tfm

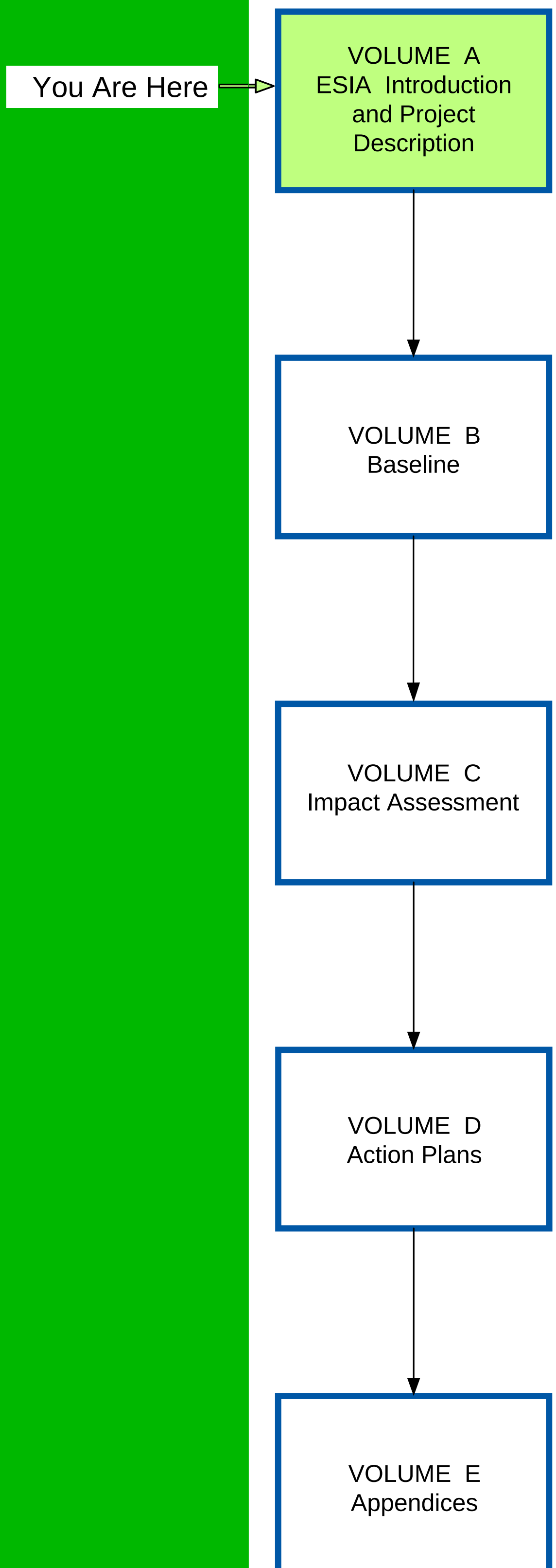
Environmental Impact Assessment Tenke Fungurume Project

Volume A: ESIA Introduction and Project Description

March 2007

Golder Associates

Tenke Fungurume Project
Tenke Fungurume Mining SARL
Application Road Map



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A1 PROJECT INTRODUCTION AND HISTORY

A1.1 PROJECT INTRODUCTION

Tenke Fungurume Mining S.A.R.L. (société à responsabilité limitée) (IDN 6-118-K30745D; NRC 7325) (TFM) is investigating the feasibility of mining and processing copper and cobalt ore in a concession area in the Katanga Province of the Democratic Republic of the Congo (DRC) (formerly Zaïre) (Figure A1.1-1). Copper and cobalt are basic materials used worldwide in residential and commercial construction, electrical and electronics equipment, transportation, industrial machinery and consumer products. Currently, there is good market demand for copper and cobalt and TFM is enthusiastic about the project.

The TFM project lies within two concessions located northwest of Lubumbashi and includes the towns of Tenke and Fungurume. The TFM project's two concessions are collectively referred to as the "concession area." The Tenke Fungurume copper-cobalt ore deposits lie mainly between the towns of Fungurume and Tenke, in an area approximately 20 kilometers long, coming to the surface in many places. The exact size and tonnage of the overall mineral resource is not presently known, but may be in the range of several hundred million tonnes.

TFM proposes mining the Kwatebala, Goma and Kavifwafwaulu (Fwaulu) ore bodies in the concession area, and constructing a mineral processing plant to extract copper and cobalt from the ore. The current estimated life of the proposed project is more than 20 years. The nearest villages to the Kwatebala ore body are Mulumbu, Amoni and Kiboko. The Goma ore body is situated outside the Tenke Gare side of Tenke. The Fwaulu ore body is located between the Kwatebala and Goma ore bodies on the western edge of the tailings storage facility.

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ÉCHELLE 1:12500000 KILOMÈTRES
SCALE 1:12500000 KILOMETERS

LÉGENDE / LEGEND

- CAPITALE / CAPITAL
- VILLE PRINCIPALE / MAJOR CITY
- LA RÉPUBLIQUE DÉMOCRATIQUE DU CONGO / DEMOCRATIC REPUBLIC OF THE CONGO
- PROVINCE DU KATANGA / KATANGA PROVINCE
- PROJET MINIER TENKE FUNGURUME / TENKE FUNGURUME PROJECT

RÉFÉRENCE / REFERENCE

Les images, l'emplacement des villes et les frontières nationales ont été obtenus sous licence de ESRI.
Image data, city locations and country boundaries obtained from ESRI used under license. Projection: Mercator transverse. Système géodésique: WGS 84 Système de coordonnées: UTM Zone 35S
Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE / TITLE

EMPLACEMENT DU PROJET TENKE FUNGURUME DANS LA RÉPUBLIQUE DÉMOCRATIQUE DU CONGO / LOCATION OF THE TENKE FUNGURUME PROJECT IN THE DEMOCRATIC REPUBLIC OF THE CONGO

Golder Associates
Calgary, Alberta

N° projet / project no. 05-1334-035.9300			Échelle telle qu'indiquée Scale as Shown	REV. 0
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SIG / GIS	CW	02 Jan 2007		
VÉRIFIÉ / CHECK	MR	13 Jul. 2006		
APPROUVÉ REVIEW	MR	13 Jul. 2006		

An environmental and social impact assessment (ESIA) and a feasibility study (FS) have been prepared to determine whether it is environmentally, socially, technically and economically feasible to complete the project. Only development of the Kwatebala ore body is assessed in detail in this ESIA (Section A5). A preliminary assessment of the Goma and Fwaulu ore bodies is presented in the cumulative effects sections of the ESIA (Volume C). An addendum to the ESIA, that will assess Goma and Fwaulu in detail, will be prepared prior to development of these ore bodies. To ensure that stakeholders' contributions are taken into consideration, stakeholder consultations have been and continue to be an integral part of the TFM project's process. Stakeholder consultation for the project was initiated in December 2005 and has continued to the present (Section A6). The first major phase of consultation occurred during project disclosure in February and March 2006 with the release of a Background Information Document (Appendix E3). A scoping document was presented and discussed during consultation in May/June 2006 (Appendix E4). Consultation on the draft ESIA occurred in late November/early December 2006.

The project will operate according to applicable local laws, including the Amended and Restated Mining Convention (ARMC), an agreement between the DRC government and TFM, and according to internationally accepted mining practices. The TFM project also will operate consistent with the Equator Principles (EP).

A1.1.1 Project Identification

The TFM project's properties lie on two adjacent concession areas (hereafter referred to as the concession) within the Territory of Lubudi, District of Kolwezi, Province of Katanga. These concessions are covered by exploitation permits, which are discussed in detail in Section A2.1.6.

A1.1.1.1 Tenke Fungurume Mining S.A.R.L

The state-owned Congolese company, La Générale des Carrières et des Mines (Gécamines), is a 17.5 percent shareholder in TFM, and Lundin Holdings Ltd. (LHL, now TF Holdings Ltd., TFHL), a company from the Cayman Islands, owns 82.5 percent of TFM. A wholly owned subsidiary of Phelps Dodge Corporation (PD) in turn owns 70 percent of LFHL. A wholly owned subsidiary of Tenke Mining Corp. owns the remaining 30 percent TFHL. PD has mining and industrial operations on five continents, is one of the world's leading producers of copper, and has a proven ability to develop mines and mineral processing facilities worldwide. It has one of the best safety records of any mining company in the world and maintains strict health, safety and environmental management systems at all its operations. It presently has

25 operations worldwide certified under the International Organization for Standardization (ISO) 14 001 standard for environmental management. PD is also known for ensuring that local communities benefit from its projects.

TFM has committed to undertake its activities in compliance with environmental standards internationally accepted as good mining practice as far as these may be applied in the DRC, as pursuant under the ARMC 2005. This sets forth the contractual framework for the operation of the project, the holding of the mining rights, the tax, customs and para-fiscal regimes, the financial and exchange system, the personnel and social investments, and the environmental protection regime. With respect to personnel and social investments, TFM has committed to work with the DRC government, local organizations and non-governmental organizations (NGOs), and in consultation with local people, to assist with community development projects in the area. The specific content of these commitments are detailed throughout this ESIA in each of the appropriate areas. TFM intends to support projects that can make the greatest positive difference over the longest time.

