waste rock will be screened for contaminants before it is used for any use other than placing on the waste rock dump. Current geological assays indicate there is an insignificant amount of Uranium in the waste rock.

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
Increase in purchasing power as a result of increased incomes has contributed to a reduction in malnutrition cases especially in infants and small children.	World Vision	ARL has identified malnutrition as a prominent feature within the Kisankala village and these has been due to diversion from an agricultural lifestyle to pre-dominantly mining related activities within most homes. As a result there is shortage of food supply and market prices are very high. ARL community health programme will include nutrition in collaboration with social development programmes from food production to ensuring a balanced diet especially for children but including adults (particularly pregnant and nursing mothers)
Due to increase in external and transit populations, the mining areas has experienced an increase in unsafe moral/sexual behaviour resulting in diseases such as HIV/AIDS and STDs.	World Vision	ARL is cognisant of the increased risk of HIV and STI transmission. It has initiated an initial awareness programme and has design a community programme that will focus on prevention of HIV/STIs, effective management of STIs and care of affected individuals. ARL will work in collaboration with the Regional Health authorities to ensure access to ART which are currently only available in Kolwezi. For ARL employees, a HIV/AIDS policy has been drafted and there will be a dedicated programme for the workforce under a trained personnel to focus on prevention, management and care. There is currently no commitment for ART provision.
Some companies are setting up their mining camps without good consideration of health and sanitation. As a result there is an increase in health problems especially among their workers.	Kolwezi District Medical Office	ARL mining camps and staff accommodation will be constructed to best engineering practices and will include utilities to cover clean and safe water supply and proper sanitation. ARL is reviewing its staff accommodation needs to also determine the best and feasible options. Single hostel accommodations in many mining operations has been a lead factor is promoting HIV risk behaviour and hence increase in HIV/STI transmission, and most mining houses have moved away from this option. ARL will duly review its staff accommodation options.
There is an increase in malnutrition as many people opt to work in the mines where there is higher income than in farming. As a result there is a reduction in available foodstuffs and balanced diet especially for growing children.	Kolwezi District Medical Office	ARL will support farming as a sustainable business for villagers who are not employed in the mine.

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
Many mining companies are not significantly contributing to improvement of health facilities in their areas of operation. Once they have excavated their minerals they just leave the people in a worse off state.	Kolwezi District Medical Office	ARL will construct a new clinic in the relocated Kisankala village, and will be supporting the Kisanfu clinic and other clinics in the region where possible. The new Kisankala village will have much improved sanitary conditions as the old village has very few toilet facilities and poor drainage. ARL will hand over the newly constructed clinic to the regional government health authorities in terms of staffing and the running of the facility to ensure sustainability. ARL will however provide technical support during the life of mine.
SECURITY & CONFLICT		
Since the mining companies cannot employ everyone, it has caused an imbalance previously not there of those who have and the 'have not'. As a result this has led to an increase in insecurity.	World Vision	With further development of the Katanga mining industry and peace and stability in the region, benefits should start to flow through all sectors of the economy.
Displacement of artisanal miners by concessions to large mining firms has resulted in concentration of the same in small areas and lack of livelihood for many. This has resulted in significant deterioration of security in these places and the district in general.	GAPAT	The government has recently announced opening of 6 new fragments specifically for artisanal miners which should go some way to alleviating the problem. Employment for ex-artisanal miners in the mining industry should also help.
Concession mining has resulted in displacement of artisanal mining hence rendering many young people their source of livelihood. This has created some conflict and tension between the companies and the artisanal miners.	Social Affairs Department, Kolwezi	As above
EMPLOYMENT & HUMAN RESOURCES		
We have been waiting for a long time for the project to start because people want to benefit through employment etc from it yet it has been like waiting for Jesus to come.	Ntambwe Yav	The delay is due to the dispute over ownership of the concession which is currently before the courts and out of ARL control. It is not possible to commence any significant work until ownership of the concession is finalised.

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
There has been a lot of movement of able, skilled human resource to the mining sector hence denying other sectors the same. This has resulted in poor performances within these other sectors.	ARDERI World Vision	Increased resources from income from the mining sector should go towards improving and increasing education facilities to increase the number of available qualified professionals in the future.
Large Mining companies are opting to work with international NGOs and firms as opposed to the local ones where as, the local ones understand the environmental and social settings of the project areas. This is also resulting in lack of capacity building for the local entities.	ADTERI	ARL is working closely with ARDERI and will engage with other local NGO's as well, as the project progresses, to deliver on its community development plan
Many of the mining companies do not employ local people particularly for skilled staff. By the time they are starting operations, many of them have already employed people from outside the locality of the mining.	Social Affairs Department, Kolwezi	ARL has a policy to employ first those in the vicinity closest to the mine site, as long as they have the required qualifications or experience. However, a world class mining operation requires a lot of technical and expert staff with professional experience and these will more than likely have to be sourced from outside the area. This is unavoidable as there is a scarcity of skilled staff due to the large number of new mining operations starting up in the Katanga region.
There has been an increase in enterprise development in the regions particularly urban centres and artisanal miner's migration centres due to an increase in population and expansion of local market	Social Affairs Department, Kolwezi	Positive impact of mining industry in the region
Recruitment processes by mining companies should be clearly defined and transparent to all.	SAESSMAC	ARL's Human Relations Policy complies with the IFC Performance Standards
TRANSPORT/ACCESS		
Our farm products cannot get to the market because the very poor state of the Kisanfu-Kisankala road.	Moshidi Kachongu Secretary to the Chief of Sector	ARL will be rehabilitating the road when operations begin.
The new farms are outside the concession area but the access routes are currently through the concession area. Once the project starts how will we access them?	Chikumba Lifuka	The new farms at Kisankala new village are easily accessible and close to the Kisanfu Road. Access to the north side of the concession from the new Kisankala village which is on the south side will be provided by a well maintained road around the project fence line.

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
An Increase in population and the number of mining companies has resulted in improvement of transport infrastructure and facilities in the area/district	World Vision	Positive impact of mining activities in the region.
PUBLIC SAFETY		
Speed bumps should be erected along the main roads where there are community centres and settlements to avoid/reduce accidents.	Kawama resident	This is outside the area of influence of ARL but ARL would be happy to assist in these issues. Speed bumps will be placed on the main road near Kisankala new village and at Kisanfu. ARL has already installed some speed bumps at strategic points within its concession.
CULTURE AND LIFESTYLE		
There is an increase in prostitution and alcoholism especially within the artisanal mining fragments.	World Vision	ARL will assist, in partnership with NGO's, in the education of the local community on health issues, however the artisanal mining areas are not in ARL's area of responsibility, but are under SAESSCAM and the DRC government. Approximately two thirds of the residents of the Kisankala Village are artisanal miners, although they are mining outside of ARL's concession. ARL's community health programme will also target these individuals and high-risk women groups in terms of creating awareness on HIV prevention, promoting safe sex practices. The programme will also include periodic presumptive treatment of high-risk women groups within the village to ensure that the prevalence of STI is reduced and hence the risk of HIV transmission. ARL's will engage guest-house owners in the programme to promote free distribution of condoms within the guest houses as a preventive measure.
Easy access to money by young men has resulted in a lot of early marriages and drop outs from school.	GAPAT	ARL will assist the community with information on the importance of education, and assist with the development of schools. Increased opportunities for meaningful long term employment in the mining industry should encourage young men, and young women, to complete their education. ARL's community health programme will include reproductive health initiatives. Amongst others, this programme will work closely with the school authorities to develop a curricular for reproductive health for the youth , both in and out of schools and on broad scale; family planning education for the community.

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
Due to the fluid nature of the artisanal miners, many children are left fatherless, without homes or unattended. As a result, there are many street children particularly in artisanal mining centres who are quickly assimilated into artisan mining of copper/cobalt.	Social Affairs Department, Kolwezi	Artisanal mining should be up graded into the modern mining through support from government and development partners.
Evicted (and to-be-evicted) artisanal miners have started investing in other businesses to secure future income. A large number of them are opening up shops and building houses for rent.	SAESSCAM	Positive project impact of alternative livelihood
PUBLIC PARTICIPATION		
We view this as our only opportunity to present our views to decision makers and therefore we should make the best of it.	Ntambwe	ARL has developed a grievance procedure which has been reviewed by the KVDC. ARL Corporate and Community Relations Manager, and Occupational Health and Safety Manager, regularly visit the village for discussions on a variety of topics, and have meetings with the KVDC. ARL staff live in the village and are known to the villagers. Therefore there are a number of ways for villagers to communicate with ARL.
NEED AND DESIRABILITY OF THE PROPOSED PROJECT		
We are tired. Nothing seems to be happening. ARL has erected a brick-making shed but there has been nothing after that yet we are talking about constructing new houses	Pande Kayombo	The contractor for the facility is preparing to complete the remaining works. The machines for brick making are already at site. Brick making has commenced and is ongoing. The village will be constructed on schedule regardless of where the bricks come from.
How many years is the ARL concession to take? Is it possible for ARL to give a fragment to the villagers with supervision from the chief so that they can be earning a living from this as the project is taking very long to start (and so is employment) and people are moving away to Kawama?	Ntambwe Yav	The minimum it will take is the currently approved 10 years, but it is more than likely to continue mining for a further 10 years, making a total of 20. No fragments will be provided to the villagers as preparation for large scale mining is expected to commence shortly.

COMMENTS RAISED	COMMENTATOR/S	RESPONSE
Many of the artisanal miners take drugs but this project offers them an opportunity to change if it starts and they are employed. The project has however taken too long to commence and it is becoming difficult to control them because due to their large numbers it is easy for them to overpower us. They will eventually move to the fragment areas by force and getting them out again will be very difficult	Chief	Isolated cases of illegal artisanal activity are being dealt with by the BRAS Security on a case by case basis. Provision of further artisanal mining fragments by the government should ease the current situation, and encourage the artisanal miners to move away from Kisankala. There are also more increased job opportunities from neighbouring mining companies such as Roq mining and AXC.

9 ASSESSMENT OF ENVIRONMENTAL AND SOCIAL IMPACTS

This chapter of the ESIA provides an assessment of the significance of the environmental impacts that have been identified, and also provides recommended mitigation measures that need to be applied to prevent or reduce the significance of impacts.

All impacts are presented **Error! Reference source not found.** below. The columns in this table are as follows:

- **Index**: A reference number for the impact, which allows cross reference to the ESMP and the description of impacts in section 9.1.1 to 9.1.6 below.
- **Issue:** A brief description of the issue to which the impact is relevant e.g. loss of flora – copper-cobalt.
- **Aspect**: A categorisation of the impact e.g. botanical, fauna, social.
- **Impact**: A brief description of the nature of the impact.
- **Phase**: The phase of operation during which the impact will occur (construction, operation and decommissioning).
- **Likelihood**: Probability of occurrence of the impact as per the impact assessment criteria in Section 6 above.
- **Time**: The time frame over which the impact will continue to occur, as per the impact assessment criteria in Section 6 above.
- **Area**: The area of the concession where the impact will occur.
- **Certainty**: The degree of confidence with which the impact can be predicted.
- **Severity**: The severity of the impact without mitigation as per the impact assessment criteria in Section 6 above.
- **Significance**: The overall importance of the impact without mitigation as per the impact assessment criteria in Section 6 above.
- **Severity with mitigation**: Severity after mitigation has been applied.
- **Significance with mitigation**: Significance after mitigation has been applied.

All possible impacts that have been identified are reflected in **Error! Reference source not found.**. However, in order to keep the ESIA report to a manageable size, only the impacts of high or moderate significance (without mitigation) have been discussed after this table, since impacts of high or moderate significance are, by definition, the impacts that could have the greatest effect on biophysical and social conditions. All impacts are, however, considered in the mitigation measures included in the ESMP and all impacts that have been identified will be incorporated into the mine's environmental management system.

Table 26: Impacts table

Index	Issue	Aspect	Impact	Phase	Likelihood	Time	Spatial scale	Certainty (confidence)	Severity	Significance	Severity with mitigation	Significance with mitigation
1.1	Loss of habitat - copper cobalt	Botanical	Direct localised loss of rare habitats, in copper-cobalt vegetation communities within the concession	Construction, Operation & Closure	Definite	Permanent	Mine pits	Definite	Very Severe	Very high	Severe	Don't Know
1.2	Loss of flora - copper cobalt	Botanical	Direct localised loss of local endemic species, in copper-cobalt vegetation communities within the concession	Construction, Operation & Closure	Definite	Permanent	Mine pits	Definite	Very Severe	High	Severe	Don't Know
1.3	Loss of sensitive faunal habitats	Fauna	Loss of sensitive habitats	Construction	Definite	Long term	Project	Definite	Very Severe	High	Severe	Moderate
1.4	Loss of wetlands	Habitat	Loss of the indigenous wetland vegetation cover due to mining related activities (e.g. roads).	Construction	May occur	Permanent	Local	Probable	Very severe	Low	Very severe	Low
1.5	Loss of Riparian Vegetation	Botanical	Direct localised loss of habitat within riparian vegetation communities	Construction, Operation & Closure	Definite (may occur)	Long term (medium term)	Local	Probable (possible)	Moderately severe (moderate)	Moderate	Slight	Moderate
1.6a	Loss of Miombo leading to loss in Biodiversity	Ecological Processes	Reduction in the number of frugivores due to mining related loss of indigenous fruit trees.	Operation	May occur	Permanent	Mine pits	Unsure	Don't know	Don't Know	Don't know	Don't Know
1.6b	Loss of Miombo leading to loss in Biodiversity	Ecological Processes	Loss of indigenous forage plants for pollinators.	Operation	Definite	Permanent	Mine pits	Unsure	Very severe	Don't Know	Don't know	Don't Know
1.6c	Loss of Miombo leading to loss in Biodiversity	Botanical	Direct localised loss of biodiversity including rare habitats and local endemic species, in Miombo vegetation communities. (94ha for WRDs 64ha for TSF causes loss of habitat for small mammals, birds and insects)	Construction, Operation	Definite	Permanent	Project	Definite	Severe (Low)	High (low)	Moderately severe (low)	Moderate
1.6d	Loss of Miombo leading to loss in Biodiversity	Botanical	Direct localised loss of biodiversity including rare habitats and local endemic species in Miombo vegetation communities	Closure	Unlikely	Permanent	Project	Definite	Severe	High	Moderately severe	Moderate
1.6e	Loss of Miombo leading to loss in Biodiversity	Ecological Processes	Loss of indigenous vegetation cover and hence forage for indigenous biota, as a result of the cultivation of exotic crops.	Operation	Definite	Permanent	Local	Probable	Severe	Low	Severe	Low
1.7a	Loss of Miombo leading to loss in habitat	Botanical	Direct loss of Miombo vegetation habitat & loss of vegetation cover due to mining-related activities	Closure	Unlikely	Permanent	Project	Definite	Severe	Moderate	Moderately severe	Low
1.8	Loss of topsoil	WRD & TSF	Removal of some topsoil during land clearance.	Construction	Definite	Permanent	Project	Certain	Moderate (Low)	Low	Moderate (low)	Low
2.1	Sedimentation of wetlands	Landforms	Loss of wetland area as a result of the release of polluted sediments into drainage lines and other wetlands from excavations, spoil heaps, ore dumps and tailings.	Operation	May occur	Permanent	Mine pits	Probable	Slight	Low	Slight	Low
2.2	Sedimentation & turbidity of streams	Icthyofauna	Water Quality – sedimentation & elevated turbidity	Construction, Operation	May	Long term	Project	Probable	Severe	High	Moderate	Moderate
2.3a	Sedimentation & dust in habitat	Botanical	Indirect loss of habitat quality due to dust, sedimentation and air quality associated with the mining process	Construction, Operation	Definite	Long term	Local	Probable	Slight	Low	Slightly beneficial	Low
2.3b	Sedimentation & dust in habitat	Botanical	Indirect loss of habitat quality due to dust, sedimentation and air quality associated with the mining process	Closure	Unlikely	Long term	Local	Probable	Slight	Low	Slightly beneficial	Low
2.3c	Sedimentation & dust in habitat	WRD & TSF	Dust generated from construction activities may be deposited on the surrounding vegetation.	Construction	Definite	Medium term	Project	Certain	Low	Low	Low	Low
2.3d	Sedimentation & dust in habitat	WRDs	Dust generated from movement of haul trucks and heavy equipment deposited on surrounding vegetation.	Operation	Unlikely	Medium term	Project	Certain	Low	Low	Low	Low
2.3e	Sedimentation & dust in habitat	TSF	Dust blown tailings deposited on the surrounding vegetation downwind of the TSF.	Operation	Unlikely	Medium term	Project	Certain	Low	Low	Low	Low

Index	Issue	Aspect	Impact	Phase	Likelihood	Time	Spatial scale	Certainty (confidence)	Severity	Significance	Severity with mitigation	Significance with mitigation
2.4a	Dust impact on air quality	WRDs	Air pollution due to airborne dust generated from the movement of haul trucks and other heavy equipment.	Operation	Unlikely	Medium term	Project	Certain	Low	Low	Low	Low
2.4b	Dust impact on air quality	TSF	Construction equipment generates dust along access routes and the cleared area for the TSF.	Construction	Unlikely	Medium term	Project	Certain	Low	Low	Low	Low
2.4c	Dust impact on air quality	WRDs	Air pollution due to wind erosion of the WRD walls and material in the WRDs.	Closure	Unlikely	Long term	Project	Possible	Low	Low	Low	Low
2.4d	Dust impact on air quality	WRDs	Construction equipment generates dust along access routes and the cleared area for the WRDs.	Construction	Unlikely	Medium term	Project	Certain	Low	Low	Low	Low
2.4e	Dust impact on air quality	WRDs	Contamination of air due to dust blown off the WRDs	Operation	Unlikely	Medium term	Project	Certain	Low	Low	Low	Low
2.4f	Dust impact on air quality	TSF	Air pollution due to dust blow from exposed tailings surfaces	Operation & Closure	Unlikely	Long term	Project	Possible	Moderate	Moderate	Moderate	Moderate
2.5	Dust impact on soil quality	WRDs	Soil contamination by dust from waste rock	Operation	Definite	Long term	Project	Probable	Low	Low	Low	Low
2.5	Dust impact on soil quality	TSF	Contamination of soil due to dust blow off the TSF.	Operation	Definite	Medium term	Project	Certain	Moderate	Low	Moderate	Low
3.1	Pollution of surface water - chemical	Icthyofauna	Reduction in water quality	Construction, operation and closure	May occur	Medium term	Project	Probable	Severe	High	Moderate	Low
3.2	Pollution of surface water - metals	Icthyofauna	Reduction in water quality due to metals from mining activities	Operation & closure	Possible to definite	Long term	Project	Probable	Severe	High	Moderate	Low
3.3	Pollution of groundwater - chemicals	WRDs	Contamination of groundwater at WRD and TSF from the accidental release of hydraulic fluid, oil or fuel from the construction vehicles.	Construction	May occur	Long term	Project	Probable	Low	Low	Low	Low
3.4a	Pollution of groundwater - metals	WRDs	Contamination of groundwater due to development of ARD and seepage through the base of the WRDs.	Closure	Definite	Long term	Project	Unlikely	Low	Low	Low	Low
3.4b	Pollution of groundwater - metals	TSF	Contamination of groundwater due to acid rock drainage (ARD) seeping under the TSF.	Closure	Definite	Long term	Project	Unlikely	High	Moderate	High	Moderate
3.4c	Pollution of groundwater - metals	TSF	Contamination of groundwater due to seepage of tailings solution and/or ARD through the base or toe of the dam.	Operation	Definite	Long term	Project	Unlikely	High	Moderate	High	Moderate
3.4d	Pollution of groundwater - metals	WRDs	Contamination of groundwater due to acid rock drainage (ARD) through the base or toe of the dump.	Operation	Definite	Long term	Project	Unlikely	Moderate	Moderate	Moderate	Moderate
3.5	Pollution of surface water - TSF failure	TSF	Contamination of watercourses with sediment and liquor due to accidental failure of TSF walls	Operation	Definite	Long term	Project	Unlikely	High	Moderate	High	Moderate
3.6	Pollution effects on fauna	Fauna	Chemical pollution	Operation	May occur	Long term (permanent)	Project/ District (Local)	Probable (Definite)	Severe (Don't know)	High	Severe (no effect)	Moderate
3.7a	Pollution of soil	TSF& WRDs	Contamination of soils at TSF from spilled fuel, oils and lubricants from construction vehicles	Construction	May occur	Medium term	Project	Certain	Low	Low	Low	Low
3.7b	Pollution of soil	TSF	Contamination of soil due to accidental spill of tailings (during transit to the TSF)	Operation	Definite	Long term	Project	Possible	High	Moderate	High	Moderate
3.8a	Pollution of air	WRDs	Localised contamination of air due to release of exhaust fumes from dump trucks etc.	Operation	Unlikely	Short-term	Project	Certain	Low	Low	Low	Low