TFM already has appointed a full-time community liaison officer based at the TFM camp in Fungurume, a full-time community development coordinator based in Lubumbashi, and a full-time environmental, social and community relations director based out of Lubumbashi. This core staff will be supplemented by the efforts of NGO staff with experience and skills appropriate to the project's community development objectives. The TFM project is actively supporting an education plan for the concession area. Now in its design stage, the education project will construct schools in both the Tenke and Fungurume urban areas, and provide targeted support to village schools among the rural communities.

TFM is committed to observing fundamental human rights and the dignity of all individuals within its area of operations. TFM is developing a formal policy to ensure that this commitment is carried out, using the concepts and procedures described in the Voluntary Principles on Security and Human Rights.

TFM is committed to financial transparency and all of its management and employees will receive anti-corruption training. Unlawful corruption and bribery are not tolerated by TFM.

A1.1.1.2 Consultant for the Environmental and Social Impact Assessment

Golder Associates Ltd. (Golder) is an independent environmental and engineering consulting company that has been retained to conduct the ESIA for TFM. Golder maintains 140 offices globally comprised of more than 5,000 staff. The work for this ESIA was conducted by Golder Associates Ltd. Calgary, Alberta, Canada and Golder Associates (Pty) Ltd., Johannesburg, South Africa. In addition, Golder and TFM subcontracted some of the specialized studies to other consulting groups and independent scientists. These independent scientists included experts in socio-economics, community consultation, involuntary relocation, endemic plant species and other specialized disciplines. A listing of these scientists, along with Golder's ESIA preparers, is provided in Appendix E1. Golder has extensive experience in conducting ESIAs for major industry projects, including the mining sector. Contact information is as follows:

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A1.1.1.3 Mineral Rights / Mining Convention

TFM's rights to mine the Tenke Fungurume copper-cobalt deposits arise from a mining convention entered into between LHL (now TFHL), the DRC and Gécamines in 1996 (the "Original Convention"). The Original Convention was governed by the 1981 mining legislation, Law No. 81-013 dated April 2, 1981, the general legislation on mines and hydrocarbons in force at the time ("Mining Law"). The Original Convention is governed by Title III (Articles 38 to 42, entitled "The Conventional Mining Regime") of the Mining Law. The Mining Law allowed, through a mining convention, the granting to the mining operator *inter alia,* a certain number of tax, customs and other advantages and incentives.

The project also was subject to the Ordinance-Law 86-028 dated April 5, 1986, ("Investments Code"), establishing criteria for the eligibility to the conventional system under the Mining Law.

After lengthy discussions with the DRC and Gécamines, the Original Convention was amended and restated on September 28, 2005. The amended and restated mining convention became effective on October 27, 2005 (ARMC). The ARMC is not a new convention, but simply amends and restates the Original Convention. The ARMC sets forth the contractual framework for the operation of the project, the holding of the mining rights, the tax, customs and para-fiscal regimes, the financial and exchange system, the personnel and social investments, and the environmental protection regime.

A1.1.1.4 Feasibility Study

A feasibility study (FS) is designed to provide an overview of the primary issues related to a business idea or proposal. The purpose is to identify any issues that may affect the success of a proposed business endeavor such as:

- Market issues and conditions.
- Organizational/technical issues.
- Overall costs.

The FS for the project was conducted by GRD MinProc, an internationally known Australian engineering company, and has been submitted as a separate document from the ESIA (MinProc 2007).

A1.2 PROJECT OBJECTIVES

A1.2.1 Rationale for Project

TFM wishes to advance the TFM project to mine and process copper and cobalt ores; produce and market copper and cobalt products, which are products useful to society; and earn a profit for its partners and shareholders. In addition, TFM wishes to conduct this operation in a manner that minimizes the negative impacts of the project on people and the environment, and maximizes the benefits the project can bring to the local, regional and national stakeholders in the DRC.

A1.2.2 Economic Viability

To date, the TFM project's mineral concession area remains under-explored. However, exploration conducted to date and the FS suggest that the mineral wealth of the Kwatebala, Goma and Fwaulu deposits in the TFM project concession area is capable of sustaining a rate of 115,000 tonnes per year of copper production and an average of 8,000 tonnes per year of cobalt production (with some flexibility to produce an additional 2,000 tonnes of cobalt from 4,500 tonnes of cobalt hydroxide) for a minimum of 40 years.

A1.2.3 Future Potential

The concessions are estimated to contain over 500 million tonnes of high-grade mineral ore. The ore has an average grade of 2.1 percent copper and 0.3 percent cobalt. The overall copper grade might be lower than this number.

The overall project is currently envisioned to be developed in three phases:

1. Kwatebala (2008).
2. Goma and Fwaulu (2017 or later).
3. Fungurume (to be determined).

This ESIA is scoped to fully assess the development of the ore body at Kwatebala. A detailed assessment of development of the Goma and Fwaulu orebodies will occur in an addendum to this ESIA prior to their development. Further details on this phased approach are provided in Sections A5.8.2 and A5.8.3.

Current and past studies suggest that production of copper could reach 400,000 tonnes per year by mining the entire oxide ore of the TFM concession area. Production at this level is assessed from a cumulative effects perspective in Volume C.

There are also extensive resources at Kwatebala Hill that have not been included in the FS. Initial exploration suggests that further drilling and engineering will demonstrate that deep oxide and mixed sulfide ores exist in sufficient quantity to justify mining. The current mine plans concentrate only on the relatively shallow oxide ore materials.

A1.2.4 Goals for Reclamation and Closure

The reclamation and closure plan is a part of TFM's commitment to ensure that the project not only complies with national and international guidelines, but that the project also operates within a sustainable development framework. To this end, the facilities will be reclaimed with the goal of re-establishing a productive use after closure, where practical and feasible. Project infrastructure, such as roads, construction camps and industrial facilities, will be integrated to the extent practical into a post-closure land use plan. The reclamation and closure plan is presented in Section D5.

The intent of the TFM project is to establish and apply an accepted standard of reclamation based on industry best practices and international standards. TFM's reclamation objectives include:

- Designing a durable and cost-effective closure strategy that minimizes the long-term cost of post-closure maintenance and monitoring.
- Returning the site to a safe and stable condition, free of safety hazards (such as unsafe buildings, equipment, open holes, chemicals and/or their residuals).
- Returning the site to a viable and, wherever feasible, self-sustaining ecosystem or socially accepted post-mining land use that is compatible with the surrounding environment.
- Using proven, demonstrated technologies, including passive closure strategies where feasible and other new technologies and practices that may emerge over the life of the project wherever feasible.
- Reducing post-mining liabilities by considering opportunities to incorporate closure considerations into the design and operation of mine facilities, and implementing closure and reclamation activities concurrently with mining.
- Assessing the social and economic implications of mine closure and developing appropriate transition strategies for TFM employees and the local community, as defined in the TFM project's environmental and social action plans (Volume D).
- Introducing the concept of alternative post-mining land uses to the local community and incorporating local priorities into the closure planning process.

The TFM project will periodically refine and update closure strategies according to actual operating, environmental and social conditions. TFM's overall objective is that closure strategies and costs will be evaluated and optimized about two years before the end of the active mining phase.

A1.3 REPORT STRUCTURE

The ESIA is composed of five volumes:

- Volume A contains the project description, the national and international regulatory framework and the internal policies that TFM and its employees will adhere to during the life of the project.
- Volume B contains the project area baseline studies which describe the environmental and social conditions in the project area prior to any project-related development.
- Volume C contains the impact assessment of project-related effects on environmental and social systems. It includes an evaluation of both positive and negative effects as well as an assessment of cumulative effects.
- Volume D contains the environmental and social management plans to address various aspects of the project.
- Volume E contains the appendices consisting of supporting documents to the ESIA.

The FS (Minproc 2007) is available as a separate report.

A1.4 PROJECT AREA

A1.4.1 Democratic Republic of the Congo

The DRC is located in central Africa. The DRC is one of the largest countries on that continent covering an area of 2.3 million square kilometers, roughly the size of Western Europe (Figure A1.1-1). The DRC straddles the equator and is largely landlocked with a very narrow strip of land on the South Atlantic Ocean. Much of the country is dense tropical rain forest in the central river basin and eastern highlands. The southern portion of the country is made up of miombo woodland, which is a mix of tropical woodland and wetland ranging across parts of the DRC, Angola, Botswana, Malawi, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe (WWF 2006b).

The capital of the DRC is located at Kinshasa in the southwest of the country close to the border with Congo Brazzaville. Current estimates place the population at more than 60 million people (CIA 2006). The legal system is based on a combination of tribal law and Belgian civil law.

The TFM project is located in the Katanga Province (Figure A1.1-1), the southernmost province of the DRC. The capital of the Katanga Province is Lubumbashi, the second largest city in the DRC (formerly Elizabethville in French, Elisabethstad in Dutch). The population of the Province is estimated at 4.1 million. Farming and ranching are carried out on the Katanga Plateau. The eastern part of the Province is a rich mining region, which supplies cobalt, copper, tin, radium, uranium and diamonds.

Government and Politics

The Republic of the Congo gained its independence from Belgium in 1960, but its early years were marred by political and social instability. Colonel Joseph Mobutu seized power and became president in November 1965. He changed his name to Mobutu Sese Seko and the name of the country to Zaïre. Mobutu remained in power for 32 years.

In 1997, Rwanda invaded the country to flush out extremist Hutu militias, giving a boost to anti-Mobutu rebels. Laurent Kabila later became president and renamed the country the Democratic Republic of the Congo (DRC). A rift between Kabila and his former allies sparked a rebellion in 1998, backed by Rwanda and Uganda. Angola, Namibia and Zimbabwe took Kabila's side, bringing the country into a wider war.

A cease-fire was signed in 1999 between the DRC, Zimbabwe, Angola, Uganda, Namibia, Rwanda and Congolese armed rebel groups, but sporadic fighting continued. Laurent Kabila was assassinated in January 2001 and his son Joseph was named head of state. In October 2002, Joseph Kabila successfully negotiated the withdrawal of Rwandan forces. Two months later, the Pretoria Accord was signed by all remaining warring parties to end the fighting and establish a government of national unity. A transitional government was set up in July 2003. Joseph Kabila remains president and is joined by four vice presidents representing the former government, former rebel groups, and the political opposition (BBC 2006; CIA 2006).

Kabila’s transitional government held an election in July 2006 to determine the presidency and National Assembly seats. Kabila obtained the highest percentage of votes during the first round of the presidential race, but did not obtain enough votes to win the election. A second round run-off election was held between Kabila and Jean-Pierre Bemba, a vice-president in the transitional government, to determine the presidency. Kabila was confirmed as the winner of this round in late November 2006.

Economy

The DRC is richly endowed with natural resources: fertile land; one of the largest tropical rain forests in the world; hydropower; and Africa's largest deposits of copper, cobalt and coltan (i.e., columbium [niobium] tantalum, locally referred to as "coltan"); and significant reserves of other minerals, including gold, coal, diamonds, tin and zinc. Copper and cobalt are the key commodities produced by the DRC.

The copper belt situated between DRC and Zambia is one of the world's greatest metallogenic provinces; it is estimated to contain 34 percent and 10 percent of global cobalt and copper reserves, respectively. The area contains the world's highest grades of copper and cobalt deposits, with tailings facilities dumps often containing grades greater than that of most other mining areas. The proposed TFM project is located within this richly endowed metallogenic region.

Natural resources figure prominently in the DRC economy. Over 55 percent of its gross domestic product (GDP) comes from agriculture, forestry and mining. Mining used to be the mainstay of DRC's economy. During the mid-1980s, the mining sector accounted for about one-fourth of the country's GDP, one-fourth of its fiscal revenue, and three-fourths of export receipts. At that time, DRC (called Zäire) was the world's largest producer and exporter of cobalt and the world's fifth largest producer of copper.

Between 1986 and 2001, DRC's formal mining[1] sector collapsed, due to large financial losses incurred by state enterprises operating in the sector, associated with mismanagement and a heavy tax burden that prevented them from maintaining plants and equipment; and an economic environment hostile to private mining operations. The decline in formal mining was partially offset by a substantial increase in artisanal mining activities, particularly artisanal diamond mining.

[1] Formal mining is based on a government-issued concession, stipulating an operator's rights and obligations concerning the exploration and exploitation of one or more geographically defined mining areas. Artisanal mining in contrast is not based on a government-issued concession and as such is in violation of existing legislation. Its activities are not systematically monitored and recorded.

Reflecting its steep output slump, the mining sector's contribution to GDP and export earnings declined precipitously. While mining remained a major source of export receipts (due to diamond exports), it accounted for only a six percent share of GDP in 2000. The mining sector was plagued with serious problems that hampered its development. These problems included a legal and regulatory environment deleterious to private sector development, serious transportation issues and a chronic lack of private investment.

By 2001, when DRC initiated the process of macro-economic stability and re-opening its economy, the mining sector's "recorded" contribution to GDP had shrunk to about seven percent. Most sectors of the economy have steadily improved, with mining, manufacturing, construction and trade contributing significantly to national economic growth.

Conditions improved in 2002 with the withdrawal of a large portion of the foreign troops. The transitional government formed in 2003 re-opened relations with international financial institutions and international donors. Economic stability improved between 2003 and 2005 under Joseph Kabila's leadership, although an uncertain legal framework continues to hamper growth. In 2005, there was renewed activity in the mining sector, the source of most exports, which boosted the DRC's fiscal position and GDP growth (BBC 2006; CIA 2006). In 2005, the mining sector's share in the DRC's growing GDP had recovered to an estimated 14 percent. More information on the DRC's economy is provided in Appendix C4.1-I.

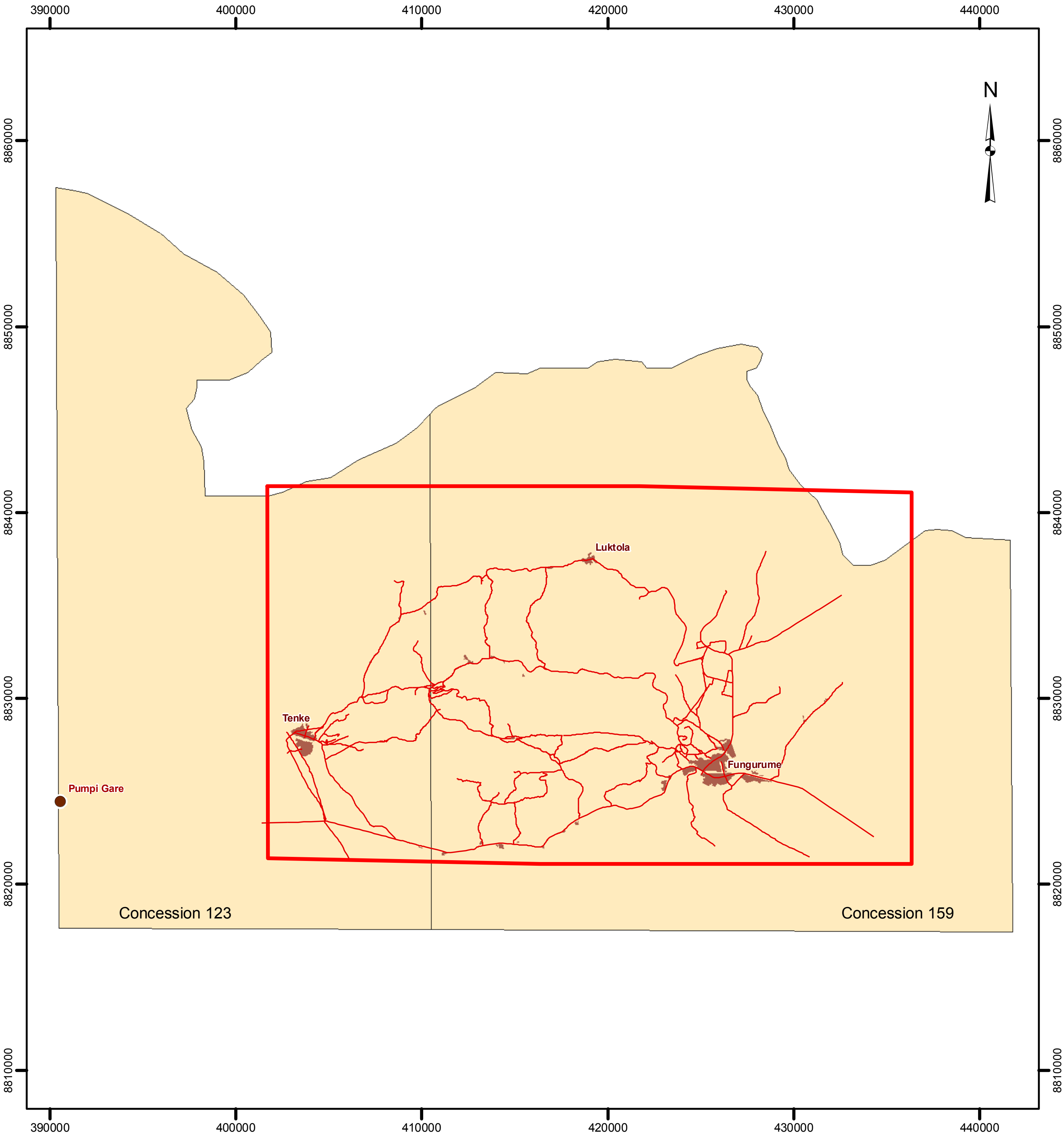
A1.4.2 Tenke Fungurume Concessions and Ore Bodies

The Tenke Fungurume deposits are located within two adjoining concessions (Figure A1.4-1). The concessions are about 180 kilometers northwest of the provincial capital of Lubumbashi.