Index	Issue	Aspect	Impact	Phase	Likelihood	Time	Spatial scale	Certainty (confidence)	Severity	Significance	Severity with mitigation	Significance with mitigation
3.8b	Pollution of air	WRDs	Exhaust fumes from construction vehicles at WRD will cause localised air pollution	Construction	Unlikely	Medium term	Project	Certain	Low	Low	Low	Low
3.8c	Pollution of air	TSF	Exhaust fumes from construction vehicles at TSF will cause localised air pollution	Construction	Unlikely	Medium term	Project	Certain	Low	Low	Low	Low
4.1	Loss of SSC - fish	Icthyofauna	Loss of Aquatic Species (fish) of Special Concern	Construction, Operation & Closure	Will occur	Long term	Project	Probable	Severe	Moderate	Severe	Moderate
4.2	Loss of SSC - fauna	Fauna	Loss of SSC	Construction	May occur	Medium term	Project/ District	Probable	Mod Severe	Moderate	Severe	Low
4.3	Loss of SSC - flora	Botanical	Improved access to rare habitats and local endemic species leading to removal of rare species	Construction, Operation, Closure	May occur	Long term	Project	Possible	Slight	Moderate	Slight	Low
4.4	Loss of fauna - increased mortality	Landforms	An increase in faunal mortality rates as a result of entrapment in steep sided excavations	Operation	Definite	Permanent	Mine pits	Probable	Slight	Low	Slight	Low
4.5a	Loss of faunal diversity	Terrestrial fauna	Loss of faunal diversity (Increased mortality rates in fauna due to increased hunting activity)	Construction, Operation	May occur	Medium term	Project/ District	Probable (possible)	Mod Severe (Slight)	Moderate	Severe (slight)	Low
4.5b	Loss of faunal diversity	Ecological Processes	Increased disruption of bird breeding by the collection of eggs	Operation	May occur	Permanent	Project	Unsure	Don't know	Low	Slight	Low
5	Fragmentation - connectivity effects	Habitats	Fragmentation of terrestrial habitat as a result of mining activities (e.g. roads, utility corridors).	Construction	Definite	Permanent	Project	Probable	Moderately severe	Low	Moderately severe	Low
5.1	Fragmentation - connectivity effects - flora	Botanical	Reduction in connectivity of habitats affecting movements of wildlife species that may be pollinators or dispersal agents of flora within Copper deposits	Construction, Operation, Closure	Unsure	Permanent	Regional	Probable	Severe	High	Severe	High
5.2a	Fragmentation - connectivity effects - fauna	Landforms	Increase in the spatial extent of rocky habitat (fauna).	Operation	Definite	Permanent	Mine pits	Possible	Don't know	Don't Know	Don't know	Don't Know
5.2b	Fragmentation - connectivity effects - fauna	Terrestrial fauna	Disruption to faunal movements	Construction, Operation, Closure	Definite	Medium term	Project/ District	Definite	Slight	Low	Severe	Low
5.2c	Fragmentation - connectivity effects - fauna	Landforms	Change in faunal dispersal characteristics in the concession as a result of the loss of topographic highs.	Operation	Definite	Permanent	Mine pits	Possible	Very severe	Low	N/A	Low
5.2d	Fragmentation - connectivity effects - aquatic	Habitats	Fragmentation of aquatic habitats due to the construction of roads.	Construction	May occur	Permanent	Mine pits	Probable	Moderately severe	Low	Slight	Low
6a	Exotic species impacts	Ecological Processes	Reduced indigenous seed dispersal due to preferential visitation to exotic plant species.	Operation	May occur	Permanent	Project	Unsure	Don't know	Don't Know	Don't know	Don't Know
6b	Exotic species impacts	Habitats	Increase in the spatial extent of exotic species due to an increase in the spatial extent of disturbed areas.	Operation	Definite	Permanent	Mine pits	Possible	Moderately severe, very severe	Low	Slight, moderately severe	Low
6c	Exotic species impacts	Habitats	Increase in the diversity of exotic species present due to introduction of ornamentals and new crops	Operation	May occur	Permanent	Local	Probable	Slight	Low	Slight	Low
6d	Exotic species impacts	Ecological Processes	Pest outbreaks as a result of the cultivation of exotic crops	Operation	May occur	Permanent	Local	Unsure	Slight	Low	Slight	Low
6e	Exotic species impacts	Ecological Processes	Reduced pollination of indigenous plant species in close proximity to the cultivated crops at the proposed new village	Operation	May occur	Permanent	Local	Probable	Don't know	Low	Slight	Low
6f	Exotic species impacts	Ecological Processes	Increased consumption of indigenous flora by exotic herbivores as a result of an increase in livestock numbers	Operation	May occur	Permanent	Project	Probable	Slight	Low	Slight	Low

Index	Issue	Aspect	Impact	Phase	Likelihood	Time	Spatial scale	Certainty (confidence)	Severity	Significance	Severity with mitigation	Significance with mitigation
6g	Exotic species impacts	Ecological Processes	Loss of indigenous fauna to exotic predators	Operation	Definite	Permanent	Project	Probable	Slight	Low	Slight	Low
6h	Exotic species impacts	Ecological Processes	Increase in the amount of seed dispersed by exotic fauna, associated with an increase in livestock numbers	Operation	May occur	Permanent	Project	Unsure	Slight	Low	Slight	Low
6i	Exotic species impacts	Botanical	Introduction of exotic species (terrestrial and aquatic)	Construction	May occur	Long term	Project	Possible	Moderately Severe	Moderate	Slight	Low
7.1	Water table lowering - effect on Miombo	Botanical	Long-term changes in Miombo Woodland may occur as a result of dewatering activities that could lower the water table in the affected area.	Construction, Operation, Closure	May occur	Long term	Project	Probable	Moderately Severe	Don't Know	Moderately Severe	Don't Know
7.2	Water table lowering - effect discharge to drainage line	Icthyofauna	Stream Flow Reduction and flow alteration due to dewatering of the mine pits and lowering the water table	Construction, Operation & Closure	Definite	Long term	Project	Definite	Very severe	High	Severe	Moderate
8.1	Water flows changes - riparian vegetation	Botanical	Impact of changed flow regime on riparian plant communities (Gallery Forest and Dambo Wetlands)	Construction, Operation & Closure	Definite	Permanent	Local	Probable	Moderately Severe	High	Moderately Severe	Moderate
8.2	Water flows changes - biophysical and ecological	Icthyofauna	Impact of increased stream flow on the aquatic system	Construction & Operation	Definite	Long term	District	Probable	Severe	High	Moderate	Moderate
8.3	Water flows changes - impoundment	Landforms	Impoundment of flows upstream of roads.	Operation	May occur	Permanent	Local	Probable	Slight	Low	Slight	Low
9	Fire	Terrestrial fauna	Increased fire risk	Operation	Likely	Long term	Project/ District	Probable	Slight	Moderate	Severe	Low
10.1a	Noise	Ecological Processes	Disruption of bird breeding by noise associated with mining activity.	Operation	May occur	Permanent	Mine pits	Unsure	Don't know	Don't Know	N/A	Don't Know
10.1b	Noise	WRDs & TSF	Heavy equipment used during construction of TSF & WRDs (front end loaders, etc) causes localised noise disturbances to humans, disturbs wildlife	Construction	Unlikely	Medium term	Project	Certain	Low	Low	Low	Low
10.1c	Noise	WRDs	Noise disturbances from WRD heavy plant equipment and dozers operating on the dump.	Operation	May occur	Medium term	Project	Certain	Low	Low	Low	Low
10.2a	Vibration	WRDs & TSF	Vibration caused by WRD & TSF construction activities disturbs wildlife.	Construction	Unlikely	Medium term	Project	Certain	Low	Low	Low	Low
10.2b	Vibration	WRDs & TSF	Heavy equipment used during construction (front end loaders, etc) causes localised vibration disturbances. (To population/houses)	Construction	Unlikely	Medium term	Project	Certain	Low	Low	Low	Low
10.2c	Vibration	WRDs	Vibration disturbances from heavy plant equipment and dozers operating on the dump.	Operational	Moderate	Medium term	Project	Certain	Low	Low	Low	Low
10.3a	Light	Ecological Processes	Disruption of the flowering phenology of short day plants in close proximity to artificial night lighting.	Operation	May occur	Permanent	Mine pits	Unsure	Slight	Low	N/A	Low
10.3b	Light	Ecological Processes	Reduced/or enhanced pollination of indigenous plant species in close proximity to artificial lighting.	Operation	May occur	Permanent	Mine pits	Unsure	Don't know	Low	Slight	Low
10.3c	Light	Terrestrial fauna	Light pollution affecting local faunal activities	Construction, Operation, Closure	Definite	Long term	Project/ District	Definite	Mod Severe	Moderate	Severe	Low
11a	Aesthetics	TSF	Detraction from the natural beauty of the landscape.	Operation	Moderate	Permanent	Project	Certain	Low	Low	Low	Low

Index	Issue	Aspect	Impact	Phase	Likelihood	Time	Spatial scale	Certainty (confidence)	Severity	Significance	Severity with mitigation	Significance with mitigation
11b	Aesthetics	TSF	Alteration of visual character of the area due to removal of Miombo woodland (129 ha) and the topsoil construction of earth-fill starter wall.	Construction	Moderate	Permanent	Project	Certain	Low	Low	Low	Low
11c	Aesthetics	WRDs	Detraction from the natural beauty of the landscape.	Closure	Low	Permanent	Project	Certain	Low	Low	Low	Low
11d	Aesthetics	TSF	Detraction from the natural beauty of the landscape.	Closure	Low	Permanent	Project	Certain	Low	Low	Low	Low
11e	Aesthetics	WRDs	Alteration of visual character of the area due to removal of Miombo woodland (104ha) and the topsoil.	Construction	High	Permanent	Project	Certain	Moderate	Low	Moderate	Low
12a	TSF failure - major	Public safety	Public safety impact due to TSF failure	Operational	Very High	Short term	Regional	Unlikely	High	High	High	High
12b	TSF failure - major	Botanical	Destruction of natural habitats in downstream areas (terrestrial and aquatic) in the case of TSF failure	Operation, Closure	Unlikely	Long term	Local	Possible	Severe	Moderate	Low severity	Low
13	Ecology disruption	Terrestrial fauna	Ecosystem disruption	Construction, Operation	Definite	Long term	Project/ District	Definite	Mod Severe	Moderate	Severe	Low
14	Infrastructure	Ecological Processes	Preferential dispersal of plant species by birds down utility lines.	Operation	Definite	Permanent	Mine pits	Probable	Slight	Low	Slight	Low
15a	Ecology disruption	Landforms	Creation of surrogate cave habitat as a result of mining activity.	Operation	Definite	Permanent	Mine pits	Unsure	Don't know	Don't know	Don't know	Don't Know
15b	Archaeology	WRDs & TSF	Disturbance or destruction of archaeological or cultural sites or the discovery of new artifacts.	Construction	High	Permanent	Project	Unlikely	High	Low	High	Low
16	Community impact on ecology	Botanical	Intensification of utilization of areas outside of the concession area as a result of displacement of people from within the concession area	Construction, Operation & Closure	Definite	Permanent	Project	Definite	Moderately Severe	High	Moderately Severe	Moderate
17a	Community safety	WRDs	WRDs may become unstable with time and become dangerous to the public when accessed.	Closure	Moderate	Long term	Project	Probable	Low	Moderate	Low	Moderate
17b	Community safety	WRDs	Danger to the public from inadvertent access to operational areas.	Operation	Moderate	Medium term	Project	Certain	Low	Moderate	Low	Moderate
17c	Community safety	TSF	Danger to the public of drowning due to walking on the TSF.	Operation	Moderate	Medium term	Project	Unlikely	Low	Moderate	Low	Moderate
18	Community loss of production	Establishment of mining concession & access control	The removal of Miombo woodland leads to loss of economic benefits of charcoal & traditional medicines (Loss of access to the resource base)	All phases	Unlikely	Permanent	Study area	Certain	Slight	Moderate	Low	Moderate
19.1	Relocation of Kisankala village	Establishment of mine on Kalukundi concession	Feelings of displacement for Kisankala village residents	Construction	Definite	Short term	Project	Probable	Slight	High	Low	Low
19.2	Disruption of social processes	Financial compensation for loss of assets	Loss of assets and misuse of financial compensation	Construction & operation	Probable	Long term	Project	Probable	Moderate	Moderate	Low	Low
19.3	Disruption of social processes	Availability of employment	Population influx	Construction & operation	Definite	Short term	Project / district	Probable	Moderate	Moderate	Low	Low
19.4	Disruption of social processes	Increased incomes from mining	Price inflation	Construction & operation	Definite	Long term	District	Probable	Moderate	Moderate	Moderate	Moderate
19.5	Disruption of social processes	Influx of employees and work seekers	Pressure on social infrastructure and facilities	Construction & operation	Definite	Short term	District	Definite	Slight	Low	Low	Low
19.6	Workplace hazards	Employment in hazardous situation on the mine	Work place hazards and accidents	Construction and operation	Probable	Short term	Study area	Probable	Slight	Low	Low	Low

Index	Issue	Aspect	Impact	Phase	Likelihood	Time	Spatial scale	Certainty (confidence)	Severity	Significance	Severity with mitigation	Significance with mitigation
19.7	Pedestrian safety	Increase mine-related traffic	Traffic safety risks	Construction and operation	Probable	Medium term	District	Definite	Slight	Low	Low	Low
19.8	Health	Dust generation, creation of open pits, influx of job seekers	Health impacts	All phases	Probable	Medium term	District / Regional	Probable	Slight	Moderate	Low	Low
19.9	Noise and vibration	Blasting and heavy vehicle traffic	Noise and vibration impacts	Construction and operation	Probable	Long term	Study area	Probable	Slight	Low	Low	Low
19.10	Economic dependency	Mine closure	Dependency after closure of Kalukundi mine	Closure	Definite	Short term	District / Regional	Probable	Moderate	High	Low	Low
19.11	Artisanal mining	Establishment of mining concession	Loss of livelihood	All phases	Definite	Long term	Study area	Definite	Slight	Low	Low	Low
19.12	Artisanal mining	Employment on mine	Change of livelihood and loss of manpower in other sectors	Construction and operation	Definite	Short term	District	Definite	Slight	Moderate	Low	Low
19.13	Disruption of social processes	Modernisation of cultural processes	Increased social delinquency	All phases	Probable	Long term	District	Probable	Slight	Moderate	Low	Low
19.14	Disruption of social processes	Influx of employees and work seekers	Uncontrolled development of new settlements	Construction and operation	Definite	Long term	District	Probable	Moderate	High	Low	Low
19.15	Disruption of social processes	Establishment of mining concession & access control	Loss of farm land	All phases	Definite	Short term	Study area	Definite	Slight	Low	Low	Low
19.17	Disruption of economic processes	Moving of the Kisankala village	Economic displacement (Loss of livelihood and income) of those that had businesses in Kisankala village	Construction and operation	Definite	Short term	Study area	Probable	Slight	High	Low	Low

9.1 Impact descriptions

9.1.1 General ecological impacts (impacts which may affect more than one environmental medium)

(a) Destruction of natural habitats in downstream areas (terrestrial and aquatic) in the case of TSF failure (Index no. 12)

Cause and comment:

Should the TSF fail, impacts of either a terrestrial or riparian nature could occur, depending on the location of the TSF. TSF failure could be the result of a combination of factors, including poor construction that ignores professional engineering design, poor maintenance of the TSF and exceptionally high rainfall.

Significance Statement:

Destruction of natural habitat as result of failure of the TSF is unlikely to occur at a localised level. Should the TSF be located close to the Kisankala River (Option C), tailings would be carried downriver far outside the concession area and would affect a long stretch of the river. However, the TSF is located near the southeastern corner of the concession in Options A, B and D, and these options would result in a much lower degree of impact on aquatic systems, as it is unlikely that tailings would flow directly into the nearest stream, the Kisankala Stream, over a distance of several hundred metres. Failure of the TSF is highly unlikely, provided that professional engineering design is followed and maintenance of the TSF is carried out according to the engineering parameters specified by the design engineers. Should the TSF fail, it would result in an impact of **high** significance.

Mitigation:

- Build in conservative design features in the TSF (proper safety factors);
- Emergency planning to mitigate effects if a failure occurs;
- Choose the southern TSF site (Option A, B or D), to reduce the risk of impacts to the more significant riparian vegetation.
- A suitably qualified engineer who is experienced in the design and management of tailing storage facilities must carry out annual inspections of the TSF.

Residual Impacts:

Residual natural risks for the environment from the TSF are expected to be in the low to moderate risk rating.

(b) Ecosystem disruption (Index no. 13)

Cause and comment:

Although there is a long history of agricultural use and transformation in the region, it still retains faunal and floral diversity that contributes to local ecosystem functioning (e.g. nutrient cycles and transfer, maintenance of biodiversity, the biological components of hydrological cycles). The most sensitive habitats for ecosystem functioning include drainage lines and dambo wetlands, which must be protected from erosion and contaminated water. The construction and operation of the mine and the associated road network can have numerous direct and indirect effects on ecosystem functioning. With block and linear developments such as roads and the TSF, the most significant impacts relate to the fragmentation of habitats, increased faunal mortalities, and restrictions on animal movements. The disruption of faunal interactions may lead to a loss or change of ecosystem function (e.g. nutrient cycling, hydrological cycling, pollination, carbon sequestration) and/or blocking of linear processes. Ecosystem disruption will be most significant during the construction and operational phases, and of less significance during the de-commissioning/closure phase.

<u>Cumulative impacts</u>

Present land use options in the region have only slightly affected ecosystem functioning in the region due to loss of large mammal herbivores, increased fire regime, chemical contamination and increased turbidity in forest streams. Project actions associated with mining will exacerbate existing impacts.

<u>Significance statement</u>

Project actions associated with mining will **definitely** result in a long-term loss of ecosystem functioning. Resulting in a ***moderately severe***, *Study Area* impact of MODERATE significance

<u>Mitigation</u>

- Habitat corridors must be maintained to allow faunal movement, so that faunal-floral interactions (e.g. pollination, seed dispersal) can continue to occur.
- Restriction of the mine 'footprint', including direct components such as buildings and transport linkages, and indirect components such as dust plumes, downstream drainage of spillage, must be kept to a minimum.
- Full containment of contaminated waters resulting from the mine operation will be essential mitigation, otherwise medium to high significance residual impacts to ground water may occur.
- It is necessary to educate surrounding communities to show the interaction of environmental management and sustainability.
- The impact within the concession may be unavoidable, however offset protection of threatened habitats/species elsewhere may reduce this impact to LOW significance.

(c) Intensification of utilization of areas outside of the concession area as a result of displacement of people from within the concession area (Index no. 16)

<u>Cause and Comments:</u>

Higher density of people using the same agricultural, grazing and other natural resources due to immigration of people due to mining may lead to over-utilisation. Disruptions to subsistence livelihood as people leave their land and try to re-establish themselves on new land. This will deteriorate further by relocation of people resulting from development of nearby mines at Goma, Kinshasa and Comide.

Significance Statement:

Intensification of utilization of natural resources outside of the concession will definitely occur as a result of displacement of people and will be of moderate significance. The impact is expected to be of permanent duration, due to the fact that people will probably stay on in the area, and the significance is therefore assessed to be HIGH.

Mitigation:

- Co-operative forest management programme;
- Compensation and resettlement planning as appropriate; and
- Possible projects to cultivate useful species should be investigated to allow people to supplement household income, reduce dependence on, and reduce loss of Miombo woodland.

Residual Impacts:

- Low to Moderate permanent loss of habitat within the vicinity of the concession due to vegetation clearing for crops;
- Low to Moderate loss of plant material used for timber, food and medicinal purposes.

(d) Contamination of soil due to accidental spillage of tailings (during transit to the TSF) (Index no. 3.7b)

Cause and comment

Tailings will be transported from the processing plant to the TSF via a pipeline. Should there be inadvertent breaks in the pipeline, the tailings would spill and hence contaminate large volumes of soil and effectively render the soil infertile.

Significance statement

Such an impact would be relatively localised and would only affect the area between the processing plant and the TSF. The impact is medium-term, as it could occur at any time during the operational phase of the project. The likelihood of occurrence would be ‘possible’, and the significance without mitigation would be MODERATE.

Mitigation

- Bund the pipeline so any such spills are contained with in a bund and sump system;
- Regularly inspect the tailings slurry pipeline for breaks;
- Include the inspection of the tailings slurry pipeline for breaks in the preventative maintenance system of the mine.

9.1.2 Botanical impacts

(a) Direct localised loss of rare habitats in copper-cobalt vegetation communities within the concession (Index no. 1.1)

Description

The copper-cobalt substrate provides a unique habitat for vegetation that is restricted to the copper-cobalt outcrops and the opencast mining process will eliminate these landscape features, thus removing the habitat and associated flora. At a *localised* level (mine area), mining activities will have result in the almost complete loss of natural habitat for copper-cobalt flora. At a *regional* (and international) level, mining activities will contribute to the decline in available natural habitat for the endemic copper-cobalt flora.

Significance

Both construction and operation phases will have a very high significance, very severe, permanent, negative, localised impact to critical copper-cobalt flora habitat including copper-cobalt rock outcrops and copper-cobalt steppe-savannah habitats within the mine area.

Mitigation

- Removal of endemic and ecologically important species and habitat to a storage area for use during rehabilitation of the WRDs;
- Boulders on outcrops hosting significant flora species should be removed where possible and placed in a nursery area, maintaining the same orientation to the environment to enable the species to continue to propagate.
- Removal and storage of topsoil before construction to be stored and used during rehabilitation;
- Reconstruction of critical habitat during rehabilitation;
- Recreation of artificial outcrops for habitat of the copper flora;
- Establishment of protected natural area on site or off-site to compensate for disturbed copper–cobalt flora communities (at a regional level) – co-operation with the government and other mining companies may be necessary, therefore the location of the protected area would need to be confirmed once negotiations with other parties have been completed.
- Establishment of Plant Micro Reserves (PMR's) in association with adjoining mining concessions. However, it must be noted that this will require legal, political, economic and social support for long-term success. It would also require the support of regional botanical studies and research programs.

Residual impacts

Artificially created and revegetated areas may allow for the conservation of aspects of the typical copper-cobalt outcrop habitat, but it will differ in structure and function to the existing natural habitat, most likely permanently.

(b) Direct localised loss of local endemic species, in copper-cobalt vegetation communities within the concession (Index no. 1.2)

Description

The copper-cobalt vegetation has many endemic flora with distributions restricted to copper-cobalt outcrops within the Katanga region and the opencast mining process will eliminate these landscape features, thus removing the associated flora.

- At a localised level (Mine area), mining activities will result in almost complete loss of natural habitat for endemic copper-cobalt flora;
- At a regional (and international) level, mining activities will contribute to the decline in available natural habitat for the endemic copper-cobalt flora.

Significance statement

Both construction and operation phases will have a very high significance, very severe, permanent, negative, localised impact to critical copper-cobalt flora including copper-cobalt rock outcrops and copper-cobalt steppe-savannah habitats within the mine concession. There is a high degree of uncertainty associated with the significance after mitigation, therefore the significance after mitigation cannot be predicted.

Mitigation

The same mitigation would apply as for the above-mentioned impact.

Residual Impact

Artificially created and revegetated areas may allow for the '*ex-situ'* conservation of endemic copper-cobalt outcrop flora, but the long-term success and survival rates of this is unknown.

(c) Loss of sensitive faunal habitats (Index no. 1.3)

Description

Construction of infrastructure, including but not limited to the TSF, processing plant, WRDs, mine village, relocated Kisankala village and road networks will result in the clearing and removal of Miombo Woodland, impacting the fauna that would generally use that habitat. Since Miombo Woodland has a wide distribution and habitat tends to be uniform throughout the region, the impact will be at a localised level and of low significance.

Significance statement:

Both construction and operation phases will definitely have a significant, moderately severe, negative, localised impact on Miombo woodland habitats within the mine area. The overall significance of the impact without mitigation will be HIGH. The significance would be high during construction, but moderate during operation and low during closure.

Mitigation:

- Identification of and direct translocation of rare plants and critical habitat to off-site or PMR areas;
- Maximum utilisation of already disturbed areas, including the existing Kisankala village and existing roads;
- Transfer of microhabitat features from disturbed areas to areas unaffected by clearing (such as branches colonised by the Orchidaceae);
- Rehabilitation of terrestrial habitats (disturbed areas) as much as possible during operation and decommissioning.

Residual Impacts:

- Moderate local negative impacts on Miombo woodland habitat due to mitigation measures indicated above.
- Low regional negative impacts on woodland habitat due to relative abundance of this habitat type within the region.

(d) Direct localised loss of habitat within riparian vegetation communities (Index no. 1.5)

Cause and Comments

Impacts to riparian vegetation is likely to be limited to the river crossing of the Kisankala stream, resulting in the loss of some Dambo Wetland. WRDs have been repositioned to avoid riparian areas (Kii stream). In the "Option C" alternative for site layout, the TSF is sited close to the Kisankala stream and may have some impact, should it be the selected option.

Significance Statement

There will be a low significance negative impact to the Dambo wetland and riparian vegetation during construction to upgrade existing gravel road across the riparian zone. There will be a moderately significant positive impact on the Dambo wetlands due to improved road surfacing and improved runoff management after mine closure due to improved management of existing erosion and the resulting decrease in sedimentation of the upper reaches of the Kisankala stream and Dambo wetland.

Mitigation

- Roads crossing the Kisankala stream must be constructed over the existing dirt road, and should be adequately surfaced and appropriate drainage structures implemented to manage runoff and trap sediment;
- Should the northern TSF and processing plant location be the selected option, design must be such that it avoids the Kisankala River with an adequate buffer in place (minimum 60m, but recommended to be at LEAST 100m);
- Copper-Cobalt containing rock must NOT be used at or near the river crossing to minimise pollution of the stream from runoff and seepage, which will negatively affect riparian vegetation in the short- to long-term.
- Infrastructure on dambo areas must be avoided where possible. Riparian areas must be avoided and proper drainage structures and sediment

control features designed for all roads. Storm water detention ponds must be constructed outside dambo wetlands.

Residual Impacts

- Low negative impacts on gallery forest and Dambo wetland habitats due to presence of road infrastructure;
- Moderate positive impact on riparian vegetation (including Dambo wetland, downstream riparian vegetation and Gallery Forest) as a result of reduced siltation and erosion from improved road construction and drainage;
- It is unlikely that any rare or endemic species will be impacted upon negatively during construction and operational within the riparian area.

(e) Direct localised loss of biodiversity including rare habitats and local endemic species in Miombo vegetation (Index no. 1.6c)

Cause and Comments:

Construction of infrastructure, including but not limited to the TSF, processing plant, WRDs, mine village, relocated Kisankala village and road networks will result in the clearing and removal of Miombo Woodland. Since Miombo Woodland has a wide distribution throughout the region, the impact will be at a localised level and of low significance. Habitat tends to be uniform throughout the region although some endemic (and protected) species of flora are likely to be present.

Significance statement

Both construction and operation phases will definitely have a significant, moderately severe, negative, localised impact to Miombo woodland habitats within the mine area.

Mitigation

- Identification of and direct translocation of rare plants and critical habitat to off-site or PMR areas;
- Maximum utilisation of already disturbed areas, including the existing Kisankala village and existing roads and rehabilitation of unused disturbed areas;
- Transfer of microhabitat features from disturbed areas to areas unaffected by clearing (such as branches colonised by the Orchidaceae);
- Reclamation of terrestrial habitats, as much as possible during operation and decommissioning.

Residual Impacts:

- Moderate local negative impacts on Miombo woodland habitat.
- Low regional negative impacts on woodland habitat due to relative abundance of this vegetation unit within the region.

(f) Direct loss of Miombo vegetation habitat and loss of vegetation cover due to mining-related activities (Index no. 1.7a)

Cause and Comments

Construction of infrastructure, including but not limited to the TSF, processing plant, WRDs, mine village, relocated Kisankala village and road networks will result in the clearing and removal of Miombo Woodland. Since Miombo Woodland has a wide distribution throughout the region, the impact will be at a localised level and of low significance. Habitat tends to be uniform throughout the region although some protected flora is likely to be present.

Significance statement

Both construction and operation phases will definitely have a significant, moderately severe, negative localised impact to Miombo woodland habitats within the mine area. The significance of the impact would be MODERATE.

Mitigation

- Restoration of some Miombo woodland during construction, operation and decommissioning (roads, processing plant and other areas having infrastructure during operational phase) will be possible;
- Reclamation of terrestrial habitats as much as possible during operation and decommissioning;
- Use of the existing Kisankala village area for activities such as infrastructure and other facilities would minimise loss of Miombo woodland to a limited extent; and
- Progressive rehabilitation of available areas must be carried out during the life of the mine.

Residual Impacts

- Low regional negative impacts on woodland habitat due to abundance of this vegetation unit within the region.

(g) Improved access to rare habitats and local endemic species leading to removal of rare species (Index no. 4.3)

Cause and Comments:

Presence of employees and subcontractors on site could remove rare and endemic species from the site, especially horticulturally important species such as those belonging to the plant family Orchidaceae (Orchids).

Significance Statement:

Mining will result in a localised, slightly significant, long-term possible loss of rare and endemic species, leading to an impact of MODERATE significance.

Mitigation:

- Employees and subcontractors should not be permitted to remove vegetation or fauna from site, unless it is part of an approved sustainable development project supervised by ARL Environmental Department, and does not include rare or endemic species.

Residual Impacts:
Negligible to low indirect impacts on vegetation and fauna due to improved access to rare species after decommissioning, although, apart from the Orchidaceae, they are unlikely to have a commercial value unless medicinal properties are discovered.

9.1.3 Impact on aquatic systems and aquatic life

(a) Sedimentation & elevated turbidity of aquatic habitats (Index no. 2.2)

Cause and comment
There will be a number of different causes of this impact, including the following:

- Erosion of exposed topsoil by construction activities (removal of soil and woodland)
- Silt will originate from erosion of sediment from the WRD and TSF surfaces, especially before these features are rehabilitated; and
- Removal of soil and vegetation will change the nature of the watershed feeding the project watercourses.

The impact will differ during the project phases as follows:

- *Construction*: Vegetation cover may be destroyed without taking anti-erosion measures. Run-off from roads, construction of causeway crossings for vehicles and clearing of topsoil at mining sites may increase soil erosion and sediment in surface run-off, resulting in sedimentation and elevated turbidity in rivers.
- *Operation*: Earthmoving activities associated with mining operations may be undertaken without taking anti-erosion measures. Run-off from roads, particularly at river crossings for vehicles, sediment-laden run-off from mining sites, WRDs and spills from the TSF may result in sediment input into rivers and elevated turbidity levels in surface waters.
- *Decommissioning*: Inadequate rehabilitation of cleared and de-vegetated areas, including mining areas, WRD sites, the TSF, roads and infrastructure sites and poor maintenance of anti-soil erosion measures, may result in sediment input into rivers and elevated turbidity levels from rainfall runoff.

Significance Statement
During the construction, operational and decommissioning phases of the project this medium to long term, severe impact within the study area will probably be of high significance without mitigation. With appropriate mitigation this impact can probably be reduced to low or moderate significance.

Mitigation
It is essential to prevent sediment-laden run-off from all cleared areas, or areas associated with the mining activities (such as workshop areas, process plant,

WRD sites) from entering adjacent rivers. Details of mitigation measures for full containment of contaminated waters are given in the ESMP and by Lyell (2008).

(b) Reduction in river water quality (Index no. 3.1)

Cause and comment:

There may be several different activities that could act as a source for this impact. The possible sources include:

- chemical pollutants (non-ore related chemicals such as fuel, oils, soaps) that inadvertently enter the water courses or groundwater;
- uncontained runoff off the WRDs and TSF; and
- Influx of groundwater contaminated by pollutants or acid rock drainage.

The impacts will differ as follows during the various phases of the mining operation:

- *Construction*: Hazardous materials & chemical pollutants (e.g. hydrocarbons, cement, paints) associated with construction activities, as well as washing soap, faeces from employees using rivers and riparian zones for ablutions, could pollute the rivers.
- *Operation:* Chemical pollutants (such as hydrocarbons) associated with mining activities and machinery polluting the mining pits and groundwater and harmful substances from ablution activities of the employees in or near rivers (such as washing soap, faeces), and spills from the processing plant, could wash into and pollute the water.
- *Decommissioning*: Chemical pollutants from machinery (e.g. hydrocarbons) and employees (faeces, soap) associated with decommissioning and rehabilitation work, may wash into the rivers and impact on flora and fauna.

Significance Statement

The mining operations may cause a medium term risk of chemical pollution resulting in severe impacts of HIGH significance in the study area. The impact will be of high significance during the operational phase, but will be of low significance during construction and closure. With appropriate mitigation this impact should be reduced to LOW significance during operation.

Mitigation:

Infrastructure will be designed and constructed to minimise potential pollution. A comprehensive waste management plan will be implemented, awareness and waste management training made compulsory for all employees, and audits and monitoring carried out to ensure procedures are being adhered to and are working.

(c) Reduction in water quality due to metals from mining activities (Index no. 3.2)

Cause and Comment

- *Construction:* During preparation for commencement of mining operations, areas of metal-bearing material could be exposed to rainfall and run-off could wash into adjacent rivers.
- *Operation*: During operations, water contaminated with metals from containment ponds, TSF and WRD sites could wash into adjacent river system (and groundwater), unless adequate precautions are taken. An extreme event (flood, earthquake) could cause TSF or WRD slope failure resulting in mine effluent being washed into the nearest river.
- *Decommissioning*: Unless adequate precautions are taken, water contaminated with metals could seep into groundwater or wash out of containment dams, the TSF and WRD sites and into the adjacent river system.

Significance Statement:

It is anticipated that there is a medium to long term risk that metal pollution of surface waters will probably occur and that during the operational phase this severe impact will have HIGH significance within the study area. With appropriate mitigation, this impact should be reduced to moderate to low significance in the study area.

Mitigation:

Careful planning and management and full containment of contaminated run-off, as well as anti-pollution management practices during mining operations and decommissioning, as set out in the ESMP. All water contaminated by metals from the mining operation should be retained and pumped to the TSF or process water tank.

(d) Contamination of watercourses with sediment and liquor due to accidental failure of TSF walls (Index no. 3.5)

Cause and Comment

Failure of the TSF could occur due to over-topping of the wall due to poor drainage management or due to erosion of the perimeter earth-fill wall. The probability of this occurring is very remote. However, if it does occur, and if the tailings were to flow into the watercourses, the consequences for aquatic life in the watercourses would be similar in nature, but on a larger scale, than the existing heterogenite washings that have been deposited in the Kisankala River.

Significance statement

This impact would have the greatest probability in the case of layout option C, in which the TSF is located in the northwestern corner of the concession, close to Kisankala stream. If the TSF were to be sited according to that alternative, in close proximity to the stream, a TSF failure would result in the tailings running directly into the stream and filling up several hundred meters of the length of the watercourse. The impact would have a low probability in the case of all the other options, as the TSF would be located in the southern portion of the concession, far from any watercourses. Should there be any TSF failure in these positions (Options A, B and D), it is unlikely that any tailings would flow into a watercourse. The probability of this impact occurring is very low, as good TSF design would reduce the probability. However the potential impact on the watercourses would be severe and may lead to a total sterilisation of life in addition to the section of river that has already been impacted by the heterogenite washings. The impact would therefore have a moderate impact without mitigation.

Mitigation

To prevent failure of the TSF, ARL must operate the TSF according to the procedures outlined in the designer's Safe Operating Manual. As a minimum, the following measures must be implemented:

- Rainfall must not be allowed to accumulate on the upper surface of the TSF. Rainwater must be decanted or pumped out and used as process water in the plant.
- In the event of a 1:100 year storm, excess water will be retained in the TSF and subsequently discharged via the decant or the pontoon pump.
- The shift supervisor is to conduct TSF inspections twice per shift.
- The TSF wall, toe drain, filter drain outlets, freeboard, pumps and beach above decant pipe must be inspected weekly by a competent person and an inspection record must be kept on site; and
- In an emergency, procedures outlined in the Emergency Response Plan must be followed.

(e) Chemical pollution (Index no. 3.6)

Cause and comment

Mining can lead to chemical contamination of the mine site and surrounding areas directly by the exposure of geologically labile chemicals during opencast mining, or secondarily via spillage of introduced chemicals. In the latter, heavy vehicle traffic associated with mining may increase local pollution from exhaust fumes, oil spillage, and accumulations of rubber compounds from tyre wear. These pollutants can cause localised impacts. Other secondary affects can also occur from the application of herbicides used to control plant growth along road verges or around the mine compound. The accumulation of herbicides and their residues in adjacent wetlands can lead to developmental abnormalities in tadpoles and metamorphosing frogs. Storage of chemicals (explosives, fuel) on the mine site increases the risk of chemical spillage. The importation of fuels and associated industrial chemicals will increase the risk of chemical pollution. Moreover, increased road traffic and human settlement will both result in increased risk of chemical pollution in the region.

Significance statement

Project actions associated with mining will probably result in a long-term risk of chemical pollution, resulting in a *Severe*, *study area / District* impact of HIGH significance.

Mitigation

Prevention of chemical pollution requires careful storage and use of such material. Chemical stores (including fuel, insecticides) should be in locked stores. Access to such stores must be controlled at all time. Inventories of stored chemicals should be maintained, and their use regulated. All cautions/recommendations with respect to storage and use of hazardous chemicals should be implemented.

All chemical materials used during mine operations will be removed on closure. However, full containment of contaminated waters resulting from the mine operation will be essential mitigation; otherwise medium to high residual impacts to ground water may occur.

Residual Impacts

Mitigation will reduce this impact to MODERATE significance.

(f) Loss of aquatic species (fish) of special concern (Index no. 4.1)

Cause and Comment

- *Construction and Operation:* Dewatering and contamination of run-off from mining operations could cause rivers to stop flowing and/or serious water pollution. These impacts could exterminate the two undescribed (i.e. new to science) and sensitive fish species, the snoutfish *Hyppopotamyrus spp*. and earfish *Kneria spp*., found in the upper Kii River.
- *Decommissioning*: Chemical pollution and stream flow modification could potentially also occur after closure, extirpating the two sensitive fish SSC if adequate maintenance and rehabilitation do not occur.

Significance Statement

The broader significance of the local extinction of these two fish species is difficult to quantify, as little is known of their conservation status and the extent of their distribution. Expert opinion is that both species should be found in most of the more undisturbed headwaters streams in this region (Dr. Roger Bills, pers. comm. March 2008). A risk-averse approach would allocate a long-term severe impact within the study area with a moderate to a high significance. With mitigation this impact may be reduced to moderate significance.

Mitigation

To conserve these fish species their present habitat requirements in the upper Kii River would have to be maintained. This would include aspects such as natural flows in terms of volumes and flow patterns, as well as good water quality and riparian, marginal and instream vegetation and habitats. Restocking from adjacent rivers after mine closure and rehabilitation is also an option.

(g) Stream flow reduction and flow alteration due to dewatering of the mine pits and lowering the water table (Index no. 7.2)

Cause and Comment

The lowering of the groundwater within the entire concession area is expected to have the most significant impact on aquatic habitats and biota within the study area. As both the Kisankala and Kii rivers originate as artesian springs, with base flows dependent on groundwater, the proposed dewatering programme will cause these two rivers to stop flowing (Knight Piésold 2008).

The predicted cessation of flow of the Kii and Kisankala streams will have a devastating impact on both the instream and riparian habitats. It is very likely that all aquatic biota would be eliminated unless this impact is adequately mitigated. However, mitigation will be problematic, as altering natural flow patterns in a river can negatively impact on the aquatic biota, even if the total flow volume remains unaltered.

The impact would be as follows during the different phases of the project:

- *Construction:* Groundwater levels lowered by preliminary pumping via boreholes in preparation for mining operations and to prevent flooding, will cause river flows to be reduced or cease, impacting on instream biota and possibly even riparian biota.
- *Operation:* Groundwater levels lowered by pumping via boreholes to enable mining operations to proceed and prevent flooding of the mine pits will cause the upper Kii River and Kisankala River to stop flowing & probably dry up completely, eliminating all instream biota and possibly even riparian biota.
- *Decommissioning:* Lowered groundwater levels could take up to 45 years to return to pre-mining levels. Apart from during rainfall events in the wet season, rivers will remain dry and not start flowing naturally until these pre-mining groundwater levels are reached. Unless mine-water is continually fed into these streams at the required rates, the impacts on the aquatic biota will be significant.

Significance Statement

Apart from a small section of the upper Kii River, both the Kisankala and Kii rivers are already moderately to largely modified and are considered to be of limited conservation importance. In addition, fish species in these streams should be well represented in adjacent undisturbed systems. Dewatering will thus definitely have a severe, long-term impact on the rivers in the study area, and will be of high significance without mitigation. Mitigation will be difficult and it is likely that an impact of moderate significance within the study area will remain.

Mitigation

The proposed mitigation is to discharge the excess dewatered mine water (or a portion thereof) into the rivers within the study area so as to restore the natural flows in these systems. However, as discussed below, the potential effectiveness of this proposed mitigation is uncertain due to a lack of information.

Many aquatic organisms are adapted to the natural fluctuations in river flow that occur at different times of the year. Many riverine fish species, for example, are dependent on increased flows in summer to trigger mass spawning events and to initiate upstream breeding migrations to suitable spawning areas. The high flows thus synchronise spawning events and also ensure that suitable spawning substrates (e.g. clean, newly-flooded vegetation) are available to fish to deposit their eggs. It is thus important that the timing and volumes of the natural flow patterns are maintained in any artificially manipulated river system.

(h) Impact of changed flow regime on riparian plant communities (Gallery Forest and Dambo Wetlands) (Index no. 8.1)

Cause and Comments

The dewatering process is likely to impact on flow within the Kii and Kisankala streams within the concession and downstream, which is likely to have a long-term impact on riparian vegetation. Water removed from the mining pits will be released into the stream throughout the year, and this will alter the natural seasonal variation of the watercourses as well as the total volumes of water that would be released into the streams. The removal of artisanal mining activities from the streams probably would lead to an improvement in water quality over time, as the pollutants deposited by artisanal mining will be flushed out of the system. Water released into the water courses will be pumped from boreholes and not from the pits directly, and should therefore be free of sediments and pollutants, unless there is pollution that enters the water table.

Significance Statement

A permanent, moderately severe, localised impact of HIGH significance may result in changes to riparian vegetation as a result of mine dewatering.

Mitigation

- Implement several smaller release points for water into the Kii and Kisankala rivers rather than one single release point.
- Release water into the Kisankala River at suitable points downstream of the Kalukundi concession, where the geomorphology and ecology is more suited to high water volumes.

Residual Impacts

- Negligible impact after mitigation in the very long-term after decommissioning; and
- Moderate to High impacts due to changes in downstream water flow as a result of dewatering.

(i) Impact of increased stream flow on the aquatic system (Index no. 8.2)

Cause and Comment

The proposed dewatering rate to keep the open pits dry will be in the region of 334 l/s, provided no large fracture is intercepted at any of the pits, as this will result in higher inflow rates than estimated (Knight Piésold 2008). Some of this excess water will be used in the process plant, for domestic consumption on the mine or by communities close to the mine. However, there will be an excess of 200 l/s of water for use elsewhere and/or to be discharged into rivers.

Getting rid of all the mine water without negative ecological impacts will be problematic, as the natural flows in the upper Kii and Kisankala rivers were estimated by Knight Piésold (2008) to be very much lower, at approximately 6 l/s and 5 l/s respectively, in January 2007 (wet season). Flows in the lower Kisankala River were estimated to be approximately 10 l/s in January 2008.

The channel morphology could also be negatively impacted. The effects would probably be a combination of the following:

- serious erosion,
- bank collapse;
- channel incision; and
- widening of the river channel.