The Tenke Fungurume copper-cobalt deposits are part of the Central African Copperbelt, a geologic structure known as the Lufilian Arc. It stretches from Kolwezi in the DRC to Luanshya in Zambia. The Tenke Fungurume deposits lie on the northern edge of this copper belt. The area contains extensive high-grade copper-cobalt mineralization.

A1.5 PROJECT HISTORY

The mineral wealth of the Tenke Fungurume region has attracted mining activity for thousands of years. This section provides a brief overview of mining activity from pre-historic times to the present.



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ÉCHELLE 1:300000 KILOMÈTRES
SCALE 1:300000 KILOMETERS

LÉGENDE / LEGEND

- ROUTE / ROAD
- CONCESSION
- VILLAGE
- ÉTABLISSEMENT HUMAIN / SETTLEMENT
- ZONE RÉGIONALE / REGIONAL STUDY AREA

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S /
Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE
TITLE

CONCESSIONS DE TENKE FUNGURUME /
TENKE FUNGURUME CONCESSIONS

Golder Associates
Calgary, Alberta

N° projet / project no. 05-1334-035.9300		Échelle telle qu'indiquée Scale as Shown	REV. 0
DESSIN / DESIGN	GE	20 Mar. 2006	
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VÉRIFIÉ / CHECK	MR	27 Jul. 2006	
APPROUVÉ REVIEW	MR	27 Jul. 2006	

FIGURE: A1.4-1

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A1.5.1 Pre-historic and Historic Mining

Archaeological studies (Section B4.2) have determined that mining activity occurred in the Tenke Fungurume region during the pre-historic period. Archaeological reconnaissance found slag (residue from the smelting process) at locations along both banks of the Dipeta River and trial excavations found slag at three other sites. Decorated pottery shards and burnt earth also were found at archaeological sites.

These studies established that mining activity in the Tenke Fungurume concession dates as far back as the Acheulean period (about 1,500,000 to 200,000 B.C. [before Christ]). Late Stone Age (about 6,000/4,000 to 2,200 B.C.) artifacts were found at a number of sites in the concession although more refined dating and detail were not obtained. Iron Age (about 500 B.C. to 1,400 A.D. [Anno Domini]) activity was found, but it was not clear whether those artifacts dated from the Early or Later Iron Age. The literature suggests that there was a great deal of mining activity in the Katanga Province region during the Iron Age.

A1.5.2 Pre-Tenke Fungurume Mining

The Tenke Fungurume region was first explored and drilled in 1918 by the Union Minière du Haut Katanga. However, because of inappropriate technology and the complex mineralogy, the deposits were never brought into production at an industrial scale.

In 1970, the Société Minière de Tenke Fungurume (SMTF) and Gécamines were awarded the concessions and began to study the feasibility of constructing a mine. Approximately 98,000 meters of drilling and 17,000 meters of trenching were undertaken. The concession was abandoned by SMTF a year later after construction of some of the infrastructure had begun. Six years later the project was abandoned entirely because of economic and political issues, and the consortium was dissolved. Considerable previous development was associated with that mining project. Although construction had begun on the plant site, including installation of a crusher and conveyor, the site was abandoned before construction was completed. Arterial roads and drilling access roads were constructed and remain in use today.

A1.5.3 Artisanal Mining

The term “artisanal” is widely used to distinguish between non-mechanized and mechanized production techniques, and in the economic development literature has most often been applied to the fisheries and mining sectors. There is no formally accepted definition of artisanal mining, however, artisanal mining is usually characterized by the lack of mechanization, low safety standards, poorly trained personnel, influx of migrant workers, low pay scale, low productivity, chronic lack of capital, illegality due to mining without concession rights, little consideration of environmental impacts, and unknown mineral reserves (Labonne and Gilman 1999). All of the issues identified above can be readily observed in the artisanal mining operations of the DRC, which have largely functioned in an informal and unregulated manner. The safety, equitability and economic issues associated with the activity in Katanga in particular are widely recognized, as most recently described by Global Witness (2004).

The DRC government and its multilateral stakeholders have sought to address problems posed by the artisanal mining sector through specific provisions of the 2002 Mining Code. The mining legislation provides a definition of artisanal exploitation as “any activity by means of which a person of Congolese nationality carries out extraction and concentration of mineral substances using artisanal tools, methods and processes, within an artisanal exploitation area limited in terms of surface area and depth up to a maximum of thirty meters” (Article 1, Definition of Terms). The 2002 Mining Code and its accompanying regulations further include requirements for how individual artisanal mining licenses may be obtained, and for how an ‘artisanal exploitation area’ can be established; the latter including prohibition of the activity on mineralized areas that are otherwise commercially feasible for mining by industrial methods.

All artisanal mining conducted in the Tenke Fungurume concession area is unauthorized and illegal. Prior to late 2005, artisanal mining in the concession area was prevalent and mostly uncontrolled (Photograph A1.5-1). Unauthorized artisanal mining has since been controlled within the TFM concession, as further described in Sections B4.1, C4.1 and D4 of the ESIA.

Although village residents described economic hardships that resulted from the loss of this activity, they were equally open about several negative aspects of hosting unauthorized digging in their communities, as summarized below:

- Heavy and constant alcohol and other substance abuse on the part of the non-resident diggers.
- Increases in prostitution and violent/sexual assaults on resident members of the villages.
- Decreased food supplies and drop in farming production due to sales of food to diggers and the pursuit of economic activities other than farming.
- Dangerous working conditions within the unsupported tunnels used by the diggers.

- Disrespect for traditional authority and local customs by the non-resident diggers.

According to baseline survey data, many of the unauthorized artisanal miners remained in the concession after the activity was stopped, contributing to the increase in population of the Tenke and Fungurume area from 26,000 in 1998 to 61,000 in 2006 (Appendix B4.1-I).

Photograph A1.5-1 Artisanal Mining at Goma Hill

A1.5.4 Current Project

TFM will manage the proposed project. TFM has spent over 38 million USD on exploration, pilot plant and capital investment on infrastructure in the area. Planning for the overall project includes the exploration of the resource, mine planning, process and infrastructure design, and environmental baseline and tailings management studies.

The TFM project is expected to last over 40 years with initial production at 115,000 tonnes per year of copper and 8,000 tonnes per year of cobalt (and up to an additional 2,000 tonnes of cobalt from 4,500 tonnes of cobalt hydroxide). The focus of the ESIA is a detailed assessment of the Kwatebala ore body, to be developed beginning in 2008. An assessment of the effects of mining the Goma and Fwaulu ore bodies (beginning in 2017 or later) is assessed from a cumulative perspective in this ESIA. A more detailed assessment of these ore bodies will be conducted prior to their development. A detailed description of the project is provided in Section A4.

A2 LEGAL AND POLICY FRAMEWORK

This section defines the legal and policy framework governing the Tenke Fungurume Mining project (the project) for the environmental and social impact assessment (ESIA). Laws of the Democratic Republic of the Congo (DRC) and policies and guidelines of the Equator Principles (EP) will apply to the construction, operation and closure of the project. The EP policies and guidelines are internationally accepted environmental and social standards for major mining projects, and are derived from the policies and guidelines of the World Bank Group.

A2.1 MINERAL RIGHTS AND DRC LEGAL REGIME

Tenke Fungurume Mining S.A.R.L. (TFM), a company incorporated under the laws of the DRC was formed for the purpose of developing the deposits of copper, cobalt and associated minerals under mining concession nº 198[2] and mining concession nº 199[3] granted to TFM in 1996 at Tenke and Fungurume in Katanga Province. Currently, TFM's shareholders are the state-owned Congolese company, La Générale des Carrières et des Mines ("Gécamines"), which owns 17.5 percent of TFM, and TF Holdings Limited (TFHL) (formerly Lundin Holdings Ltd.), a Bermuda company, which owns 82.5 percent of TFM. Phelps Dodge Corporation indirectly holds a 70 percent interest in TFHL and is accordingly the majority shareholder in TFM. Tenke Mining Corp., a Canadian company, holds the remaining minority interest in TFHL.

A2.1.1 The Mining Convention of 1996

TFM's rights to mine the Tenke Fungurume copper-cobalt deposits arise from a mining convention entered into between Lundin Holdings Limited (now TFHL), the DRC and Gécamines in 1996 (the "Original Convention"). The Original Convention was governed by the 1981 mining legislation, Law No. 81-013 dated April 2, 1981, the general legislation on mines and hydrocarbons in force at the time ("Mining Law"). The Original Convention is governed by Title III (Articles 38 to 42, entitled "The Conventional Mining Regime") of the Mining Law. The Mining Law allowed, through a mining convention, the granting to the mining operator *inter alia,* a certain number of tax, customs and other advantages and incentives. The project also was subject to the Ordinance-Law 86-028 dated

2 Renumbered nº 123 by the *Cadastre Minier Certificat d'Exploitation* nº CAMI/CE/940/2004 dated November 3, 2004; renewed by Ministerial Decree dated October 10, 2006, pending division and renumbering by the *Ministère des Mines*.

3 Renumbered nº 159 by the *Cadastre Minier Certificat d'Exploitation* nº CAMI/CE/941/2004 dated November 3, 2004; subsequently divided and renumbered nº 159, nº 4728, and nº 4729 by the *Ministère des Mines* through Ministerial Decree dated July 7, 2006.

April 5, 1986, (“Investments Code”), establishing criteria for the eligibility to the conventional system under the Mining Law.

A2.1.2 The Mining Law of 1981

When the Tenke Fungurume investment project was agreed to in 1996, the applicable legislation governing the mining industry in the DRC was the Mining Law. Under the Mining Law, large-scale mining is conducted pursuant to the granting of a mining concession, which grants an exclusive right to conduct all operations regarding prospecting, research and exploitation of the mineral substances within the delimited perimeter of the concession, without limit as to depth. The mining concession entitles its holder to proceed with all operations of concentration (milling), metallurgical and chemical treatment, and transformation.

Under the Mining Law, a mining concession is granted for a term of 20 years and is renewable once or twice for successive 10-year terms. Thereafter, the mining concession holder may seek to obtain a new concession. The renewal is automatic, provided the concession holder justifies a real activity, presents an exploitation program deemed sufficient by the Service of Mines and duly preformed its legal duties during the prior concession period.

A2.1.3 The Amended and Restated Mining Convention of 2005

After lengthy discussions with the DRC and Gécamines, the Original Convention was amended and restated on September 28, 2005. The amended and restated mining convention became effective on October 27, 2005 (ARMC). The ARMC is not a new convention, but simply amends and restates the Original Convention. The ARMC sets forth the contractual framework for the operation of the project, the holding of the mining rights, the tax, customs and para-fiscal regimes, the financial and exchange system, the personnel and social investments, and the environmental protection regime.

Under the ARMC, TFM has committed to undertake its activities in compliance with environmental standards internationally accepted as good mining practice (as discussed in more detail throughout Section A2). With respect to personnel and social investments, under the ARMC TFM has committed to create a fund to assist local communities affected by the project with the development of local infrastructure and related services, such as those pertaining to health, education and agriculture. This fund will be financed by payments from TFM at a rate of 0.3 percent of the net sales revenues (ex-works from the mine) of production.

A2.1.4 New Mining Code of 2002

On July 11, 2002, the DRC established a new mining code, Law No. 007/2002 (New Mining Code). Consistent with the terms of the New Mining Code, TFM opted to maintain its rights under the Original Convention rather than operate under the New Mining Code. The only obligations provided for in the New Mining Code which apply to the project are those concerning the validation and conformation of the mining titles (i.e., the original "mining concessions" nº 198 and nº 199, which are now evidenced by "exploitation permits" nº 123, nº 159, nº 4728, and nº 4729) related to the project. Accordingly, the legal, economic, financial, fiscal and social conditions of the project are governed by the ARMC and the 1981 Mining Law. Pursuant to a stability of legislation clause in the ARMC, the rights and obligations of the parties (i.e., the DRC state and TFM) unrelated to the statutory mining regime are primarily governed by the general laws of the DRC in force on November 30, 1996, the date of the Original Convention.

A2.1.5 Governor Authorization under Mining Law

Pursuant to Article 45 of the Mining Law, the holder of a mining title must obtain the authorization from the Governor of the Province to occupy land inside the mining perimeter necessary for its activity and related industries. The occupation authorization grants, in the absolute, without prejudice to possible rights of third parties, the holder of the mining title all the prerogatives that the title entitles him to, including:

- Constructing industrial and habitation installations.
- Using the water of non-navigable or non-floatable waterways.
- Digging canals and channels.
- Establishing means of communication and transportation of all kinds, both within and outside the mining perimeter.

The Governor Authorization under the Mining Law grants general prerogatives under the Mining Law, but does not exempt certain mine operation activities from specific permits and authorizations, notably in relation to environment, health and safety. These permits and authorizations include an exploitation permit for dangerous, unhealthy and nuisance establishments, the generation of electricity, the use of water, etc. (Section A.2.1.6).

A2.1.6 Specific Permits Required

As stated above, after obtaining the Mining Law Authorization, additional permits and authorizations are required, such as the construction of the four villages in a new location within the lining concession; wood felling; mine establishments; and mine operations including use of water resources, water discharge and electrical infrastructure improvements.

After reviewing the applicable DRC legislation pursuant to the ARMC's stability of legislation provision (see above sub-section A2.1.4), several permits and authorizations were identified as required for mine development. Due to the passage of time since the laws applicable to TFM's project were promulgated and the disruption in governmental services due to civil war, TFM is faced with the difficult task of operating under stabilized laws that may be unfamiliar to the DRC government officials responsible for regulating TFM's activities. To overcome this hurdle, TFM will work with the responsible governmental agencies to determine the process for review, issuance and fee structure for the required permits and authorizations. Based on our experience, this will require utilization of the current laws review, processing and issuance mechanisms, while maintaining an eye toward the requirements of the stabilized legislation. In many cases, this will require TFM to prepare permit applications that comply with both the stabilized legislation and the current law requirements. With respect to fees, TFM will seek to utilize the fee structures established as of the date of the ARMC, September 28, 2005, for the various activities that require permits or authorizations. This approach is consistent with TFM's commitments under the ARMC to utilize the fiscal regime as established under the New Mining Code as of the date of the ARMC.

Given the reorganization of the current DRC government from a transitional government to an elected government, and the inherent difficulties associated with operating under stabilized legislation, the specific procedures to obtain a permit or authorization may change. The following paragraphs describe the specific permits and authorizations that have been identified as required for mine development, as well as the procedures and fee structures that TFM intends to use to obtain the various permits or authorizations.

a) Construction permits for village relocation.

The construction related to the relocation of the villages of Amoni, Kiboko and Mulumbu, as more fully described in the Resettlement Action Plan (see Section A2.6 below), will require a construction permit. A construction permit is required pursuant to Articles 20 and 21 of the Decree on Urban Planning dated June 20, 1957, before starting any works involving:

- Building, re-building, demolishing or modifying constructions, except for conservation and maintenance work.
- Thoroughly modifying the landscape (earthworks).

- Logging, except in situations of emergency or for normal exploitation.
- Subdividing land where buildings will be constructed, and offering the plots of land or those buildings for sale.

Construction permits are obtained from the Governor of the Province, who will review the construction plans while giving appropriate consideration to urban planning. The Governor delegates this review and permitting process to two technical branches of the government, namely the Land Registry ("Cadastre Foncier") and the Urbanism and Housing Department, according to the "Arrêté Départemental" CAB/CE/URB-HAB/012/88 dated Oct 22, 1988, regulating the Construction Authorization and the Conformity Certificate. The process for collection of fees for the issuance of the construction permits are established by the Law N°04/075 of July 16, 2004 "establishing the nomenclature of actions which generate administrative, judiciary or national incomes and participation, as well as tax collection." While not legally required, TFM has voluntarily accepted, without waiving its rights, the application of these current permit review and fee structures to overcome the inherent difficulties associated with obtaining an authorization using the procedures and fees established in 1957.

In summary, a land permit and construction permit are required for the four new sites where the three villages will be relocated. The first permit is granted by the Land Registry in Kolwezi. The second permit is granted by the Department of Urbanism and Housing in Lubumbashi.

b) Wood felling permit.

Although most areas proposed for land clearing prior to construction of the mine and ancillary facilities are only sparsely forested, there are some areas of intact Miombo forest within the footprint of the project where authorization is required. TFM does not plan to conduct any deforestation outside of the mining concession. The Forest Decree of April 11, 1949 Articles 23 through 26 govern TFM's wood felling activities. The Mining Law supplements the Forest Decree of 1949 by restating the obligation for companies felling wood on a mining concession to request and be granted a general wood felling authorization by the Governor.

A Wood Felling Declaration detailing planned wood clearing must be made by TFM under the Forest Decree of 1949, Article 25, and triggers a fee under Article 23 that TFM pays under the fee structure established by the Law No. 04/075 of July 16, 2004 "establishing the nomenclature of actions which generate administrative, judiciary or national incomes and participation, as well as tax collection" as if the Wood Felling Declaration had been a Wood Felling Permit required under the current Forest Code of 2002. The competent authority for issuing a wood felling permit is the Provincial Division of the Ministry of

Environment. The fees required for the issuance of this permit are established by the Interministerial Decree No. 005 / CAB / MIN / ENV / 2005 and No. 107 / CAB / MIN / FINANCES /2005 of 24 July 2005.

c) Exploitation permit for dangerous, unhealthy and nuisance establishments.