The impacts during the different phases of the mining project would be as follows:

- *Construction*: Pumping of boreholes to dewater the pits and the subsequent discharge of large volumes of dewatering water to rivers (Kisankala and Kii) would impact on instream biota and the geomorphology of river channel.
- *Operation*: Large volumes of dewatering water discharged into the low flow Kii and Kisankala rivers with unnatural flow patterns could cause serious disruption of ecological functioning of systems, as well as bio-physical damage to river channel and riparian zones.
- *Decommissioning*: The groundwater levels (and hence base flows in affected rivers) could take up to 45 years to return to pre-mining levels. The Kii and Kisankala rivers would therefore remain dry for this length of time after decommissioning, unless the water flow is artificially maintained.

Significance Statement

If all the dewatering water is discharged at a rate of over 200 l/s into the Kisankala (and/or upper Kii) River within the study area, this will definitely have a severe, long-term impact on the study area and will be of high significance. However, the rivers are already heavily impacted by existing mining operations, and the good quality water that ARL intends to release to the river may produce a positive impact. With mitigation (e.g. discharging via a pipeline into the lower Kii River) it is possible that this impact could be reduced to moderate significance.

Mitigation

The Kii and Kisankala rivers are already severely impacted by artisanal miners' washing activities and other mining companies' tailings management practices so the significance of the project-related impacts on these streams will be low.

A detailed hydrogeological study must be undertaken to determine the optimum dewatering strategies. It is anticipated that a portion of the surplus water will have to be piped into the lower Kii River, downstream of the Kalukundi Mining area, where the larger river channel could possibly accommodate higher volumes without negative impacts. Preliminary data indicated that flows of well over 300 l/s are common in the lower Kii River downstream of the study area under natural conditions.

It would be impractical to pump water into the river for the 45 years that it will take for the ground water level to recover, therefore studies of unaffected rivers in the area need to be undertaken to investigate the possibility of restocking of fish from these rivers when the stream flow has returned to natural levels.

9.1.4 Impacts on air quality

(a) Air pollution due to dust blow from exposed tailings surfaces (Index no. 2.4f)

Cause and comment

Although the intention is to progressively establish vegetation on the external walls of the TSF during the operational phase of the mine, the exposed tailings on the upper surface could become airborne in windy conditions. The dust could then be deposited on the nearby residential areas, especially during the dry season.

Significance statement

This impact would have a low intensity of long-term duration as it could occur throughout the operational phase and the decommissioning and closure phases, if re-vegetation is not successful. This impact would have a MODERATE significance.

Mitigation

- The tailings management plan should include cycling of the tailings deposition around the facility to maintain an level of moisture in all surfaces to reduce dust generation; and
- Re-vegetation of the external walls must take place progressively during operation of the mine to ensure that vegetation becomes established as soon as possible.

9.1.5 Impacts on terrestrial fauna

(a) Loss of faunal diversity (increased mortality rates in fauna due to increased hunting activity) (Index no. 4.5a)

Cause and comment

The protection of the faunal and floral heritage in the region is generally poor, and the exploitation of rock outcrops and forest streams by artisanal miners has resulted in environmental degradation. Hunting of all animals in many areas continues, although hunting is now largely opportunistic due to resource loss. This hunting pressure compounds the impact of habitat loss where many habitat fragments are already too small to maintain viable long-term populations of even medium-sized mammals. In addition wild animals, e.g. monkeys, raptors, and small carnivores, such as mongoose and genet are often viewed as pests on livestock and crop fields and therefore killed. Predation by domestic animals generates an additional impact on small vertebrates in the region.

The perilous state of protected areas in the DRC was highlighted by the DRC Parks Relief Mission survey of the National Parks of Katanga Province (Upemba NP and Kundelungu NP). Wildlife in both parks had been decimated, and a survey of over 230 km of tracks in Kundelungu National Park (10°34'S, 027°51'E) confirmed so few wildlife sightings they could be summarised in a single paragraph.

Due to habitat loss and mortalities directly associated with specific project actions, a loss of faunal diversity will probably occur. Faunal mortalities will occur during all phases (construction, operational, and de-commissioning/closure) but will be most significant in association with habitat loss during the construction phase.

Cumulative impacts

Loss of faunal diversity from project actions will compound the existing faunal impoverishment due to existing land use and settlement.

Significance statement

Project actions associated with mining will result in a substantial loss of habitat, fragmentation of habitats, and high levels of disturbance and possible pollution that will probably result in a medium term loss of faunal diversity. Resulting in a *moderately severe*, *Study Area/District* impact of MODERATE significance.

Mitigation

Habitat linkages with surrounding faunal reservoirs must be maintained to allow future re-colonisation of rehabilitated habitats after mine closure. Exploitation of faunal resources by local communities on the mine site must be monitored to ensure sustainability, and protection of threatened species. Residual impacts are probable unless mitigated and requires a change in existing unsustainable resource use if faunal rehabilitation on mine closure is to be successful.

Mitigation only within the mine concession area is unlikely to be successful. Offset protection of threatened habitats/species elsewhere may reduce this impact to LOW significance.

(b) Loss of species of special concern (Index no. 4.2)

Cause and comment

The general loss of faunal diversity is particularly important for threatened species and those of special (e.g. endemic, cultural or trade) significance. Although national inventories of threatened species are either not available, or not up-to-date for all faunal groups, the assessment of potentially threatened species is here based on international lists, or those identified as being of concern in adjacent regions. The expected loss of faunal diversity may involve SSC, that may include threatened species, species endemic to the region, those of cultural or commercial significance, or those that are particularly important for ecosystem functioning.

Although numerous SSC occur in the greater mine site area, no threatened species were observed on the mine site during the faunal survey. Several non-threatened, CITES-listed species (Flap-necked chameleon, Spek's hinged tortoise, Meyer's Parrot) were observed. Suitable habitat for SSC occurs on the mine site, particularly for threatened and endemic small mammals associated with forest streams. Project actions may lead to the loss of some of these species due to disturbance, increased mortality and/or further loss or degradation of habitat. Loss of SSC will occur during all phases (construction, operational, and de-commissioning/closure) but will be most significant in association with habitat loss during the construction phase.

Cumulative impacts

Most threatened large mammals and birds have been impacted nationally by unsustainable exploitation and previous land use patterns. Further loss of such species due to project actions would exacerbate this loss.

Significance statement

Project actions associated with mining will probably result in a medium term loss of SSC. Resulting in a *slight*, *Study Area/District* impact of MODERATE significance

Mitigation

The presence of SSC should be monitored during the construction and operational phase of the mine. The discovery of any threatened species should be brought to the attention of conservation authorities, and this may require protection of the area until a recovery plan is implemented. Disturbance to habitats that may contain threatened species, e.g. forest streams, should be minimised. Re-colonization of the mine area on closure with lost SSC will be difficult if adjacent 'refugia' for such species are absent due to future adjacent land use practises. Residual impacts are likely.

Mitigation only within the mine concession area is unlikely to be successful. Offset protection of threatened habitats/species elsewhere may reduce this impact to LOW significance.

(c) Reduction in connectivity of habitats affecting movements of wildlife species that may be pollinators or dispersal agents of flora within copper deposits (Index no. 5.1)

Cause and Comments

- Mining of the Copper-Cobalt outcrops may impact upon the migration of important pollinators and dispersal agents of the endemic metalliferous flora;
- Concession may impact upon regional migration of faunal species that are dispersal agents and/or pollinators of Copper-Cobalt flora;
- Noise (including blasting, machinery and anthropogenic) may have localised impacts on movement of fauna that are important dispersal agents or pollinators of flora.
- Although the concession has a limited footprint within Katanga it is possible that the permanent removal of outcrops may have a significant impact on connectivity at a regional level for Miombo Woodland.

Significance Statement

A probable, low significance, long-term impact to connectivity of habitat may occur as a result of mining activities within Copper-Cobalt outcrops, impacts to connectivity between copper outcrops at a regional level is unknown.

Mitigation

No information is available to make an assessment of the impact to the biology of the endemic flora (and associated fauna) due to the large-scale removal of some outcrops that could form a link along the Katangan Copper Belt with adjacent outcrops. Rehabilitation / re-vegetation to connect fragmented habitats during decommission phase may mitigate any impacts in the long-term.

Residual Impacts

There will be a moderate impact on the fragmentation of habitats. For overall landscape biodiversity, there will be a low impact on Miombo woodland and gallery forest, but a high impact on copper-cobalt habitats.

(d) Introduction of exotic species (terrestrial and aquatic) (Index no. 6i)

Cause and Comments

Exotic species may be introduced from outside the mining area by trucks. These species could become established as weeds within the concession, particularly *Tithonia diversifolia*, will become common along roadsides in the area. In addition, the influx of people in the area could cause the increased deliberate importation of exotic ornamental garden plants.

Significance Statement

A long-term, moderately severe impact may occur within the study area resulting in the introduction of exotic species.

Mitigation

- Use of local indigenous species for reclamation must be adhered to;
- The weed *Tithonia diversifolia* noted along river courses on the Likasi road to the east should be monitored and controlled on site in riparian areas and road verges;
- As part of the social development plan, it is recommended that an educational component be implemented to address the issue of exotic species and their implications to the environment and people.
- During the operational phase, ongoing weed eradication programs must be implemented under the supervision of ARL's site Environment Department.
- During decommissioning the concession area must be cleared of exotic species that could be problematic.

Residual Impacts

Increase in some weedy species may occur after mitigation.

(e) Light pollution affecting local faunal activities (Index no. 10.3c)

Cause and comment

Mining operations and associated vehicle traffic will create noise and light pollution that can depress local populations of sensitive faunal groups. Animals differ in the degree to which they tolerate such disturbance, and can be expected to have potentially negative and positive impacts on various faunal groups. Large breeding birds do not usually tolerate continuous disturbance. Increased noise and motor vibrations in wetlands may also impact amphibian breeding choruses, but these impacts will be localised and many amphibian species are surprisingly tolerant of vehicle noise. They are less tolerant, however, of increased light levels and ponds adjacent to and illuminated by elevated lighting may have reduced amphibian populations.

Construction and operation of the mine facility will result in increased levels of both noise and light pollution that can depress local populations of sensitive faunal groups. Noise and light pollution will occur during all phases (construction, operational, and de-commissioning/closure). Noise will be most significant during the construction phase, whilst light pollution will be most significant during the operational phase when traffic movement and people numbers are highest. Both will continue, although with less significance, during the de-commissioning/closure phase.

Cumulative impacts

Due to its rural nature relatively little noise and light pollution currently occurs in the mine region.

Significance statement

Project actions associated with mining will definitely result in a long-term increase in noise and light pollution. Resulting in a *moderately severe*, *Study Area/District* impact of MODERATE significance.

Mitigation

Mine site security lights should be shielded and restricted to essential areas. Road traffic and mine operations should be restricted, where possible to daylight hours. Use of generators should be restricted and housed in facilities to dampen undue noise. With proper mitigation on mine closure there will be no direct residual impact. However, it is likely that the mine will stimulate associated housing developments in the region, which will continue after mine closure and cause an indirect residual impact. Mitigation will reduce this impact to LOW significance.

(f) Increased fire frequency (9)

Cause and comment

It is possible that the frequency of fires will increase due to the influx of people into the area around the Kalukundi concession, even though a number of steps will be taken within the concession to reduce fire frequency. These steps include:

- Moving the residents of Kisankala village to a new village on the southern boundary of the concession;
- Firebreaks in the concession;
- Prohibition on the setting of fires within the concession to promote palatable grazing; and
- Strict control over fires close to infrastructure to protect the infrastructure.

It is therefore likely that fires outside the concession will increase, leading to direct impacts (via increased mortality and disturbance) and indirect impacts (via possible vegetation changes associated with fire tolerance) to fauna.

Changes in water flow dynamics following mine activities will reduce the water table locally, drying vegetation to unnatural levels and making it more susceptible to fire. Construction and planning of associated roads should anticipate an increased fire risk. An increased fire risk may occur during all phases (construction, operational, and de-commissioning/closure) but will be most significant during the operational phase when environmental impacts are at their highest, and when traffic movement and people numbers peaks.

There are a number of secondary impacts that would occur as a result of an increased fire frequency, including the following:

- Reduction in the number of decomposers present in/on the soil surface;
- Reduction in the amount of organic matter (leaf litter) on the soil surface; and
- Accelerated sheet erosion associated with an increase in the frequency of fire-induced loss of vegetation cover.

Significance statement:

Project actions associated with mining will, directly and indirectly, probably result in a long term increased fire risk. Resulting in a *slight*, *Study Area/District* impact of MODERATE significance.

Mitigation

Storage of highly flammable material (e.g. fuel) on site should be in adequately protected, secure sites, with facilities for fire fighting available. Vegetation surrounding the mine complex should be controlled, with firebreaks and controlled back burns, to reduce the risk of fire spread. All litter and refuse should be regularly removed from the mine site. With proper mitigation and the removal of flammable material on mine closure there will be no residual impact. Mitigation may reduce this impact to LOW significance.

9.1.6 Social impacts

(a) Public safety impact due to TSF failure (Index no. 12a)

Cause and comment

Failure of the TSF could occur due to over-topping of the wall due to poor tailings management or due to erosion of the perimeter earth-fill wall. The probability of this occurring is very remote. However, if it does occur, the consequences could be disastrous if people are located in the path of the TSF failure.

Significance statement

Although the consequences of loss of life due to TSF failure would be disastrous, none of the alternative TSF locations in options A, B or C or D are upstream of the mine staff village or the proposed location of the Kisankala village. In options B and C, which are the seriously considered options, the TSF is situated northeast and northwest of the proposed Kisankala village. Drainage on the site is in a north-westerly direction; therefore tailings will not affect the village if there is a TSF failure. The probability of loss of life is low. However, the potential loss of life means that this impact would continue to have a very high severity and a HIGH significance.

Mitigation

As part of the detail design work to follow by Knight Piésold, a dam break analysis will be conducted to determine the zone of influence of the resultant spill. This is a standard requirement in terms of the South African National Standard (SANS) 10286: 1998 (Mine Residue). In the event of any dwellings or any critical mining or plant infrastructure falling within the zone of influence, consideration should be given to constructing diversion walls with mine waste material. An internationally recognised tailings expert must subject the detail design to a rigorous peer review.

To prevent failure of the TSF, ARL must operate the TSF according to the procedures outlined in the designer's Safe Operating Manual. As a minimum, the following measures must be implemented:

- Rainfall must not be allowed to accumulate on the upper surface of the TSF. Rainwater must be decanted or pumped out and used as process water in the plant.
- In the event of a 1:1000 year storm, excess water will be retained in the TSF and subsequently discharged via the decant or the pontoon pump.
- The shift supervisor must inspect the TSF twice per shift.
- The TSF wall, toe drain, filter drain outlets, freeboard, pumps and beach above decant pipe must be inspected weekly by a competent person and an inspection record must be kept on site;
- In an emergency, procedures outlined in the Emergency Response Plan will be followed; and
- ARL must inform the public concerning the dangers of entering into areas of mining operations through public consultation, liaison with local

community leaders and erection of warning signs. Mine security must remove intruders from the mine site.

(b) Waste rock dumps may become unstable with time and become dangerous to the public when accessed (Index no. 17a)

Cause and comment

As settlement of material occurs in the WRDs, their slopes may become unstable over time and they may become dangerous to the public.

Significance statement:

The impact has a moderate intensity and could occur within the concession (on the WRDs) only. The duration of the impact would be long-term, since the instability would occur after decommissioning. The likelihood of occurrence is probable, and therefore the significance of the impact to the human population would be MODERATE.

Mitigation

To maintain the stability of the WRDs and prevent erosion, ARL must apply the following procedures:

- A strategy of dumping weathered waste rock in central dump areas and using more competent waste rock for construction of the outer walls. The more competent waste must also be used to dress dump slopes.
- The WRD has been designed according to best industry practice with an overall slope angle of 18°.
- The dump construction must be regularly checked to ensure that it is as per design.
- Perimeter drains must be constructed to control/manage surface run-off.
- ARL must progressively rehabilitate the sidewalls of the dumps over the life of the mine with appropriate indigenous vegetation to prevent erosion and rehabilitate the upper surface of the dump at closure.

(c) Danger to the public from inadvertent access to operational areas (Index no. 17b)

Cause and comment

Although security will be maintained throughout the life of the mine, it is possible that members of the public could gain inadvertent access to potentially hazardous activities like the movement of large vehicles, explosive events at the mine pits and crushing operations, amongst others. Lack of familiarity with these operations is likely to cause the public not to exercise the same controls to prevent injury as the mine staff.

Significance statement

The impact has a moderate intensity and could occur anywhere within the concession where there are hazardous activities, especially along roads and in the mine pits. The duration of the impact would be medium term (over the entire operational life of the mine). The likelihood of occurrence is probable, and since the consequence of the impact to public could be serious injury, the significance of the impact to the human population would be MODERATE without mitigation.

Mitigation

- Twenty-four hour security must be maintained around the perimeter of the operational areas throughout the operation of the mine to ensure that access to the public is restricted.
- An educational programme must be maintained in the community and schools to inform the public of the dangers of mining operations.
- Community representatives must be taken on a tour of mining operations to familiarise them with the operations and point out the dangers to them.

(d) Danger to the public of drowning due to walking on the TSF (Index no. 17c)

Cause and comment

As tailings are deposited on the top of the TSF, a pond will form as the solids settle out from the tailings. This could pose a danger to members of the public during the operational phase. Once the surface of the TSF dries out during the decommissioning phase, the risk to the public will diminish to an insignificant level.

Significance statement

The impact is restricted to a very small area, namely the top of the TSF, and is therefore of limited extent. The impact would be restricted to the operational phase of mining. There is a low likelihood of drowning occurring, due to the security presence that will keep the public out of operational areas, and the steep slopes of the TSF, which will discourage access. Nevertheless, because loss of life is possible, the impact has a MODERATE significance without mitigation.

Mitigation

The same mitigation measures as the previous impact must be applied.

(e) Feelings of displacement for Kisankala village residents (Index no. 19.1)

Cause and comment

As indicated in the RAP of the project, a total of 2,361 people as at February 2006 making up the village of Kisankala will be displaced from the area to pave way for mining activities. Even though this population will be resettled and compensated, the impact of starting life in another place will be felt. This population will feel psychological impacts as they will feel they have lost the memories of a place they have been calling home.

Another group of displaced people will be the artisanal miners who have been mining outside the concession area since the arrival of ARL. According to RAP resettlement criteria, approximately 366 will not be resettled as they are not considered permanent residents, household owners or had not confirmed by the cut off date. This group will be compensated for the value of their temporary accommodation and assisted to move. In most cases, artisanal miners who moved to Kisankala village due to the presence of fragments nearby are not interested in being resettled in the new village.

Significance statement

The feelings of displacement will be felt particularly during the construction phase, when the village will be moved. This impact is definite, but even though the impact will be felt over the short term, it s significance will be HIGH, due to the emotional attachment that people (especially the permanent residents of Kisankala village) feel for their homes.

Mitigation

The displaced population who qualify for permanent accommodation will be resettled in the new proposed village to be constructed by ARL. The Kisankala Village Development Committee includes members of ARL staff to ensure peoples concerns and requirements for the village move are heard, and a grievance procedure has been put in place so ensure a smooth transition. Community Liaison Officers will be appointed. People who do not qualify such as temporary residents or those who settled after the cut off date will be compensated and assisted to move to another location.

(f) Loss of assets and misuse of financial compensation (Index no. 19.2)

Cause and comment

The resettlement compensation program could create a group of vulnerable people if they are given cash as a form of compensation. Handing of cash to some community members could have a negative impact on livelihoods as there is a possibility of misuse and indulgence in alcohol abuse with the compensation money. This activity could have adverse effects on women and children as they have no ownership over family property according to the customs of the area. Compensation could therefore result in increased hardship for these people.

This impact will be felt more on the population that is considered non-permanent based on the RAP eligibility criteria, which only caters for compensation for those who are considered to be permanent residents.

Significance statement

This impact will be felt during the construction and operational phases. This impact will occur over the long term on a project-wide scale. It is an impact of probable certainty and moderate severity. The overall significance of the impact will be MODERATE.

Mitigation
The resettlement and compensation should involve building the new Kisankala village and assistance with moving. Cash payments should be avoided as a form of compensation. This will discourage misuse of compensation cash and avoid a situation where the resettled population lives in poverty without housing and money to buy essentials. If cash compensation is unavoidable, before it is handed out, the recipients should be counselled on wise use of the cash to avoid misuse that could bring destitution to their families.

(g) Population influx (Index no. 19.3)

Cause and comment:
Owing to the high unemployment levels in DRC, any significant development that could result in employment will tend to attract large numbers of job seekers. This influx is expected to start during construction phase. It has also been difficult to estimate the number of people who will be attracted by the project given that Kisankala is an already vibrant mining village. The project will attract job seekers and other people who will come to the area to provide support services including traders, hoteliers, and sex workers. The population influx will be cumulative due to other mining operations starting up in the area.

The impact of the population influx to the area could have both beneficial and adverse aspects depending on how the population is managed. The impacts could be cultural, socio-economic, political as well as environmental.

Population influx to the area will increase the demand for services including health, food, shelter, water, transport and recreational facilities. The potential negative impacts that may result from a population influx of job seekers, should this occur on a large scale, include health and pollution hazards of squatting communities, prostitution, spread of HIV/AIDS and sexually transmitted diseases (STDs), disruption of existing communities, increased alcohol abuse, assault, theft and violence, noise and increased traffic. Influx of people in the area might introduce infectious diseases to previously unexposed (immunologically naïve) populations.

However changes in population might have some positive effects on the socio-economic environment. The increase in population will create a market for agricultural and commercial goods and services thus promoting the development of the local area.