TFM will require authorization to establish and conduct certain activities related to its mining operations. Pursuant to Ordinance 41-48 dated February 12, 1953, concerning dangerous, unhealthy and nuisance establishments ("Ordinance 41-48"), any person or entity wishing to perform an activity that may prove dangerous, unhealthy or a nuisance must seek and obtain an Exploitation Permit prior to erecting, transforming, relocating or operating the establishment. The competent authority for issuing an Exploitation Permit is the Provincial Division of the Ministry of Environment. The process for collection of fees for the issuance of this permit is established by Law N°04/075 dated July 16, 2004 "establishing the nomenclature of actions which generate administrative, judiciary or national incomes and participation, as well as tax collection." The fees required for the issuance of this permit are established by the Decree N°027/CAB/MIN/ECNT/95 dated May 17, 1995 modifying the tax rates established in Ordinance 79-244 dated October 16, 1979, and the Inter-departmental Orders No. 006 / CAB / MIN / ENV / 2005 and No. 108 / CAB / MIN / FINANCES / 2005 dated July 25, 2005. The Ministry of Environment will issue permits only after an on-site investigation and consideration of environmental, health and safety issues.

The activities considered as dangerous, unhealthy or a nuisance are exhaustively listed in the table annexed to Ordinance 41-48. In practice, the operation of an establishment such as a mine involves more than one activity listed in the annex to Ordinance 41-48. In these cases, only one permit is required to cover all the activities that will be performed by a single establishment. After the Exploitation permit is issued, if the establishment wishes to engage in other activities subject to Ordinance 41-48, it may request a modification of its permit to cover the additional activities. For TFM, activities that require permitting include:

- Mining-related activities, such as fuel storage, flammable products storage, laboratory, chemical products, storage of explosives, hospitals, electrical equipment, acid storage, and use of asphalt.
- Mining-related activities with the potential to discharge liquid, gases and other substances in lakes and watercourses or otherwise affect water resources; TFM will have a sewage discharge from both the construction camp area and the mine/processing plant area, as well as the potential to discharge to groundwater or surface water from the processing plant and mine.

d) Authorizations for the use of surface water and underground water.

TFM plans to use groundwater from the existing well field near Fungurume and from a new well field to be installed near Kwatebala. This water will be used as a drinking water supply for the construction village and the primary water supply for operation of the copper and cobalt processing plant. TFM will require certain authorizations to utilize these water resources.

Pursuant to the Ministerial Order No. 00144/DPT-MINER/86 dated September 2, 1986, a person is prohibited from drilling a well or using surface water from a watercourse without the prior authorization of the Minister of Energy, unless such use has been authorized by REGIDESO, a water-supply agency. Prior to receiving authorization to use groundwater or surface water, TFM must obtain an authorization from REGIDESO and pay applicable fees.

Additionally, in certain zones where the Governor of the Province has decided that water resources must be carefully regulated due to scarcity or exceptional needs, the authorization of the Governor must be obtained. According to Ordinance 52-443 dated December 21, 1952, concerning measures to protect sources, underground aquifers, lakes and watercourses, to avoid pollution and waste of water and to control the exercise of usage rights and conceded rights of occupation, the Governor's authorization is required prior to any use of water if these special circumstances exist. While the Governor has not made a scarcity or exceptional needs determination on the TFM concession, pursuant to its obligations under the Mining Law 1981, TFM will nonetheless request the authorization from the Provincial Governor to undertake the planned water-related activities.

TFM must apply for water use authorizations with the Provincial Division of the Energy Ministry. For purposes of determining the appropriate authorization fee, TFM has voluntarily agreed, without waiving any of its rights, to the application of the Law N°04/075 dated July 16, 2004 "establishing the nomenclature of actions which generate administrative, judiciary or national incomes and participation, as well as tax collection," applying the fees specified in the Inter Ministerial Decree n0011 / CAB / MIN / ENERG / 2005 and N°081 / CAB / MIN / FINANCE / 2005 dated July 8, 2005 fixing the rates of taxes and fees to be collected by the Ministry of Energy. This approach is similar to that utilized for the Wood Felling Permit and Exploitation Permit for dangerous, unhealthy and nuisance establishments.

e) Authorization to conduct activities with the potential to affect water resources.

The TFM project has the potential to affect the quantity and quality of groundwater and surface water in the Kwatebala area. In addition, there will be a need for discharge of treated sewage effluent from the construction camp and from the mine/processing plant area. These activities require specific authorization under Ordinance 52-443, dated December 21, 1952 (“Ordinance 52-443”).

Under Ordinance 52-443, concerning measures to protect sources, underground aquifers, lakes and watercourses, to avoid pollution and waste of water, and to control the exercise of usage rights and conceded rights of occupation, and the Ordinance of July 1, 1914, concerning pollution and contamination of sources, lakes, watercourses and parts of watercourses, any person wishing to engage works and building activities that may affect the flow or the existence of water resources located in the surroundings must obtain the prior authorization of the Governor of the Province. This authorization complements Governor Authorization under the Mining Law and the Exploitation Permit granted by the Ministry of Environment under the Ordinance 41-48, concerning dangerous, unhealthy and nuisance establishments.

f) Authorizations to install electric cables and to transport electricity across public and private land.

TFM power infrastructure construction and improvements will be in coordination with La Societe Nationale D’Electricite (“SNEL”), the DRC entity responsible for the majority of electrical infrastructure improvements required to deliver electricity to the TFM project. The installation of electrical cables and the transmission of electricity require an authorization from the Provincial Division of the Energy Ministry and the payment of a fee. TFM has voluntarily agreed, without waiving its rights, to comply with the fee structure established by Law N°04/075 of July 16, 2004 “establishing the nomenclature of actions which generate administrative, judiciary or national incomes and participation, as well as tax collection.”

A2.1.7 Environmental and Social Impact Assessment (ESIA)

The Mining Law does not require an ESIA to be prepared by the TFM. However, consistent with TFM’s obligations under the ARMC, TFM has committed to comply with the policies and guidelines of the World Bank and Equator Principles (See Section A2.2 below), which requires the preparation of an ESIA. Discussion will be held with the DRC Government to clarify a process that allows for a meaningful review of key sections TFM’s ESIA. TFM anticipates the review process to substantially mirror the review required under the New Mining Code.

According to the New Mining Code, the process for submitting and obtaining approval of an environmental impact assessment is as follows:

- The project proponent develops the scope of the assessment in collaboration with the government.
- The project proponent provides the Mining cadastral Office or "CAMI" with a draft assessment, which includes an environmental management plan (EMP) that details how the project will eliminate, reduce or mitigate adverse environmental impacts.
- After review by an inter-ministerial committee, the CAMI provides a ruling in which comments and recommendations are provided on the proposed program for mitigating adverse environmental impacts.

TFM's ESIA complies with or exceeds the requirements for an environmental assessment under the New Mining Code. Despite the lack of a legal obligation to do so, TFM has decided to voluntarily seek, without waiving its rights, government approval and consensus on its proposed approaches for environmental management, and will therefore submit key sections of the project ESIA for review by the CAMI. As part of this review process, TFM will ask the CAMI to confirm TFM's compliance with environmental standards internationally accepted as good mining practice, the standard to which TFM is responsible under the ARMC. TFM believes that its compliance with applicable DRC laws and the Equator Principles will result in meeting or exceeding the requirements of the ARMC.

A2.1.8 International Treaties and Agreements

The DRC is a signatory to several international treaties. Some of these treaties, particularly those that set environmental standards, may affect the design, operation or mitigation activities of the project. The DRC also has ratified international agreements that pertain to human and civil rights, which are applicable to certain TFM policies.

A2.1.8.1 Environmental Treaties

The DRC is a party to international environmental treaties that address, generally: (a) the protection and preservation of (i) biodiversity (Convention on Biological Diversity), (ii) endangered species (Convention on International Trade in Endangered Species), (iii) various ecosystems (Convention on Wetlands of International Importance especially as Waterfowl Habitat; Treaty on the Central African Forests Commission; United Nations Convention to Combat Desertification), and (b) the reduction of greenhouse gases (United Nations

Framework Convention on Climate Change, Kyoto Protocol). The treaties that are most likely to impact the project are discussed in greater detail below.

United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol

The object of the UNFCCC (2006) is to globally stabilize greenhouse gas (GHG) emissions at a level that will allow ecosystems to adapt while enabling economic development. The UNFCCC is intended to serve as a framework document that is general, flexible and may be amended over time to focus and make more effective global efforts to deal with global warming and climate change. The first addition to the treaty, the Kyoto Protocol, was adopted in 1997.

Parties to the UNFCCC agree to take climate change into account when engaging in certain activities, including agriculture, industrial development, energy consumption and natural resource extraction. The parties also agree to develop national programs to slow climate change. Developed countries that ratify this protocol commit to reduce their emissions of carbon dioxide and five other greenhouse gases, or engage in emissions trading if they maintain or increase emissions of these gases.

Developing countries that ratify the Kyoto Protocol are not required to commit to reductions in greenhouse gases, but rather to implement programs to monitor, mitigate and adapt to climate change. This is accomplished by, among other things (a) formulating cost-effective regional and national programs to improve the quality of data and modeling of emission sources and GHG sinks, (b) ensuring that relevant programs address issues in the energy, transport, industry, agriculture, forestry and waste management sectors (at a minimum), (c) promoting and financing access to and the transfer of environmentally sound technologies and practices pertinent to climate change and creating an enabling environment for the private sector to encourage such access and transfers, (d) promoting and developing systematic observation systems and data archives relating to climate change, and (e) developing education and training programs, including the secondment of personnel to train experts in the field of climate change (the Kyoto Obligations).