Significance statement
Judging by the experience of other projects in the region, the likelihood that this impact will occur is definite. This impact will be felt over the long-term on a district-wide level, and its overall significance is therefore MODERATE.

Mitigation
To minimise population influx in the area, ARL employment policy should give preference to the local population. Only after exhausting the human resources available should the company resort to hiring people from outside the immediate area. This measure will easily be achieved by adopting the census results as a guide in establishing the local population. This policy will also prevent conflict between the local people and outsiders who may feel that people from outside are grabbing their opportunities.

The employment policy should give preference to the people of the local village and the most vulnerable from the project impacts, then move to the district level, then to the regional level and eventually to the national level. In positions that require specialised training, ARL should design a phased training program that will enable Congolese employees to obtain the necessary skills to move into these positions.

(h) Price inflation (Index no. 19.4)

Cause and comment
Increase in purchasing power of the community through higher incomes from the mines compounded by population increase and low productivity will lead to inflation in the cost of goods and services much to the detriment of the local population especially the poor and vulnerable, who will be able to purchase less essentials. Though increase in employment and wages is good for the local economy, if the income is not distributed across the population, the plight of the poor will worsen. This impact magnified because the area does not produce enough food and it depends on imported goods. Inflationary pressures in nearby areas such as Kolwezi provide an indication of the changes that may occur around Kalukundi. Inflation in the cost of goods and services is being experienced in Kolwezi due to an increase in the expatriate population. For example in 2004, one month’s rent for a 3 bedroom house was US$ 25, while at the time of this survey, a similar house was going for USD$ 500 - a 20-fold increase. This trend is set to continue as more concession areas are opened up and the population of expatriates and other high end employees of the mining industry companies settle in Kolwezi and other areas. This is a cumulative impact that is brought about by the mining industry and other industry development.

Significance statement
It is virtually certain that this impacts will occur, judging by experience with similar projects in Kolwezi, which have resulted in an increased demand for housing, food and services. This impact will be long-term, as it will remain as long as the mine is in existence. It will impact not only on the immediate surroundings of the mine, but its influence will be felt on a district level. The overall significance is therefore MODERATE.

Mitigation
This impact can be mitigated by the project inducing development and production of goods and services to cater for the increased demand. Some of the opportunities that could be explored include poultry farming, pork farming, vegetable farming, carpentry, brick making, transport, bakeries, recreation and entertainment business, food vending, fish mongering, and tailoring. The Kalukundi Project should support training and skills development, business and infrastructure development, agricultural development, and social and community development.

(i) Health impacts (Index no. 19.8)

Cause and comment:
The project has a potential for triggering negative health impacts through domestic water contamination, dust, creation of breeding grounds for disease vectors, population influx that might introduce new diseases in the area and inadequate sanitation facilities.

The mining process will consist of excavation, transportation and extraction of copper and cobalt from the host material. Blasting and/or grinding of hard rock will also occur. As a consequence, the production process may result in the dispersion of particulate matter into the air. Particulate matter dispersed into the air will be fugitive windblown dust from the excavation and blasting and transportation of ore on trucks. Development of respiratory disease due to inhalation of respirable dust has been shown to be in direct proportion to the total load of dust inhaled over a time period.

The creation of ponds, drains and water tanks may favour the multiplication of waterborne disease vectors such as flies, mosquitoes and other parasites and the introduction of new ones. Increased occurrences of diseases that may be induced by the presence of the water ponds include malaria, cholera as well as other diseases such as yellow fever, and dengue. The surface water in the area is acidic and the possibility of Schistosomiasis (or bilharzia) is consequently unlikely.

Significance statement
There are currently no significant artificial sources of dust in the region of the Kalukundi concession. There are two small commercial mines in close proximity, which are potential dust generation sources. Without proper mitigation measures, the Kalukundi mine has potential to be a major source of dust in the area. This impact may occur during all phases (construction, operation and decommissioning). The overall significance of the impact is MODERATE.

Mitigation
A dust management plan must be implemented incorporating rehabilitation of exposed surfaces, use of water trucks and sprays to keep exposed surfaces damp, tailings management to minimise drying of the tailings surface, and a dust monitoring program to identify problem areas.
An awareness program on health hazards should be implemented to safeguard employees as well as the community members' health.

(j) Dependency on Kalukundi mine causing impacts after closure (Index no. 19.10)

Cause and comment:
This impact has been felt in many areas of DRC after the collapse on Gécamines, which rendered many people destitute after the closure of the mining company. This was due to over dependency on Gécamines for jobs, facilities and infrastructure. At the closure of the Kalukundi project, the people employed and supported by the project might be rendered helpless if strategies are not put in place to provide them with an alternative source of livelihood.

At project closure, a large proportion of the directly and indirectly employed people will be unemployed. The facilities and services that will have been provided or supported by the Kalukundi Project corporate social responsibility programme may also cease operation if they have not become independently sustainable. Sectors or areas that may suffer most include education, water and sanitation, road transport and trade, and other social welfare services that will be provided directly or indirectly by ARL. This impact will start to be felt during the decommissioning phase of the project as people are laid off.

Significance statement
The likelihood that this impact will occur is definite, based on the current lack of services provided by government or other service providers in the study area and based on historical experience with Gécamines. This dependency will occur on a regional scale around the mine. Its overall significance will be HIGH.

Mitigation
To mitigate this impact, a sustainability program and closure plan should be implemented. The aim is to build the capacity of the local population to carry on after mining has ceased (initial mining plan is for 11 years, but it will more than likely be 20 or more). The decommissioning phase of the project should have a re-skilling plan for the employees of the company to enable them to continue to develop after the project comes to an end.

Additionally a retrenchment package should be incorporated into the employment policy to cushion the employees after the end of mine life. The retrenchment package should include basic livelihood skills development and entrepreneurship skills as well as agricultural production.

(k) Change of livelihood (Index no. 19.12)

Cause and comment

The attraction of the labour force to the mining industry will lead to a change in livelihood means amongst the community members from mostly agriculture to working in the mining industry. The mining sector is viewed as an attractive venture for the community members thus absorbing many of the young able-bodied persons in the community. This will impact negatively on the agricultural sector due to abandonment of farming for more lucrative mining jobs that will be created by the project. It should be noted that agriculture contributes more than 50% of the GDP of the DRC. The effect of this impact is felt in food security, which leads to a consumer society that cannot produce food for itself, but relies on imported foods. Other sectors that will be affected are the education, health and commercial sectors. This is a cumulative impact that is already being felt as a result of artisanal mining in the project area. The result will be a drop in locally grown agricultural produce.

Significance statement

This impact will be experienced during construction and operation. The likelihood of occurrence is definite, and even though it will only be felt over the short-term, this impact can be predicted with a high degree of certainty. It is therefore of MODERATE significance.

Mitigation

To avoid a change of livelihood brought about by the Kalukundi Project, alternative means of livelihoods should be promoted and developed in the area. This is a free market that can only be mitigated by the development of other sectors. Measures to mitigate the move towards mining will have to come from government and other players, including development partners. Through ARL's corporate social responsibility program, it can promote other sectors of the economy through training, establishing micro credit schemes and through serving as a market for the products and services. Taxes and revenue provided to the government by the Kalukundi Project and other mining ventures will enable the government to develop its own training schemes and provide attractive salary packages to its staff.

(l) Increased social delinquency (Index no. 19.13)

Cause and comment

Increased wages, population increase and outside cultural influence will increase social delinquency such as increase in crime, prostitution (which will lead to an increase in STDs more so HIV/AIDS), and alcohol abuse. This will not be solely due to the Kalukundi Project, but will be as a result of the changes that any 'traditional' society undergoes in case of rapid development. This will be a cumulative impact as the artisanal population is already engaged in alcohol and substance abuse and prostitution as evidenced in the Kisankala. The nearby village of Kawama is also experiencing insecurity due to an influx of artisanal miners.

Significance statement

This impact has been observed in similar instances where there are concentrations of artisanal miners. The likelihood of occurrence is probable and the impact will be experienced over the long-term and at a district scale. The overall significance is therefore MODERATE.

Mitigation

There is need for government authority to establish its presence in the area. At the moment there is a lack of any administrative structures apart from the traditional chief and the police who seem to have been overwhelmed by the increased population, especially the artisanal miners.

To prevent idleness among the young people in the area, which in most cases is the cause of social delinquency, they should be provided with facilities and activities that promote social interaction and positive community behaviour. Some of these social activities include sports competitions with the nearby villages, inter-company sports, music and theatre.

(m) Uncontrolled development of new settlements (Index no. 19.14)

Cause and comment

Lack of housing may be a problem which could lead to uncontrolled and poor settlements. ARL will provide accommodation units to house 272 people in its onsite and offsite villages. It is estimated that 120 people will already be housed, or will find their own accommodation in the surrounding villages. The earthmoving contractor will be required to provide housing for their own staff which amounts to 337 people. The operation phase will require an estimated 734 direct employees. This leaves an excess of 5 people which means there is adequate housing for the direct permanent staff. However, the influx of secondary businesses, staff and job seekers may mean there will be a sprouting of unplanned settlements within the project area to provide accommodation to this population.

These uncontrolled settlements are common in the area as seen in Kawama centre, which has expanded in the last two months to a large village without sufficient sanitary and other social infrastructure and facilities. This development will create health and sanitation problems, as well as social delinquencies within the settlement due to poor planning.

<u>Significance statement</u>
The uncontrolled development of new settlements close to mining activities has been observed in other localities in the region, and the likelihood of occurrence is therefore considered to be “definite”. This impact will continue to occur over the long-term on a district scale. The significance is assessed to be HIGH, due to the secondary effects that uncontrolled settlements with no infrastructure planning could have.

<u>Mitigation</u>
ARL should promote the planning of settlements in collaboration with the local authorities. ARL could provide water through drilling of boreholes in those settlements and improve sanitation by providing toilet facilities and improving drainage. Education on health issues should be continued and the existing health programmes undertaken by ARL should be expanded to these settlements, if possible.

(n) Economic displacement (loss of livelihood and income) of those that had businesses in Kisankala village (Index no. 19.17)

<u>Cause and comment</u>
The displacement of the Kisankala village will result in economic displacement of the section of the business community that is considered temporary. The most affected persons will be those without legally recognizable claims to land, including the itinerant business community associated with the artisanal miners. This population of economically displaced persons is estimated at 83. However due to the delay in project implementation there have been opportunistic settlers who have settled in the area after the cut-off date. These recent settlers are not considered here.

<u>Significance statement</u>
The likelihood is rated as definite, since it is certain that the Kisankala village will be moved. The impact will be felt over the short term as business owners move their premises to the new village. The scale of the impact is considered to include the study area. The fact that the impact will influence people’s livelihood contributes to this impact being rated of HIGH significance.

<u>Mitigation</u>

According to IFC Performance Standard 5, this impact should be mitigated by compensating economically displaced persons for loss of assets or access to assets at full replacement cost. ARL should provide targeted assistance (e.g. credit facilities, seeding money for businesses and farms and farm inputs, training, or job opportunities) and opportunities to improve or at least restore the income-earning capacity, production levels, and standards of living of economically displaced persons whose livelihoods or income levels are adversely affected. For artisanal miners who will be economically displaced, they should preferably be absorbed by ARL. If this is not possible and if they require, they should be assisted to move to designated artisanal mining areas. ARL will resettle some of the businesses in the new village to continue with their business. However, only businesses with existing structures at the cut off date will be given new structures. In order to maintain the village plan, the Kisankala chief has stated that for new persons to construct housing in the new village, the structures must be permanent housing of satisfactory quality, and only then will they be allowed to reside there.

9.1.7 Cumulative impacts

The most important cumulative impacts associated with the proposed mining project are those related to the effects of the proliferation of mining operations in the region where the mine will be located. These impacts are problematic impacts to assess, since this ESIA is a site-specific report that assesses as specific set of activities associated with a single mining operation. Data on the other mines in the area have not been collected.

There are, however, certain impacts that can be identified in mining activities on adjacent concessions, based on the expected similarity of other mining operations. Generically, the social and biophysical impacts that can be expected on the Kalukundi concession can also be expected on adjacent mining concessions to a lesser or greater degree, depending on the nature of the mining operations. Mining operations that are artisanal in nature can be expected to have a significant social impact, similar to the social impacts that are already being experienced in the Kalukundi village. Biophysical impacts of other mining operations will be similar to the Kalukundi concession if the mining operations are formal and mechanised in nature. However, if the mining operations are artisanal in nature, their impacts would be different. Although mechanised mining would results in almost complete destruction of the ore outcrops (in contrast to artisanal mining, which does not destroy entire outcrops), there are certain impacts which are worse under artisanal mining. A prominent example is the sterilisation of the Kisankala River through the dumping of ore in the river by artisanal miners. This is a practice that would not be followed by ARL.

However, irrespective of their nature, the impacts of mining are likely to be experienced across the region where mine concessions have been granted. Although it is not the role of this ESIA to recommend management for other mining operations, and the other operations must be subject to their own EIA processes, the impacts of mining in the region must be seen holistically and appropriate management measures must be implemented to limit the cumulative negative impacts of this and adjacent mining concessions. It will therefore be important for the mining operations to communicate and develop co-operative strategies to mitigate their cumulative impacts.

Both social and biophysical impacts can be expected to be cumulative in nature. The most important cumulative impacts are:

- Positive social impacts through improved economic conditions in the region. The creation of a number of mining operations will result in the creation of a large, albeit dispersed market for goods and services, which will significantly stimulate the local economy and act as a catalyst for the government to improve service delivery in the region.
- Negative social impacts, for instance:
  - a population influx (due to other mining operations)
  - Price inflation
  - Change in livelihood from agriculture to mining
  - Increased social delinquency
- Ecosystem function in terms of terrestrial faunal species is already heavily degraded. Thus the project will compound the existing faunal impoverishment due to existing land use and settlement. Most threatened large mammals and birds have been impacted nationally by unsustainable exploitation and previous land use patterns. Further loss of such species due to project actions would exacerbate this loss.
- impacts on water quality and quantity in the Kisankala/Kii/Bona river system and ultimately Lac Nzilo
- The destruction of copper cobalt outcrops habitats and their associated flora in the Katanga Region.

Cumulative impacts have been addressed in the mitigation measures identified by the specialists and these mitigation measures have been incorporated in the ESMP. Some of the mitigation measures will require the setting up of co-operative structures with other mining concessionaires within the region. Co-operation and assistance from the DRC and Katanga Province government will also be required.

10 ALTERNATIVES ANALYSIS

An alternatives analysis needs to be conducted as part of the social and environmental assessment. The purpose of alternatives analysis is to improve project design, construction and operation decisions based on feasible project alternatives (IFC 2006).

Analysis of alternatives compares reasonable alternatives to the proposed project site, technology, design, and operation in terms of their potential environmental and social impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. It also states the basis for selecting the particular project design proposed and justifies recommended emission levels and approaches to pollution prevention and abatement (IFC 2006).

Alternatives considered for the Kalukundi Project were the following:

- Processing Plant;
- TSF, locations and type;
- WRD locations;
- Relocated Kisankala Village location;
- Mine Site Village location;
- Senior and Junior Staff Accommodation location;
- No Project; and
- Closure alternatives.

10.1 Processing Plant

10.1.1 Location

The site of the process plant was chosen for the following reasons:

- this site has low potential to host underlying mineralisation;
- it is a reasonable distance from all four defined ore fragments and in very close proximity to the potential ore from the Kesho fragment; and
- this location provides good foundation development for the major operating structures (crushers & mills), due to the presence of near surface weathered outcrop (Digby Wells & Associates 2008).

An alternative location was investigated at the northwest part of the concession (Option C) but this was determined to be the least environmentally favourable due to the proximity to the Kisankala stream, and the fact that the ground slopes toward the stream. (Bok 2008). There is also little room for the TSF in the vicinity of the proposed process plant location. A plant site immediately west of the current Kisankala village was one of the original plant site options, but was replaced with the current site due to the thick soil cover in the areas west of the current Kisankala village site and therefore not optimal for foundations.

10.1.2 Alternative process technology

The solvent extraction process chosen for Kalukundi is the state of the art process typical for this type of ore and application and is renowned for being highly efficient in the processing and extraction of metal. It is also highly efficient in the use of reagents, which to a very large degree are recirculated within the process plant and are not disposed of to the TSF (Digby Wells & Associates 2008).

Numerous other options were studied and evaluated in detail as alternatives to leach extraction and SX/EW to metal (Boylett 2002). Other alternatives to metal production were seriously considered, but the extraction to metal was adopted as the most efficient processing method both for the company and for the country. The issue of maximum beneficiation within the boundaries of the DRC was a serious consideration at a time when only raw ore was being exported from the country.

Heavy Media Separation (HMS) plant was studied as a possible treatment option, which would be a lower capital cost alternative to the plant proposed in the bankable feasibility study. However, the use of HMS technology was rejected due to:

- HMS technology is more suited to sulphide ore, and HMS recovery with the oxide ore such as that at Kalukundi will be significantly lower.
- Lower copper concentrate grades due to mineralogy of the Kalukundi ore.
- HMS concentrates from Kalukundi ore will contain both copper and cobalt. However cobalt is a penalty element in a copper concentrate, reducing the value of the copper concentrate produced, thereby reducing revenue.
- Higher losses to fines due to oxide ore.

Heap leaching was also considered as a lower cost alternative to agitated leach. However, this option was rejected due to:

- Testwork showing both oxidative and reductive conditions are required to achieve sufficient recoveries of copper and cobalt. The change in conditions cannot be achieved using heap leaching, which will result in below optimum recovery.
- Clay content of the ore will prevent sufficient drainage to be achieved in the stockpile.
- Annual wet season will adversely impact on the operation heap leaching, particularly with clay type ore.

10.1.3 Toll treating

Rather than build a plant, an option would be to truck ore to the existing plants in Kolwezi or Likasi. This option was assessed, but found to be highly unfavourable due to the poor condition of roads, the long haulage distances, high cost of trucking and the lack of suitable facilities with capacity available to toll treat ores (Boylett 2002).

10.2 Tailings storage facility, locations and type

10.2.1 Tailings storage facility location

The alternatives for location of the TSF was determined by:

- The location of surrounding water courses;
- A land site as level as possible;
- Operational considerations - the TSF should be as close as possible to the processing plant to reduce slurry transport system costs and potential for tailings spills; and
- Location of known and potential ore occurrences.

Four options for the location of the TSF and other infrastructure are shown in Appendix 1. The options are designated A, B, C and D. Option A is the original planned location south of the power line, which was deemed to be too close to the proposed Kisankala village relocation site, leading to the development of Options B to D. Option B moves the TSF to the east to put a buffer between the village and the facility. In Option C the TSF and the processing plant are in the northwestern corner of the concession near the Kisankala stream. Option D is the same as Option B, but with the proposed future expansion cell to the south of the facility, rather than to the west. This is because there is a potentially viable ore body immediately to the west of the TSF, but further work is required to substantiate this.

The four layouts have been assessed in relation to the environmental aspects listed in Table **27** below. For each aspect the alternatives were ranked by an environmental specialist from the most desirable (i.e. score = 1) to least desirable (i.e. score = 4). If two or more alternatives were regarded as comparable they were assigned the same rank. As Option B and D were assigned the same lowest score they are equally desirable and the preferred alternatives, with Option C the least desirable (Illgner 2008).

Table 27: Comparison of the four layout options in relation to selected environmental aspects

LAYOUT				
	Option A	**Option B**	**Option C**	**Option D**
Location of Plant	N of power line on the E border of concession.	N of power line on the E border of concession.	Between TSF and power line adjacent to W border of concession.	N of power line on E border of concession.
Location of TSF	S of power line in the SE corner of the concession. Return water dams located W of the SW corner of the TSF.	S of power line in SE corner of concession. TSF located closer to E boundary than Option A. Return water dams adjacent to NW corner of TSF.	NW of concession, S of Kisankala stream, adjacent to W boundary of concession. Return water dams adjacent to SE corner of TSF.	S of power line in SE corner of concession. TSF closer to E boundary than Option A. Return water dams adjacent to SW corner of TSF.
Location of Village	Centrally situated on S border of concession.	Centrally situated on S border of concession.	Centrally situated on S border of concession.	Centrally situated on S border of concession.
Location of Mine Camp	SE corner of concession, SE of TSF.	E border of concession, N of plant.	SE corner of concession.	E border of concession, N of plant.
Location of Alternative Mine Camp	NW of concession, S of Kisankala stream.	NW of concession, S of Kisankala stream.	None.	NW of concession, S of Kisankala stream.

Table 28: Comparison of the four layout options in relation to selected environmental aspects

Aspects	Option A	Option B	Option C	Option D
Topographic Highs	1	1	1	1
Drainage Lines and other Wetlands	1	1	4	1
Miombo Woodland	1	1	1	1
Cuprophilous Vegetation	1	1	1	1
Habitat Fragmentation	3	1	4	1
Ecological Processes	3	1	4	1
TOTAL	**10**	**6**	**15**	**6**

Knight Piésold will carry out the detailed design of the TSF in Johannesburg once project commencement has been approved. As part of this detailed design, a dam break analysis will be undertaken and in the event of any dwellings or any critical mining or plant infrastructure falling within the zone of influence, engineering controls will be put in place such as constructing diversion walls with mine waste material (Digby Wells & Associates 2008). The dam break analysis will assist in determining the optimum location for the TSF.

Article 80 Annex IX of the DRC Mining Regulations states that any TSF must be more than 60 m away from any water body or course, and good environmental practice would suggest that the larger the buffer the less the risk. Assessment by flora, fauna and ichthyofauna (fish) specialists identified that Option C, with the TSF in the north-west corner, was the least favourable option, as the TSF and process plant are located on sloping terrain relatively close to the Kii and Kisankala rivers.

Options A, B and D are appear to pose a similar and reduced environmental risk as the TSF and process plant are located on flat terrain further away from any river course or drainage lines compared to alternative C (Bok 2008), and so have less impact on faunal diversity.

Option A is perceived to be too close to the relocated Kisankala village, leaving Options B and D as the most favourable. The final location will be decided after detailed design work and further drilling to determine mineralogy under the proposed TSF extension cell.
Consideration was given to placing the TSF outside the concession on a neighbouring property, but it was determined that further resource drilling would need to be carried out by the other company before negotiations could be entered into. This option could still be investigated for the expansion cell and for future TSFs, but it is not being pursued now due to time constraints.

10.2.2 Tailings storage facility type

The treatment process has a direct bearing on the nature of the tailings and other effluent. The solvent extraction process chosen for Kalukundi has a highly efficient use of reagents that are re-circulated within the process plant as much as possible and the volume of reagents disposed on the TSF is minimised.

The choice of the paddock system with earth starter walls and outer walls raised using tailings is largely based on the method being a proven industry standard method. Nevertheless at the detail design stage, value-engineering methods should be applied to investigate the feasibility of using waste rock to build the impoundment walls, should the northwest site be chosen. This is located slightly closer to the pits and waste rock impoundment may prove to be environmentally and economically more effective than using tailings to construct the TSF walls.

It was determined that a liner was not necessary due to the non hazardous nature of the tailings and the limited movement of the ‘worse case scenario’ contamination plume, as seen in Figure 43. The TSF will be sealed with a compacted clay layer, and monitoring bores will be placed around the TSF. If any contamination is detected an interception trench will be installed and contaminated solution collected and pumped back into the process water circuit. An internationally recognised tailings expert will subject the detail design to a rigorous peer review.

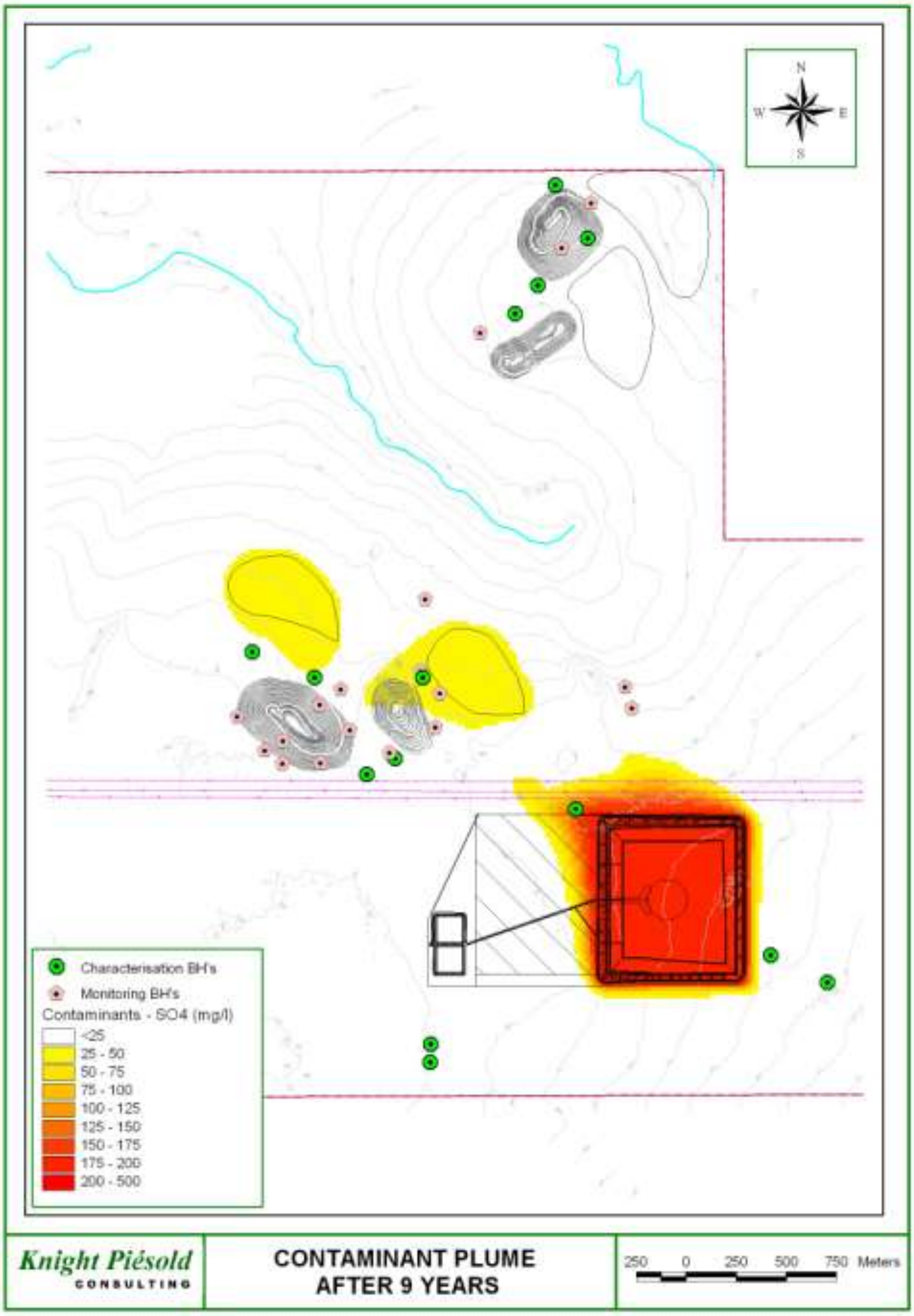

Figure 43: 'Worst case scenario' contaminant plume after 9 years (not to scale)

10.3 Waste Rock Dumps

10.3.1 Location

The site layout at Kalukundi is to a large degree dictated by the occurrence of ore bodies beneath the surface, existing mining right boundaries, the power lines crossing the property and the drainage patterns. The WRD positions must be located close to the relevant open pits to limit the cost of waste rock transport. There will be four dumps created during mining from the Kii, Principal, Anticline and Kalukundi open pits. The location of most of the site infrastructure was based mainly around the presence of mineralisation, which could be mined in the future. The decision to develop four dumps was based on the economics of the project and minimisation of trucking distances to increase mining efficiency.

However, the Kii and Kalukundi WRDs were moved from the original proposed location to the east of the Kii and Kalukundi pits, to the western side. This is for two reasons. The original location was too close to the Kii River source, and the recent drilling has established an extension to the east of each of these fragments, which will extend the size of the pits in the easterly direction.

10.3.2 Design

The alternatives for waste rock design are:

- Standard design with benches and berms; and
- Design mimicking natural outcrops as in Figure 44 and Figure 45, no berms, concave slope, rock armoured, supporting typical copper/cobalt flora.

Historically, WRDs built with standard bench and berm design have showed significant risk of developing erosion problems after high rainfall events requiring expensive mediation works. New design concepts indicate that mimicking natural concave slopes can minimise this risk.

Test work will be carried out on waste rock and topsoil to determine erosion characteristics and plant propagation potential to determine the best WRD design using international good practices.

Figure 44: Typical natural rocky slopes of Kalukundi copper / cobalt outcrops

Figure 45: Typical natural rocky slopes of Kalukundi copper / cobalt outcrops

10.4 Water release into the Kii and Kisankala streams

There are two options available to maintain water flow in the Kii and Kisankala Rivers after decommissioning of the mine. Unless these rivers are artificially maintained, their upper reaches will remain dry for a period of approximately 45 years after decommissioning, due to the drop in the water table.

One option is to release water into the upper reaches of these rivers through water obtained from boreholes. A second option is to release water from storage dams constructed in the upper catchment of both rivers to recharge the existing headwater dambos. The maintenance of a high water table in these dambos would help to ensure a constant flow of good quality water into the upper reaches of the two streams.

There is currently insufficient information to assess the pros and cons of these alternatives. Further studies, as indicated in section 11.3.2 are necessary in order to determine the best solution.

10.5 Relocated Kisankala Village location

Three resettlement site options were identified for the resettlement of residents of Kisankala Village (AMC). These options were presented to Chief Nsemba Kipaya Timothe and his council during the consultation meeting on 20th January 2005. These are outlined below and illustrated in Figure 46.

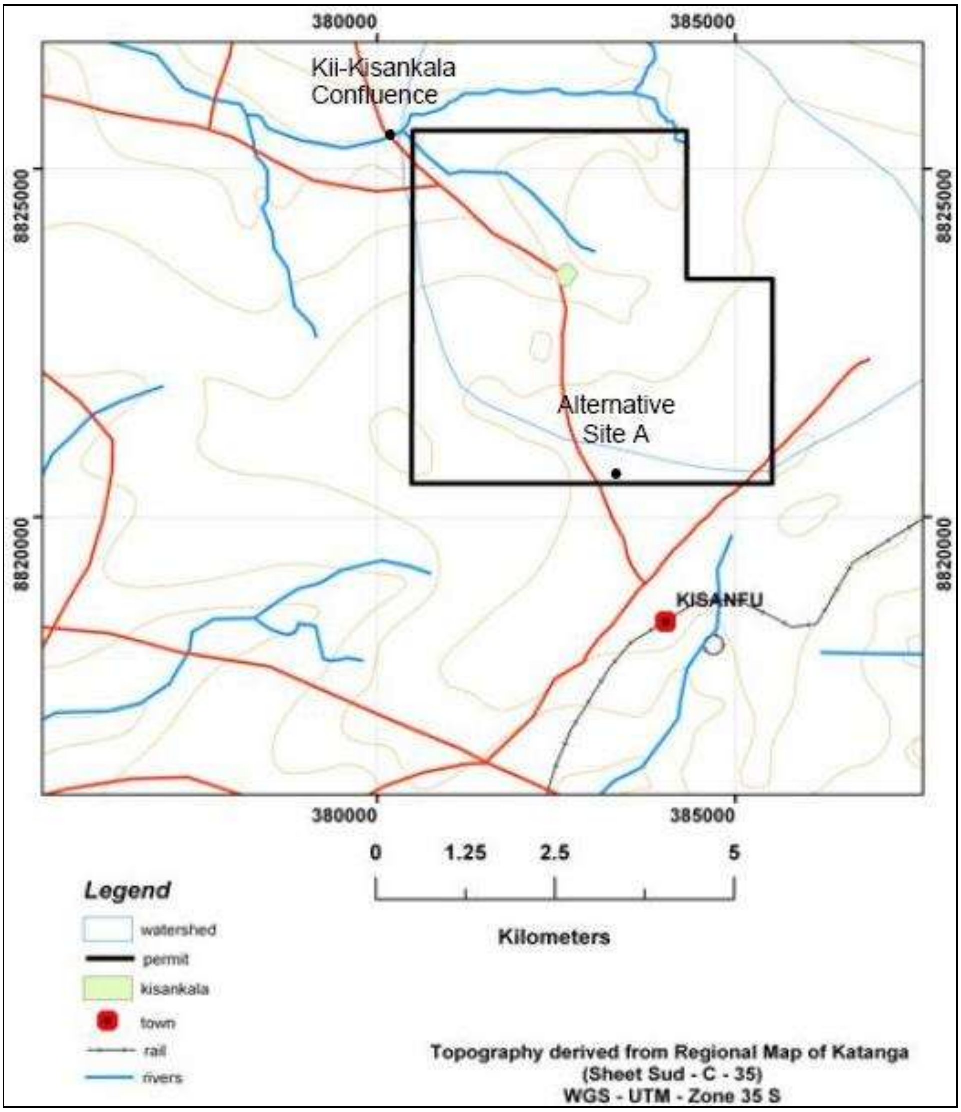

Figure 46: Three options for the relocated Kisankala village

10.5.1 Kisanfu

Kisanfu is located 4.5 km south of Kisankala Village. It is a small railway township, with a railway station, a SNCC (National Railways) compound, a small clinic, three basic schools and a small market. Access to Kisanfu is via the Kolwezi - Likasi main road, located 500m from the centre of Kisanfu, and the Kolwezi – Likasi railway, which passes through Kisanfu. Kisanfu is electrified (a transformer is located here, fed by the Nzilo power line). The main problem at Kisanfu is water supply, as residents have to travel 3.5 km to the nearest water abstraction point (a spring 3.5 km south west of Kisanfu). An old pumping station is located at the water extraction point and was designed to pump water via a 50 mm pipe to provide drinking water to Kisanfu. The pipe is still intact and the reservoir remains, however the pumping equipment has been removed.

Positive aspects:

- Existence of basic infrastructure (clinics and schools) which can be upgraded;
- Established community with good access;
- On a different watershed from the mine site (no potential to be impacted by mine discharge);
- Electricity is available;
- Water supply infrastructure is available although it would require some rehabilitation; and
- Development of clinics and schools would benefit a greater number of the population in the area.

Negative aspects:

- Different administrative structure in Kisanfu. The relocation of the Chief to Kisanfu may cause a reduction in his administrative powers and could be a source of friction between local people;
- Moving Kisankala people from the area that they are accustomed to and concentrating the population of two villages into one at Kisanfu; and
- Conflict between the two different groups due to the provision of certain standard of housing, which is then not provided for the existing residents.

10.5.2 Kii – Kisankala Confluence

The confluence of the Kii and Kisankala Rivers is located 3 km north west of Kisankala village, 200 m away from the northwestern corner of the permit area. Currently the area is being used extensively for agriculture with many fields of cassava and maize located along the sides of the river valley. The area has good fertile alluvial soils but is not inhabited at this time.

Positive aspects:

- Within the administrative boundaries of the Chief;
- Access to water with the spring nearby;
- Good fertile soil; and
- Access via Kisankala – Samba road (in good condition).

Negative Aspects:

- Far from markets
- Long distance from the main Likasi-Kolwezi main road artery;
- Downwind of mine so potential for impacts from mining operations in the form of dust discharge and noise;
- Movement to Kisanfu (nearest market/ route to Kolwezi or Likasi) will be restricted by mine operations, therefore a new road would need to be built from the confluence to Kisanfu avoiding mine operations;
- A new village including clinics and schools would have to be built from scratch; and
- This area is still subject to exploration and there is strong potential for locating a new occurrence of exploitable ore in this location. Significant artisanal workings are active just north of the concession boundary here.

10.5.3 Area between Kisankala village and Kisanfu

This site is located halfway between Kisankala Village and Kisanfu within the administrative boundaries of the Chief (2 km south of Kisankala and 2.5 km north of Kisanfu) along the Kisankala – Kisanfu road. This site is currently relatively undisturbed Tropical Dry Congo Woodland.

<u>Positive aspects</u>

- Good access to the Kolwezi-Likasi Road and railway;
- Good access to markets (Kisanfu);
- Has strong local support from the Chief, his administrators and the villagers;
- New drill holes have established an adequate supply of good quality potable water for the village. There is sufficient water to supply some of it for irrigation of crops;
- The preferred site is level with a very slight slope to the west;
- There is potential to expand the village should there be a requirement to do so in the future;
- The village housing can be constructed between the existing trees thus limiting the impact on the local flora and leaving the larger trees for shade; and
- The village will be away from the main mining activities, hence reducing the risk of accidents relating to active vehicle traffic associated with the mining activities.

<u>Negative aspects</u>

- There will be a need to clear an area of vegetation causing localised impacts to flora and fauna; and
- Building of a completely new village.

10.5.4 Preferred relocation site

During deliberations with the Chief and his Council on 20th January 2005 the area between Kisankala village and Kisanfu was identified as the potentially preferred choice. On 26th June 2007 Chief Nsemba, the chief of Kisankala village, signed a memorandum agreeing to the proposed site for the relocation.

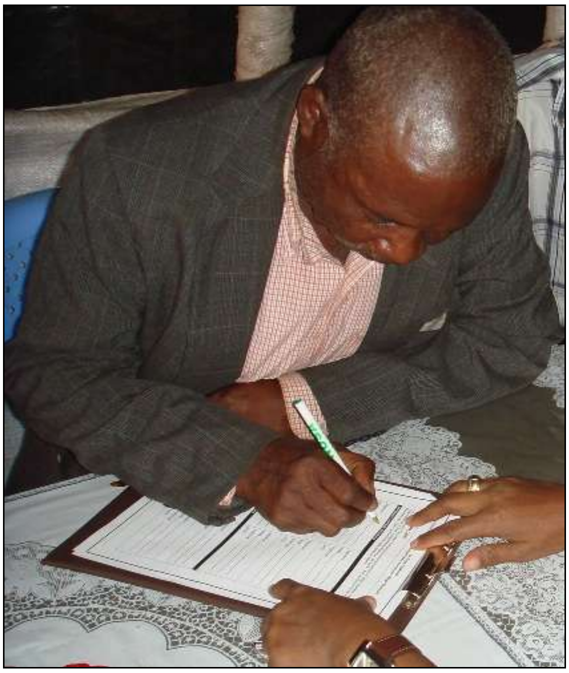

Figure 47: Chief Nsemba signing the agreement for the relocation of Kisankala village

10.6 Mine Site Village location

The mine site village is to house senior management and other staff required to be on site at all times. The Village will consist of 40 houses, one guesthouse and will house a maximum of 74 people. The village is expected to be low impact due to the low number of residents, and the plan is to minimise clearing as much as possible by placing houses between existing trees.

Two options for the location of this village have been indicated on the plan and it was determined that the north eastern location is favoured due to the minimum amount of trees (Figure 48) to be cleared and the presence of natural clearings suitable for construction of the temporary construction camp nearby. The area is fairly level and should not require any excavations.

Figure 48: Vegetation at proposed Mine Site Village location

10.7 Senior and junior staff accommodation location

ARL intends to create accommodation for approximately 170 people in an off site location. It is envisaged that two styles of accommodation units will be built. Initially 29 units are required for senior staff and 141 for junior staff.

The towns/villages of Lualaba, Kisanfu and Tenke were investigated as potential locations for the accommodation to be built. Figure 49 shows the location of the villages in relation to the Kalukundi Project site.

The aim of the project is to provide high quality accommodation in an amenable location in order to attract and retain good quality staff at the operation. At the same time advantages to the Congolese community need to be maximised where possible.

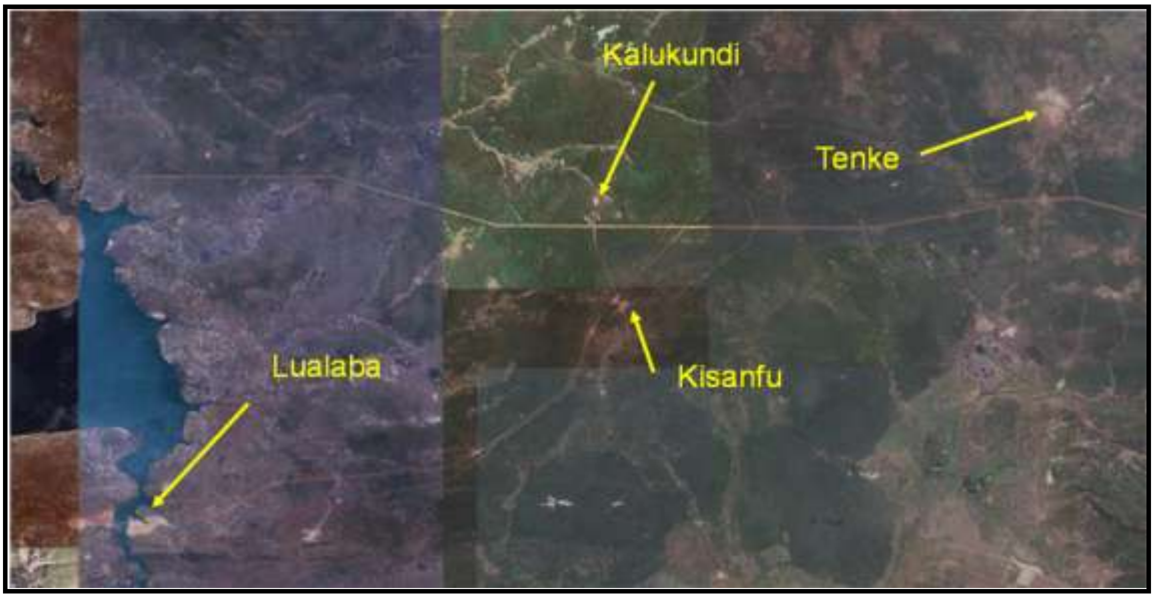

Figure 49: Location of villages investigated for the mine camp

Figure 50: Location of villages investigated at Lualaba

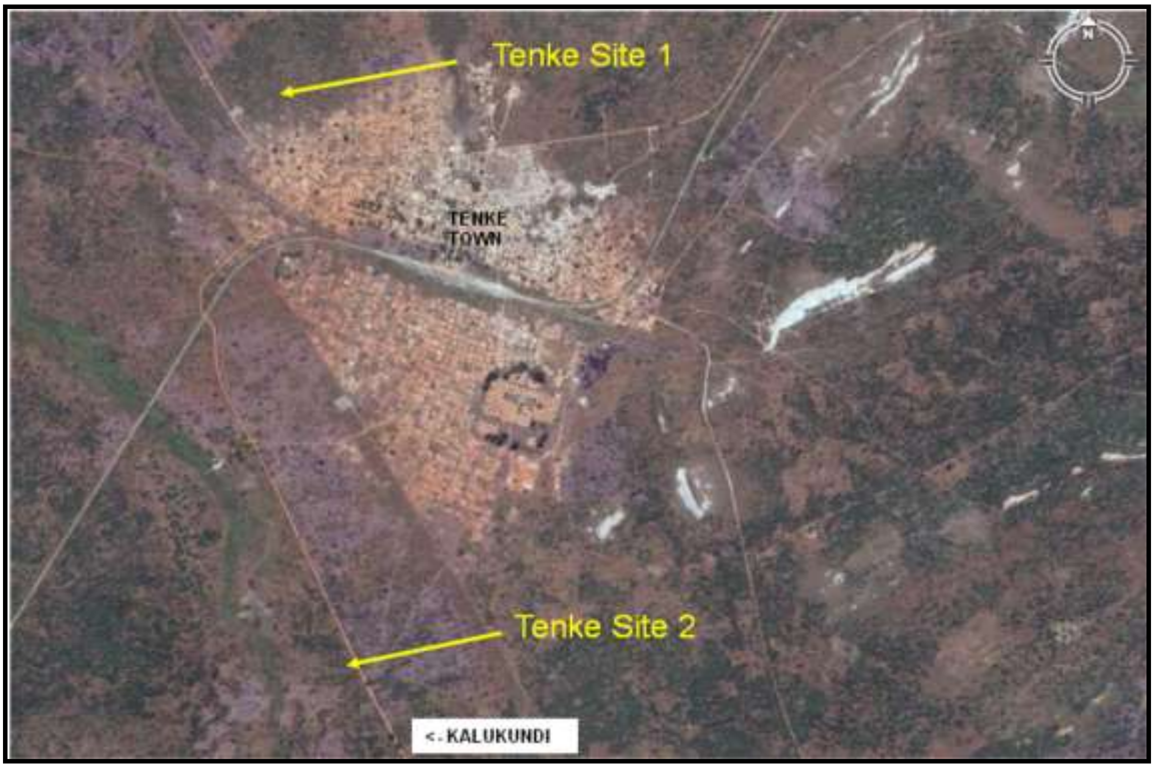

Figure 51: Location of villages investigated at Tenke

ARL personnel visited the sites of Tenke and Lualaba towns in December 2007. The local administrators were contacted and interviewed at both locations, and a tour of the towns' facilities was carried out. Kisanfu residents were interviewed as part of the investigation. The Cadastre's office in Kolwezi was visited to determine the procedure for getting the land granted.