The UNFCCC entered into force in the DRC in April 1995 and the Kyoto Protocol entered into force in the DRC in June 2005. The DRC submitted its first (and only) national communication with respect to implementation of the UNFCCC in September 2002. This communication sets forth the framework for the adoption of a national climate change action plan. Such action plan would incorporate the Kyoto Obligations and other initiatives to address climate change on a national level, such as measures to ensure the modernization of production equipment to reduce pollution and GHG emissions. The provisions of a national climate change action plan may require future permitting of GHG emissions for the project.

Convention on Biological Diversity (CBD)

The CBD is the first global agreement on the conservation and sustainable use of biological diversity. The CBD is legally binding and the countries that join it are obliged to implement its provisions. The CBD identifies a common problem, sets overall goals, policies and general obligations; and organizes technical and financial cooperation. The three main goals of the CBD are (a) conservation of biodiversity, (b) providing for sustainable use of the components of biodiversity, and (c) ensuring that the benefits arising from the commercial and other utilization of genetic resources are shared in a fair and equitable way. The responsibility for achieving the CBD's goals rests largely with the individual countries that have agreed to implement the CBD. Such countries are required to develop national biodiversity strategies and action plans, and to integrate these into broader national plans for environment and development.

The CBD entered into force in the DRC in December 1994. The DRC submitted a revised national biodiversity action plan, as required by CBD, in January 2002. This action plan sets forth the projects to be undertaken by the DRC from 2002 until 2010 with respect to meeting CBD's goals. Included in the action plan are 18 projects related to biodiversity to be implemented by the DRC, including projects intending to (a) establish plans for protecting and rehabilitating species and ecosystems threatened by industry (including reinforcement of the DRC's obligations under the Convention on the International Trade in Engdangered Species of Wild Fauna and Flora [CITES]), (b) establish a plan to manage the sustainable development of forestry resources and ensure an equitable division of the benefits of such development, (c) establish a national reforestation plan, and (d) conduct a study on the impact of mining in the DRC on biodiversity and develop a code of environmental conduct for the mining industry. The provisions of the national biodiversity action plan may require TFM to implement certain forestry and species management initiatives related to the project. The project also may be subject to the provisions of the DRC's code of environmental conduct for the mining industry, when developed.

Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES)

The aim of CITES is to ensure that the international trade in specimens of wild animals and plants does not threaten their survival. CITES accords varying degrees of protection to more than 33,000 species of animals and plants and requires that signatory governments implement a licensing system for the import or export of CITES-listed species.

CITES entered into force in the DRC in October 1976. Other than plant materials, such as seeds and voucher specimens destined for scientific purposes under the project's Biological Diversity Action Plan (BDAP, Appendix D3.1-II), the TFM project does not maintain any activities that will involve the importing or exporting of any flora, fauna or animal species. The export of plant materials under the BDAP program will be carried out in conjunction with the University of Lubumbashi and Gembloux Agricultural University (Belgium), and will observe all legal requirements for the export of specimens for scientific collection.

Treaty on the Central African Forests Commission (COMIFAC Treaty)

The Central Africa Forests Commission (COMIFAC) is a sub-regional reference body that ensures the application of international conventions and forestry development initiatives in Central Africa. The COMIFAC Treaty is intended to set up an overall legal framework to govern and consolidate sub-regional cooperation in the fields of conservation and sustainable management of forest ecosystems. Implementation of national forestry policies and conservation plans in line with the COMIFAC Treaty are the responsibilities of the members.

The DRC has been a member of COMIFAC since June 2002. Pursuant to the COMIFAC Plan of Convergence (Convergence Plan) adopted in May 2002, the DRC has committed to harmonize its forestry laws and policies with other COMIFAC signatories to facilitate trans-border forestry management. In particular, the Convergence Plan calls for the development and financing (including from a forest products sales tax) of policies and programs to certify and trace forest products, combat fraudulent and illegal trade in forest products, and ensure an adequate valuation of forest resources for the benefit of local populations. The DRC policies and programs, when implemented pursuant to the Convergence Plan, would require TFM to establish certain forestry management initiatives or to satisfactorily document forest product sales (if any) related to the project.

The Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Wetlands Convention)

The Ramsar Wetlands Convention is an intergovernmental treaty adopted in February 1971 to provide for the conservation and wise use of wetlands, primarily to safeguard habitat for water birds. Over the years, the scope of the Ramsar Wetlands Convention has broadened to cover all aspects of wetland conservation and use. More than 1,280 wetlands have been designated for inclusion in the List of Wetlands of International Importance, covering some 108.7 million hectares (1,087 million square kilometers).

The Ramsar Wetlands Convention entered into force in the DRC in May 1996 and obligates the DRC to include wetland conservation considerations in its national land-use planning. Generally, guidelines to the Ramsar Wetlands Convention assist signatory countries in ensuring that foreign investment contributes to the long-term sustainability of the wetland resources being used by the investor. The DRC must conduct a rigorous assessment (including review of environmental, economic and social factors) of the potential impact of foreign investment on wetlands and must have impact assessment practices in place. The Ramsar Wetlands Convention guidelines also contemplate the payment of environmental bonds or similar endowments by foreign investors to support the long-term sustainability of the wetlands resource being used.

No wetland sites under the purview of the Ramsar Wetlands Convention are located in or near the TFM concessions.

A2.2 EQUATOR PRINCIPLES

The Equator Principles (EP) are a set of informal and voluntary rules and standards used by international lending institutions to promote social and environmental sustainability in project finance. TFM has committed to comply with the EP in the construction, operation and closure of the project. Moreover, it is likely that the EP will apply to the project because the large majority of international lending institutions, from whom TFM likely will borrow funds, have agreed to apply and enforce the EP (or a set of similar environmental and social standards) when assessing the social and environmental impact of projects. However, it is recognized that not all banks will apply the EP as project guidelines. Rather, private banks will assess the project against the IFC's performance standards (A2.2.2) or their own policies if they are more restrictive.

The application of EP ensure that minimum standards and established best practices with respect to the protection of existing social and environmental systems are applied to large projects being undertaken in an international setting, particularly in developing and newly industrialized states. The EP enable international lending institutions to take a risk-based approach to providing project financing by ensuring that projects adhere to internationally recognized best practices.

A2.2.1 Application of Equator Principles

The EP, through their incorporation of World Bank Group guidelines and policies, set forth a process to be used by international lending institutions to categorize, assess, mitigate and monitor the social and environmental risk of projects. The steps to be followed by international lending institutions include: (a) review of the project sponsor's social and environmental assessment; (b) categorization of the potential impact of a project, from minimal impact to potentially significant adverse impact; (c) evaluation of the project sponsor's action plan to determine likely compliance with host country laws and relevant International Finance Corporation (IFC) standards; (d) consultation with local populations affected by the project; (e) public disclosure of the project's Social and Environmental Assessment and action plan; and (f) insertion of covenants in the loan agreement to ensure that the project sponsor provides regular reports and complies with relevant laws and standards and the project sponsor's Social Environmental Assessment and action plan.

The specific international guidelines and standards that apply to the project are the Performance Standards on Environmental and Social Sustainability, (IFC 2006b). Other international guidelines relating to air quality, water quality, noise and other issues (such as World Bank Group and the World Health Organization guidelines) also may apply to the project. These guidelines provide required boundaries for the project's design and operations to meet and maintain certain environmental and human health standards.

A2.2.2 International Finance Corporation (IFC) Performance Standards

The IFC implemented the most recent version of the IFC Performance Standards in April 2006 to address gaps in the previous guidelines, emphasize private sector considerations and ensure better compatibility with other IFC policies. In the IFC's view, long-term profitability and positive project outcomes are more likely to be attained by borrowers and international lending institutions that manage risk well. The new IFC Performance Standards seek to ensure that projects foster a sustainable economic, social and environmental system and add value to community infrastructure beyond the scope and life of a project. Accordingly, the IFC Performance Standards set forth specific objectives, systems, policies and practices to be followed by project sponsors.

IFC Performance Standard 1 provides information on setting up the management system that will be in place throughout the life of the project and establishes the organizational structure, responsibilities, policies, procedures and practices, and resources essential for successfully implementing the project-specific management program. IFC Performance Standards 2 through 8 deal with discrete topics and may not be relevant for every project. During the initial assessment process, the project sponsor and the international lending institution will determine which of the IFC Performance Standards apply, and incorporate them into the Social and Environmental Assessment and action plan as appropriate.