The ARL management team assessed the relative benefits of each aspect for each town and a matrix was formed to allow comparison of proposed sites as shown in Table **29**. The site with the highest score was deemed to be the most suitable. The result was that the town of Lualaba was considered to be most suitable, but the scores for Kisanfu and Tenke were very close, so a more detailed assessment and further consultation needs to be carried out prior to finalising the decision.

Table 29: Comparison of alternative staff accommodation sites

Note: Points: 3 is most favoured, 1 is least favoured; Weighting: 5 is most important, 1 is least important

Aspect		Lualaba	Tenke	Kisanfu	Points: Lualaba	Points: Tenke	Points: Kisanfu	Weighting (1 to 5)	Weighted score: Lualaba	Weighted score: Tenke	Weighted score: Kisanfu
Distance from mine		31 km	29 km	4 km							
Existing infrastructure	Police	Yes local police in Bazano's old house	Yes	Nil	3	2	1	1	3	2	1
	Clinic/ hospitals	UNICEF (west side) under construction/ Landrecy clinic (East) very basic	Small centre de sante - catholique, visited - v.v. poor quality	There's a small clinic offering medical services, run by SNCC (railway)	3	1	2	4	12	4	8
	Road	One main road through town maintained by Bazano as trucking. DCP maintains main road west to Kolwezi. All other roads basic tracks	Within town good condition dirt roads maintained by TFM. Access road from Kalukundi not bad, not good. New road to be built. Road to Fungurume (30K) maintained by TFM (not sighted)	Dirt roads around the village, not serviced in years. Village borders on main road.	2	1	3	5	10	5	15
	Water	No water system, carried by hand from source, which is potable, Lake Nzilo not drinking water.	There's a water reticulation system but poor distribution; alternative supply is carried by hand, water hole being drilled at school , driller said the water is at 30 to 40 m and not the best quality	No water. Water source at +/- 2 km by Kisanfu stream has infrastructure but needs refurbishment	2	3	1	1	2	3	1
	Electricity	SNCC power system failed 3 yrs previously and not repaired. Power lines through town all in disrepair	Partial reticulation of power to some areas. Big power line goes through town.	Yes, through the SNCC transformer	1	2	3	5	5	10	15

	Restaurants	3 bars, no restaurants of decent quality (some sighted along main road)	Some small restaurants said to be of low quality	About two of them, of low standard, by the main Kolwezi road	2	3	1	3	6	9	3
	Churches/mosques	a lot' - more than 20 churches, one mosque	16 churches and 1 mosque	About 6 churches, no mosque	3	2	1	3	9	6	3
	Waste management	A pit is dug at the back of each house. Town relatively tidy	Said to be carried out by TFM. The town looks tidy with no accumulation of rubbish	Everyone has a pit in the backyard	2	3	1	3	6	9	3
	Schools	3 primary schools and 1 secondary. A new primary school being built by DCP.	4 primary schools and 2 secondary schools	1 primary school that most children attend unless there isn't any money to send them there.	3	2	1	5	15	10	5
	Mobile coverage	excellent signal	excellent signal for CELTEL and average for VODACOM	No network, only on top of an anthill	3	2	1	5	15	10	5
	Market/shops	2 small market places, some basic shops on main street	Good well stocked market place with fresh vegetables etc.	The small market is by the main road side, couple of tuck shops on main road	2	3	1	4	8	12	4
	Hotels/guest houses	1 at bridge under construction, some basic ones elsewhere	Nil	There's one by the main road	3	1	2	4	12	4	8
Health impacts	Clinic/ hospitals	Already assessed above									
	Healthy environment	Significant malaria problem, fair bit of hygiene related disease/bilharzia	Said to be no problems. People report to clinic with malaria and water borne diseases such as worms	Malaria is the no. 1 enemy	1	3	2	5	5	15	10
	Clean/tidy town	Relatively free of rubbish,	No rubbish, plenty of newly painted shops	Generally tidy	1	3	2	4	4	12	8
	Safe environment	A lot of theft of bicycles, goats, break-ins. Security is a problem	Agricultural society, no through traffic, relatively safe	Yes	1	3	2	5	5	15	10
Social aspec	Entertainment	Nil	Nil	None				6	0	0	0
	Restaurants	Small	Small					6	0	0	0

	Sporting facilities	Soccer - field on each side of the bridge, some soccer tournaments	One communal ground. Abandoned 25 m swimming pool sighted.	Have a soccer pitch	3	2	2	2	6	4	4
	Recreational facilities	Fishing - way of life for many people	Nil	None	3	2	2	2	6	4	4
	Access to major towns	Kolwezi is 25 km	Fungurume is 30 km, TFM is 12 km.	On the main road, 50 km from Kolwezi	3	2	1	4	12	8	4
Political impact	Chiefs views	Chef Mubanja lives at the NW end of Lualaba, Chef Mwanza Minda has control of the area surrounding the barge on the east bank.	Regional: Chef Bayeke (after Fungurume) /Local: Chef Mwelapande (3km from Tenke) not spoken to	The local chief lives at +/- 20 km from Kisanfu, at Dikanda (Direction of Kawama). Don't know of his views							
	General populations views	Chef de secteur said they would be delighted to have 500 of us come to live with them	Chef de poste and offsider said they would be delighted to have 500 of us come to live with them	Population would be very favourable to arrival of new residents.							
	Regional development	Being developed by DCP and others	High unemployment in town, most people agriculturalists. Some interaction with TFM	The Chinese are said to be establishing a permanent camp there very soon	1	2	3	4	4	8	12
Mine closure	Impact on community	Should be tempered by the presence of Balzano, Mutanda, DCP and DEM mining projects in area, and the fact that it's a major transport route	Should be tempered by the presents of TFM mine 12 km away		3	2	1	2	6	4	2
	Impact on house values	As above	As above	Significant, as no major mines nearby. (Not sure about Phelps Dodge at Kisanfu)	3	2	1	2	6	4	2
Costs	Capex - Condition of road	Partially rehabilitated by Balzano	New road will have to be constructed for 5 km to main road, main road needs maintenance	Only needs site access road to be maintained	2	1	3	5	10	5	15
	Opex - road maintenance				2	1	3	4	8	4	12
	Opex - bus				2	1	3	4	8	4	12
	Opex - call out times essential staff				2	1	3	5	10	5	15
					5	**50**	**46**		**193**	**176**	**181**

10.8 No Project

Negative impacts:

A no project option will mean that the status quo remains, that the formal mining project as designed is not implemented and that the current artisanal mining activities on the site continue. Such a scenario would not necessarily mean that that the environment would remain free of impacts. As indicated in section 5.8, elements of the biophysical environment such as the aquatic systems are already heavily disrupted by artisanal mining and social conditions are characterised by rapid migration and movement of people. It therefore follows that the absence of a project does not mean that impacts are not going to occur.

The booming artisanal mining activity currently contributes to social impacts in the community. If the status quo were to remain, it would mean that the existing social impacts of poverty and uncontrolled artisanal mining would continue unabated. A no project option will also see all the anticipated project benefits (including the 500 to 600 direct employment opportunities during the construction phase and 460 employment opportunities for Congolese nationals during the operational phase) not being realised. Apart from the loss of these employment opportunities, the lost opportunities of the no mining option will include:

- loss of direct foreign investment of US$ 800 million;
- loss of opportunities for skills development;
- loss of infrastructure development;
- loss of opportunities for improvement in living standards for Congolese nationals; and
- loss of opportunities for economic exposure and development.

The ‘no project’ option will also have a negative effect on the environment aquatic environment, with particular reference to the Kii and Kisankala streams. These streams are currently being heavily impacted by artisanal washing activities and are in an extremely degraded state. The project will remove the artisanal activity from that area (at least for the 10 years of mining operation) and allow natural re-vegetation processes to recolonise the affected portions of the stream, thus leading to an improvement in water quality. Charcoal burning and hunting activities will also be stopped within the concession during mining, leading to local flora and fauna recovery, although is must also be noted that these activities are likely to simply move to the neighbouring concessions or areas outside of the concessions.

The ‘no project’ option will have a negative impact on the revenue streams of both the Democratic Republic of Congo and on Gécamines, which is trying to recover from serious debt. The development of such a significant copper and cobalt producer locally would inject capital into both the local and national treasury though taxation and royalties.

The 'no project' option would mean the investments in infrastructure and community development that the project would be able to bring about would not be realised. Thereby resulting in the continuation of the poor state of the local economy, infrastructure and services, which are legacies of the DRC's recent history. .

Positive impacts:
The positive impact of the no-mining option would be primarily biophysical in nature. No mining would lead to less clearance of Miombo woodlands as the pits, WRD, TSF and infrastructure areas will not be cleared, and therefore the disturbance to flora and fauna would be minimised. The potentially significant impact on the relatively scarce "copper flora" occurring on the copper and cobalt fragments would also be avoided. It must be stated that the copper flora would continue to be disturbed by artisanal mining in the no-project alternative, although to a lesser extent due to the absence of mechanisation in artisanal mining. Further biophysical impacts that would be avoided are the release of large volumes of water that will be pumped to dewater the pits, as well as noise and dust impacts that may affect the Kisankala village.

On the social side, the relocation of Kisankala village would be avoided. However, given the transient nature of residence in the village, it is doubtful whether the avoidance of the relocation would have a significantly positive impact on the residents, since the majority of the residents are artisanal miners who are by nature very mobile.

10.9 Closure alternatives

10.9.1 Open Pits

The options for closure for open pits are:

- Back fill with waste rock;
- Use as a TSF; and
- Allow to fill with water at end of mine life.

The cost to back fill the pits is impractical as it would require millions of dollars in earthmoving costs alone, and is not considered a favourable option as it deprives access if the mining is to recommence, and it removes a possible asset for the community. The base of the pits could provide a portal for underground operations in future years if an extension of a viable ore body below the bottom of the pit is proven.

Back filling pits with tailings is a favourable option as the risks associated with in pit tailings facilities are much less than surface TSFs. This option will be pursued in later stages of the mine life when some pits have been depleted and it is established that there are no feasible ore bodies at greater depth below the pits. The feasibility of this option cannot be determined at this stage due to lack of adequate drilling data at depth.

Allowing the pits to fill with water at the end of mine life is the most likely option due to the good quality of the groundwater at Kalukundi (Knight Piésold 2008). This option will have the great advantage of providing the community with a large water supply at the end of mine life for recreation and other uses. There is potential for sustainable enterprises that could use this asset, such as irrigated agriculture and fish farming.

10.9.2 Waste Rock Dumps

The different options for WRD design were discussed above in Section 10.3.2.

10.9.3 Removal of infrastructure

There are two options for the rehabilitation of infrastructure at the end of mine life:

- Demolish and salvage all infrastructure and rehabilitate footprint
- Hand over selected infrastructure to government or community for projects and other uses.

The advantage of the second option is the assets will continue to have a value to the community, and to benefit the community.

The infrastructure assets that may be handed over are items like power services, water services, roads, accommodation units/villages, offices and workshops. Infrastructure that are likely to be removed for salvage value and community safety reasons are the processing plant, processing ponds, water ponds and tailings infrastructure.

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

11.1.1 Significant impacts

The most significant impacts that would be caused by the proposed mining project at the Kalukundi concession are indicated in **Error! Reference source not found.** below.

Table 30: Summary of the most significant impacts

Index no.	Impact	Phase	Significance	Significance with mitigation
1.1	Direct localised loss of rare habitats, in copper-cobalt vegetation communities within the concession	Construction, Operation & Closure	Very high	Don't Know
1.2	Direct localised loss of local endemic species, in copper-cobalt vegetation communities within the concession	Construction, Operation & Closure	High	Don't Know
1.3	Loss of sensitive habitats	Construction	High	Moderate
1.5	Direct localised loss of habitat within riparian vegetation communities	Construction, Operation & Closure	Moderate	Moderate
1.6c	Direct localised loss of biodiversity including rare habitats and local endemic species in Miombo vegetation communities	Closure	High	Moderate
1.6d	Direct localised loss of biodiversity including rare habitats and local endemic species, in Miombo vegetation communities. (94ha for WRDs 64ha for TSF causes loss of habitat for small mammals, birds and insects)	Construction, Operation	High (low)	Moderate
1.7a	Direct loss of Miombo vegetation habitat & loss of vegetation cover due to mining-related activities	Closure	Moderate	Low
2.2	Water Quality – sedimentation & elevated turbidity	Operation	High	Moderate
2.4f	Air pollution due to dust blow from exposed tailings surfaces	Operation & Closure	Moderate	Moderate
3.1	Reduction in water quality	Construction, operation and closure	High	Low
3.2	Reduction in water quality due to metals from mining activities	Operation & closure	High	Low
3.4b	Contamination of groundwater due to acid rock drainage (ARD) seeping under the TSF.	Closure	Moderate	Moderate
3.4c	Contamination of groundwater due to seepage of tailings solution and/or ARD through the base or toe of the dam.	Operation	Moderate	Moderate
3.4d	Contamination of groundwater due to acid rock drainage (ARD) through the base or toe of the dump.	Operation	Moderate	Moderate
3.5	Contamination of watercourses with sediment and liquor due to accidental failure of TSF walls	Operation	Moderate	Moderate
3.6	Pesticide-induced increased mortality amongst pollinators, leading to reduced pollination of indigenous plants	Operation	High	Moderate (No significance)
3.7b	Contamination of soil due to accidental spill of tailings (during transit to the TSF)	Operation	Moderate	Moderate

Index no.	Impact	Phase	Significance	Significance with mitigation
4.1	Loss of Aquatic Species (fish) of Special Concern	Construction, Operation & Closure	Moderate	Moderate
4.2	Loss of SSC	Construction	Moderate	Low
4.3	Improved access to rare habitats and local endemic species leading to removal of rare species	Construction, Operation, Closure	Moderate	Low
4.5a	Loss of faunal diversity (Increased mortality rates in fauna due to increased hunting activity)	Construction, Operation	Moderate	Low
5.1	Reduction in connectivity of habitats affecting movements of wildlife species that may be pollinators or dispersal agents of flora within Copper deposits	Construction, Operation, Closure	High	High
6i	Introduction of exotic species (terrestrial and aquatic)	Construction	Moderate	Low
7.2	Stream Flow Reduction and flow alteration due to dewatering of the mine pits and lowering the water table	Construction, Operation & Closure	High	Moderate
8.1	Impact of changed flow regime on riparian plant communities (Gallery Forest and Dambo Wetlands)	Construction, Operation & Closure	High	Moderate
8.2	Impact of increased stream flow on the aquatic system	Construction & Operation	High	Moderate
9	Increased fire risk	Operation	Moderate	Low
10.3c	Light pollution affecting local faunal activities	Construction, Operation, Closure	Moderate	Low
12a	Public safety impact due to TSF failure	Operational	High	High
12b	Destruction of natural habitats in downstream areas (terrestrial and aquatic) in the case of TSF failure	Operation, Closure	Moderate	Low
13	Ecosystem disruption	Construction, Operation	Moderate	Low
16	Intensification of utilization of areas outside of the concession area as a result of displacement of people from within the concession area	Construction, Operation & Closure	High	Moderate
17a	WRDs may become unstable with time and become dangerous to the public when accessed.	Closure	Moderate	Moderate
17b	Danger to the public from inadvertent access to operational areas.	Operation	Moderate	Moderate
17c	Danger to the public of drowning due to walking on the TSF.	Operation	Moderate	Moderate
18	The removal of Miombo woodland leads to loss of economic benefits of charcoal & traditional medicines (Loss of access to the resource base)	All phases	Moderate	Moderate
19.1	Feelings of displacement for Kisankala village residents	Construction	High	Low
19.2	Loss of assets and misuse of financial compensation	Construction & operation	Moderate	Low
19.3	Population influx	Construction & operation	Moderate	Low
19.4	Price inflation	Construction & operation	Moderate	Moderate
19.8	Health impacts	All phases	Moderate	Low
19.10	Dependency after closure of Kalukundi mine	Closure	High	Low
19.12	Change of livelihood & loss of manpower in other sectors	Construction and operation	Moderate	Low

Index no.	Impact	Phase	Significance	Significance with mitigation
19.13	Increased social delinquency	All phases	Moderate	Low
19.14	Sprouting of uncontrolled settlements	Construction and operation	High	Low
19.17	Economic displacement (Loss of livelihood and income) of those that had businesses in Kisankala village	Construction and operation	High	Low

When all impacts are considered, the impacts of highest significance are those that will affect the natural environment. Although there will be a number of social impacts of high significance, the majority of the impacts on social conditions are of moderate significance. Furthermore, it is clear from the description of the existing environment that the social fabric in the Kalukundi concession and indeed in the entire Katanga Province is already highly disrupted, and that the additional impacts that will be imposed by the project are similar in nature to the impacts that have already occurred through the migration of significant numbers of artisanal miners into the study area. Therefore, the disruption to social conditions and the existing social impacts are already very severe, and the project will not add substantially new impacts to those that are already present.

These social impacts must be compared with the predicted benefits of the project, as indicated in Section 2. The positive economic impact of the project is highly significant, and the revenue from taxation that will accrue to government provides resources that can be used to significantly improve the condition of infrastructure in the Katanga region. The economic benefit to the local economy is also significant, since the project will not only support several hundred Congolese employees directly, but it will also support significantly more of their dependents. It is estimated that, on average, each employee will support eight dependents or family members. This should result in a general improvement in standards of living in the study area and provides an alternative livelihood to the current artisanal mining.

In contrast to the social impacts, the majority of the impacts on biophysical resources are negative in nature and some of them will be difficult to mitigate. These include the impact on the aquatic systems and the impact on copper-cobalt associated flora, which occurs exclusively on the outcrops where the open pits will be created. On a site-specific scale, the habitat for copper-cobalt associated flora is likely to disappear completely within the concession. Outcrops within the concession such as the Kesho fragment and Kinshasa fragment will not be mined in terms of current mining proposals. However, when the Katanga region is considered, it is clear that the cumulative impacts on copper-cobalt associated flora could be a potentially significant due to the proliferation of mining concessions across the province. On a site-specific scale, the impact on biodiversity is limited due to the small size of the concession, but when a regional view is taken, it is apparent that the large number of mines may in time lead to the destruction of a very large number of copper-cobalt outcrops and their associated flora.

The impact on the aquatic environment will also be severe. Firstly, during operation of the mine, dewatering of the pits will lead to a surplus of water being released into the Kisankala stream. This will alter the flow dynamics and seasonality to such an extent that instream aquatic fauna may not be able to survive, especially in the upper reaches of the streams close to the point of release. After decommissioning, the water table is predicted to take 45 years to recover to its pre-mining level, meaning that springs that currently feed the Kisankala and Kii streams at their origins will dry up. Unless the flow in the upper reaches of the streams can be artificially maintained, these springs will remain dry during the dry season for decades after mining has ceased.

There is a relatively high degree of uncertainty associated with the mitigation of the impact on floral biodiversity and on the impacts on the aquatic environment. Further studies on the mitigation of the aquatic impacts and co-operation between the mines and government on a regional level to mitigate the impacts on copper-cobalt flora are essential (see below).

11.2 Recommendations

In spite of the significant nature of the negative biophysical impacts and the uncertainty associated with their mitigation, it is concluded that the majority of the environmental impacts that are likely to be caused by the project can be mitigated to acceptable levels, provided that the mitigation as identified in this report and the ESIA are strictly adhered to.

It is vital that further research is carried out in order to develop effective mitigation measures for the impacts on the aquatic system and offset conservation measures are implemented to mitigate the impact on copper-cobalt associated flora. Such offset measures must be a combination on on-site and offsite measures undertaken in association with other mining companies and government.

It is recommended that Alternative Layouts B or D must be implemented, as this provides the greatest degree of certainty that impacts on the aquatic environment can be avoided in the event of TSF failure. The final decision of the layout should be made based on further technical studies.

It is critical that the ESMP must be implemented throughout the life of the mine and that a formal certified environmental, health and safety management system must be implemented to give effect to the mitigation measures. An accredited certification body must certify such a system within a year of the commencement of operation.

11.3 Further studies that are necessary

There is still some uncertainty associated with selected impacts due to the scarcity of information about the environment at the Kalukundi concession. The studies as mentioned below are necessary in order to optimise the mitigation measures. Implementation of the project should not, however, be delayed pending the outcome of these studies.

11.3.1 Independent review of TSF design

Independent review of the TSF design must be undertaken to ensure that the design conforms to best practice safety standards.

11.3.2 Hydrology of Kisankala and Kii streams

A study of stream hydrology of the Kii and Kisankala streams must be undertaken to assess their ability to accept large volumes of water from dewatering of the pits and the instream flow requirements of the aquatic biota. The study must provide an understanding of the hydrological dynamics of the Kisankala and Kii streams, so that mitigation can be designed to mimic the natural flow regime (in terms of volume, speed and seasonality) as closely as possible. The study must identify appropriate discharge points along the river course. The study must include expert opinion from a hydrologist and possibly a fluvial geomorphologist.

To ensure adequate flows in downstream areas in the Kii and Kisankala rivers, a series of discharge points along the river course may be required to compensate for these unnaturally high losses via seepage.

Data on natural river flows in the lower Kii River will be required to determine the best location to discharge over 200 l/s of excess dewatered water. This hydrological information may allow environmentally suitable releases to be made and to prevent serious negative biophysical impacts (e.g. channel incision and/or bank erosion) resulting from unnaturally large volumes of dewatered water being discharged into the Kisankala and upper Kii rivers.

Further options for the use of the excess dewatered water could be explored, such as for washing heterogenite ore on adjacent mining concessions. If environmentally sensitive ore washing facilities are created away from the Kii River, it will prevent contaminated water from polluting the river. This would have significant environmental benefits.

Further options for the use of the excess dewatered water could be explored, such as for washing copper-cobalt ore on adjacent mining concessions. If environmentally sensitive ore washing facilities are created away from the Kii River, thus preventing contaminated water from polluting the river, this would have significant environmental benefits.

11.3.3 Mitigation of impacts on copper-cobalt flora

Onsite and offsite offset mitigation measures need to be developed to mitigate the impacts on copper-cobalt associated flora. These measures must include the investigation of the creation of a possible regional botanical reserve.

12 REFERENCES

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13 APPENDICES

Appendix 1: Figures

Figure 52: Option A

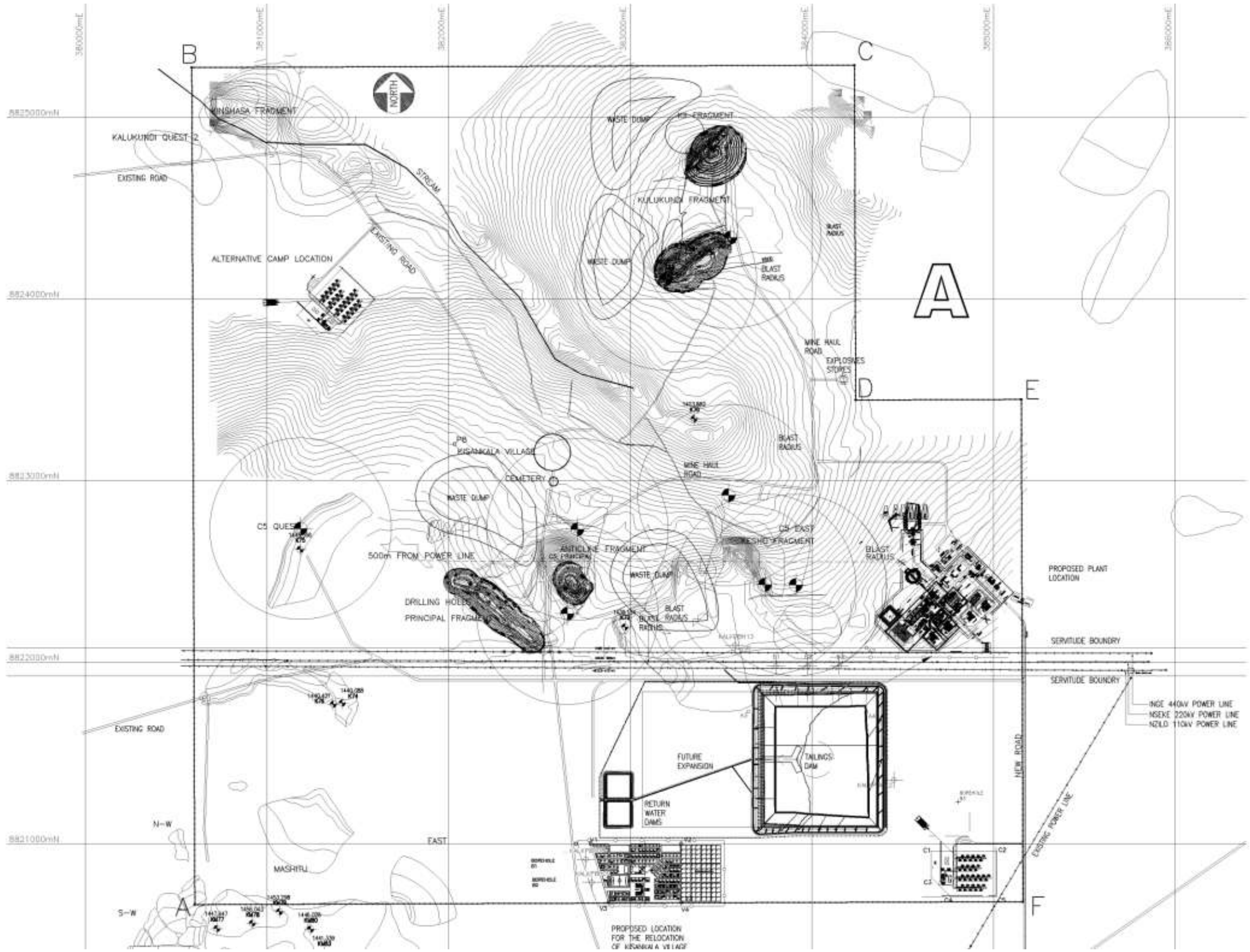


Figure 53: Option B

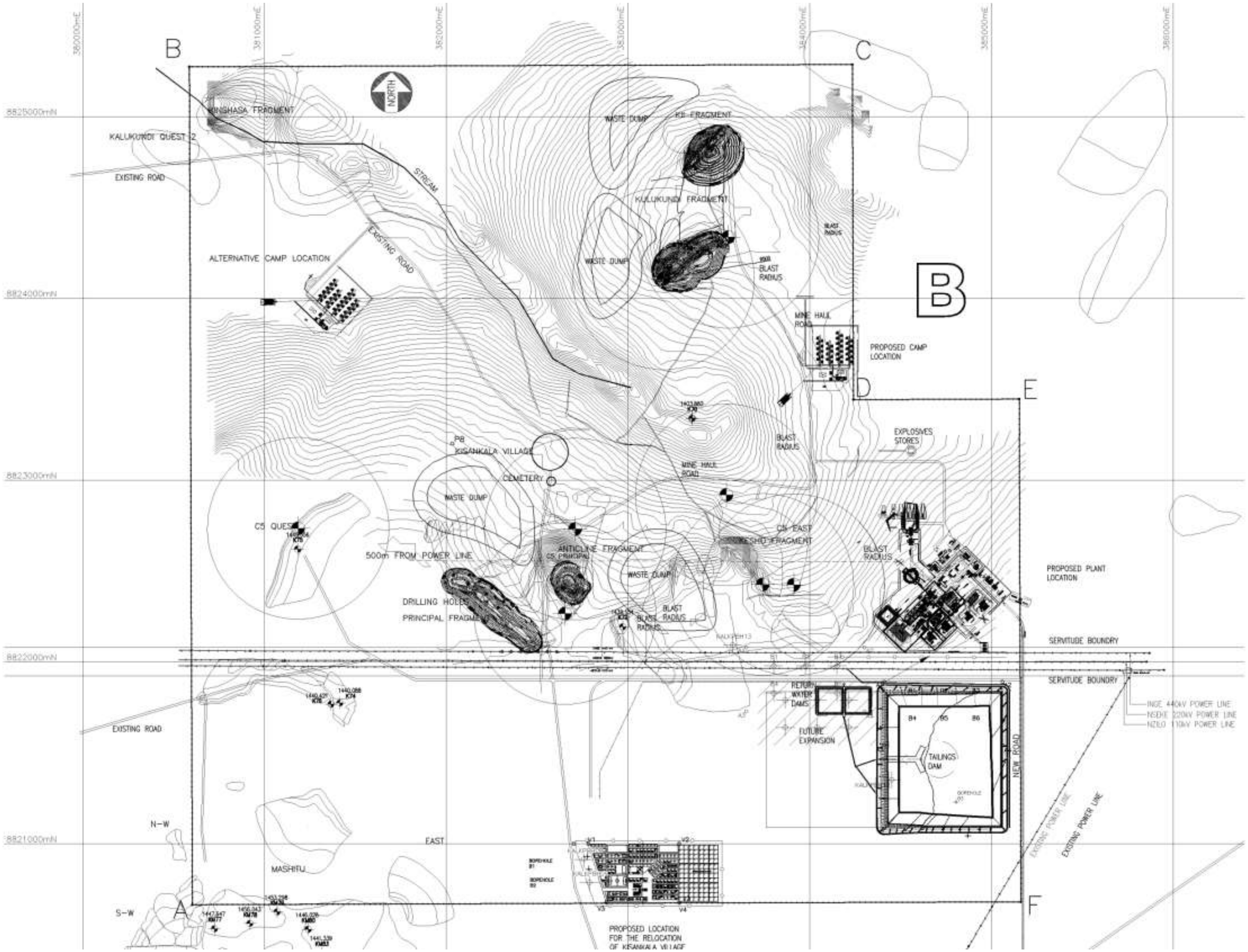


Figure 54: Option C

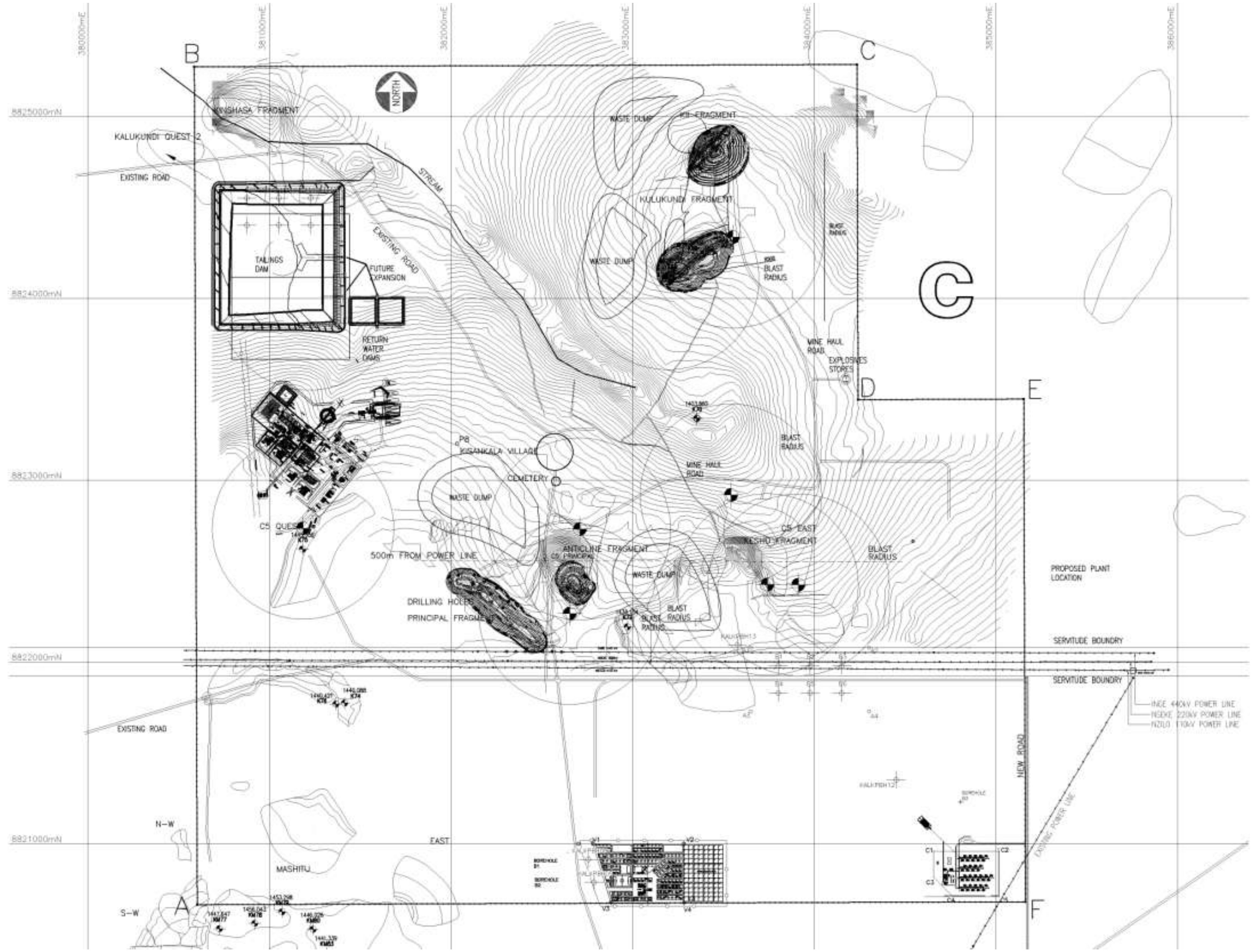


Figure 55: Option D

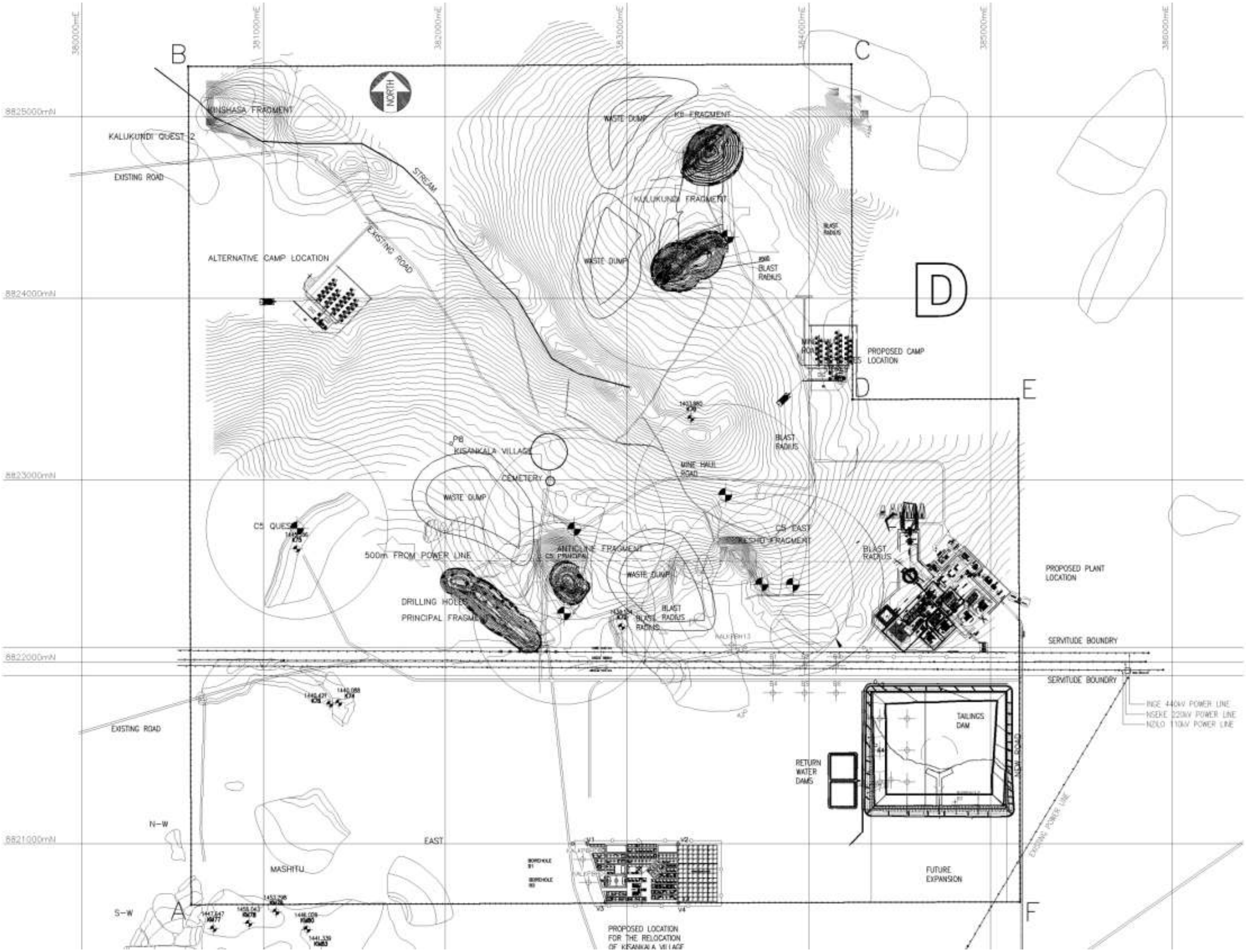
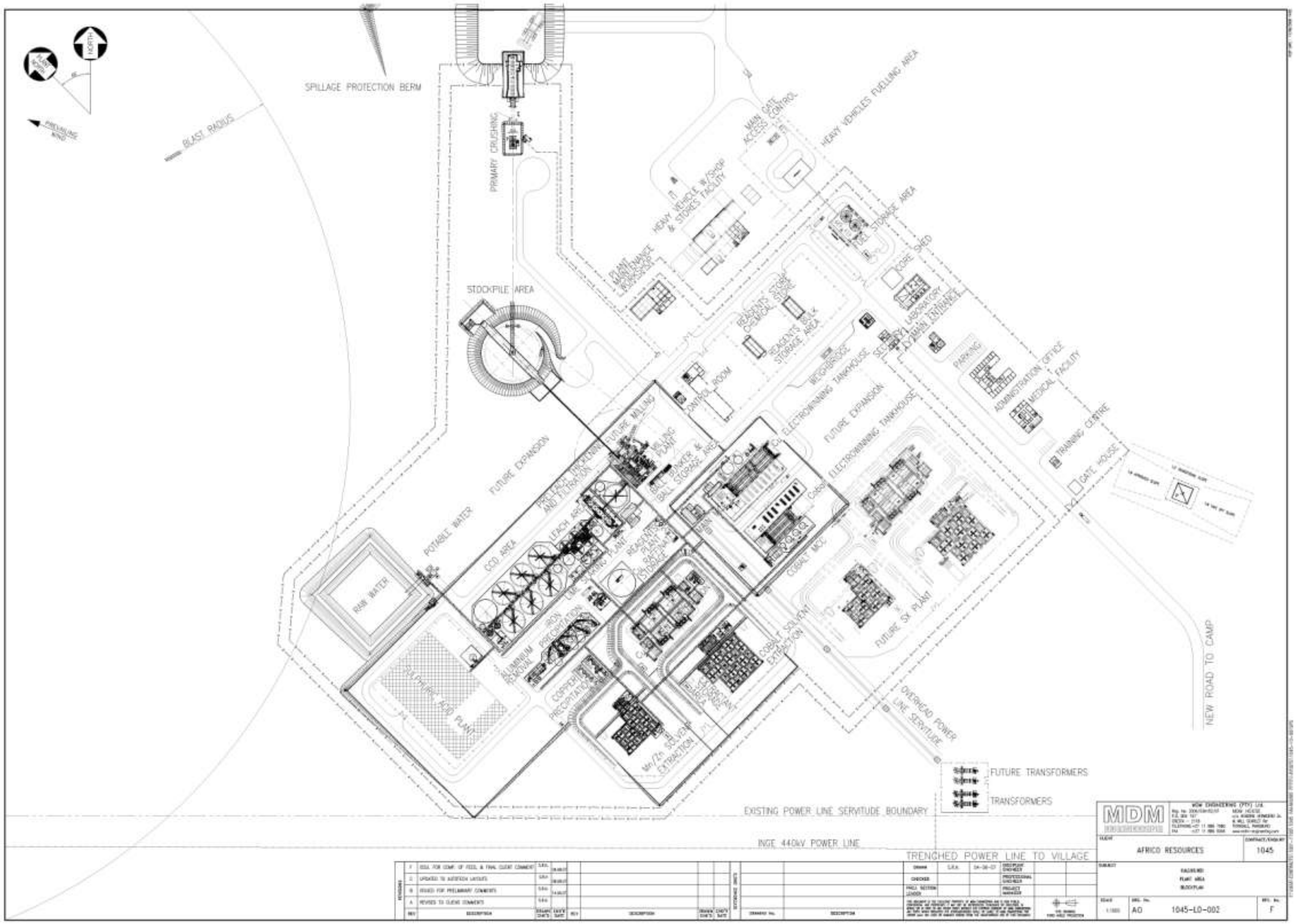


Figure 52: Processing plant layout



Appendix 2:
Botanical Assessment

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Appendix 3:
Icthyofauna (Fish) Assessment

Appendix 4:
Land Degradation Assessment

Appendix 5:
Terrestrial Fauna Assessment

Appendix 6:
Social Impact Assessment

Appendix 7:
Report on the Tailing Storage Facility and Waste Rock Dumps