The international lending institutions to the project will likely require TFM to demonstrate compliance with several relevant IFC Performance Standards, which are summarized below in their entirety:

- Social and Environmental Assessment and Management Systems (IFC Performance Standard 1):
  - Requires the development of an action plan that will establish a management system, which incorporates the following: (i) the social and environmental assessment; (ii) management programs to address identified risks and impacts; (iii) processes for establishing, maintaining, and/or strengthening the organizational structure; (iv) adequate training for responsible employees; (v) building and maintaining a constructive relationship with the impacted community, including disclosure, consultation and an appropriate grievance mechanism; (vi) effective monitoring of the project sponsor's implementation of the management system; and (vii) internal reporting on the effectiveness of the management program and external reporting on the action plan. The development process should include significant stakeholder engagement, particularly engagement with local communities.
- Labor and Working Conditions (IFC Performance Standard 2):
  - Requires the implementation of an appropriate human resources policy, which should include: (i) documenting and communicating working conditions and terms of employment to all employees/workers; (ii) respecting collective bargaining agreements and otherwise providing reasonable working conditions; (iii) complying with national laws regarding labor; (iv) providing for equal opportunities, non-discrimination and fair treatment; (v) adopting a plan to mitigate adverse impacts if there is the possibility of retrenchment; (vi) providing an appropriate and effective grievance mechanism for workers/organizations; (vii) prohibiting exploitative or hazardous child labor; (viii) prohibiting all forced/compulsory labor; (ix) providing a safe and healthy work environment, (x) taking steps to prevent accidents, injury and disease; and (xi) using commercially reasonable efforts to ascertain that contractors are reputable.
  - Pollution Prevention and Abatement (IFC Performance Standard 3):
  - Outlines the IFC policy on pollution control and mitigation, as described in the Pollution Prevention and Abatement Handbook (PPAH) (see below).
  - Focuses on internationally accepted practices for pollution prevention, minimization and control, including provisions for: (i) considering ambient conditions (including future land use) and applying pollution prevention and control technologies and practices that are best suited to avoid or minimize adverse impacts on human health and the environment; (ii) tailoring project-specific techniques to unique hazards and risks of the project, consistent with good

international industry practice; (iii) avoiding or minimizing pollutant releases, waste generation, and release of hazardous materials; (iv) preparing an emergency preparedness and response plan; (v) promoting the reduction of project-related greenhouse gas (GHG) emissions and monitoring such emissions in accordance with internationally-recognized methodologies; and (vi) formulating and implementing an integrated pest management plan, including selection of pesticides that are low in human toxicity and have minimal environmental effects.

- Community Health, Safety and Security (IFC Performance Standard 4):
  - Requires that the project be designed to minimize risks to public health and safety during all phases of development. Water and tailings dams whose failure would have an impact on local communities must be reviewed by independent experts during the design phase.
  - Requires preparation of a community health and safety plan, which should include provisions for: (i) establishing preventative measures to address risks (favoring prevention/avoidance over minimization); (ii) disclosing the action plan and other relevant information to the affected community and engaging with the affected community on an ongoing basis consistent with IFC Performance Standard 1; (iii) ensuring that structural elements of the project (design/operation/decommission) in accordance with good international industry practice; (iv) retaining experts when necessary to protect the affected community; (v) preventing accidents and incidents on public roads/infrastructure; (vi) preventing or minimizing community exposure to hazardous materials releases; (vii) exercising commercially reasonable efforts to control the safety of deliveries of raw hazardous materials and transportation/disposal of waste; (viii) avoiding or minimizing impacts from land use changes; (ix) preventing or minimizing community exposure to communicable diseases (AIDS and malaria in particular) resulting from project activities (including influx of labor); (x) collaborating with community and local government to prepare an emergency preparedness and response plan; (xi) assessing risks to those within and outside the project posed by (private or governmental) security arrangements; (xii) ensuring that security personnel are not implicated in past abuses and receive adequate training regarding conduct toward workers and the local community; (xiii) establishing a grievance mechanism for the affected community to express concerns about security arrangements; and (xiv) investigating any credible allegations of unlawful or abusive acts by security personnel and reporting such acts to public authorities when appropriate.

- Land Acquisition and Involuntary Resettlement (IFC Performance Standard 5):
  - Provides that involuntary resettlement pertains to displacement due to losses of both real property and assets (e.g., loss of land or shelter) and economic resources (e.g., loss of income or means of livelihood).
  - Requires that the project sponsor: (i) consider feasible alternative project designs to avoid or minimize physical and economic displacement; (ii) provide compensation at full value for losses and provide assistance to restore prior standards of living; (iii) devise standards that are transparent and consistent; (iv) provide land-based compensation where livelihoods of displaced people were land-based; (v) execute decision-making processes on an ongoing basis that include consultation and informed participation of affected communities throughout the life of the project; (vi) establish a grievance mechanism consistent with IFC Performance Standard 1; (vii) carry out a census to identify people needing compensation if involuntary resettlement is unavoidable; (viii) document all transactions to acquire land rights, as well as compensation and relocation activities; (ix) establish procedures to monitor and evaluate the implementation of resettlement plans; (x) offer displaced persons choices among feasible resettlement options, including adequate housing or cash compensation, where appropriate; (xi) provide replacement property of equal or higher value with equivalent or better characteristics and location, if displaced persons had formal legal rights or recognized claim to land; (xii) provide relocation assistance sufficient for displaced persons to restore standards of living at an adequate alternative site, if displaced persons had no recognized claims to land; (xiii) provide targeted assistance (credit facilities, training, job opportunities, etc.) to those who are economically displaced or whose livelihoods or income levels are adversely affected; (xiv) take additional measures to supplement government action if government action does not satisfy requirements of this IFC Performance Standard.
- Conservation of Biodiversity and Sustainable Natural Resource Management (IFC Performance Standard 6):
  - Synchronizes with the Convention on Biological Diversity (CBD) in that both conservation and the sustainable use of natural resources are promoted and all ecosystems and all levels of biodiversity are required to be considered, including the introduction of alien and invasive species and changes in GHG emissions due to changes in land use.
  - Requires that the project sponsor: (i) assess the significance of project impacts on all levels of biodiversity as an integral part of the social and environmental assessment process by taking into account different values attached to biodiversity by specific stakeholders, using qualified and experienced external experts where necessary; exercising care to minimize conversion or degradation of modified

habitats, and enhancing habitat and protecting biodiversity when possible; (ii) avoid converting or degrading natural habitats, unless there are no technically or financially feasible alternatives, the overall project benefits outweigh the costs, and conversion and degradation is mitigated appropriately; (iii) ensure that mitigation measures achieve no net loss of biodiversity; (iv) avoid project activities in critical habitats, unless there would be no measurable adverse impacts on the habitat, no reduction in population of the endangered species, and lesser impacts are properly mitigated; (v) for areas legally protected for conservation of biodiversity, act in a manner consistent with defined management plans, consult area sponsors and managers, consult local communities, and implement additional programs to promote and enhance the conservation aims of the protected area; (vi) avoid introducing any new alien species and exercise diligence to prevent unintended or accidental introductions; (vii) manage renewable natural resources (including activities involving the harvesting of fish or other aquatic species) in a sustainable manner, preferably demonstrated by independent certification; (viii) ensure that activities involving natural forest harvesting or plantation development do not cause conversion or degradation of critical habitat; and (ix) obtain independent certification required for natural forest and plantation management of lands under control of the project sponsor.

- Indigenous Peoples and Natural Resource Dependent Communities (IFC Performance Standard 7):
  - Defines "natural resource dependent communities" as those having "a close attachment to unique areas or habitats containing resources that cannot be readily replaced or substituted, including land, flora, fauna, or water; and reliance on grazing, hunting, gathering, or artisanal fishing for their livelihood."
  - Requires that the project sponsor: (i) identify through the social and environmental assessment all communities of indigenous people that may be affected and work to avoid adverse impacts whenever feasible; (ii) minimize, mitigate or compensate for impacts in a culturally appropriate manner where avoidance is not feasible; (iii) develop proposed action with informed participation of affected people and document such action in a formal, time-bound plan, or as part of a broader community development plan with a separate component focusing on indigenous people; (iv) establish an ongoing relationship with affected communities throughout the life of the project, ensuring their free, prior, and informed participation on matters affecting them directly; (v) ensure that the community engagement process is culturally appropriate and commensurate with the risks and potential impacts to the group, including by involving indigenous people representative bodies (e.g., councils of elders), consulting persons of different age and gender in a culturally appropriate manner, providing indigenous people sufficient time for

their collective decision-making processes, facilitating expression of the views and concerns of indigenous people without external influence or coercion, and ensuring that the grievance mechanism established in IFC Performance Standard 1 is culturally appropriate and accessible for indigenous people; (vi) identify areas where development benefits may be used to improve standards of living and livelihoods in a culturally appropriate manner; (vii) retain qualified and experienced external experts when using traditional or customary lands (i.e. does not require legal ownership) to assist in documenting that the affected communities' land is used in a way that does not prejudice their claims, the project sponsor has undertaken efforts to avoid or minimize the size of land proposed for the project, and the affected communities are informed of their rights under national laws regarding their land; (viii) offer compensation and due process to those with full legal title to land, along with culturally appropriate development opportunities; (ix) enter into good faith negotiations with indigenous people and document their informed participation; (x) consider feasible alternatives to avoid relocation of indigenous people from traditional or customary lands; (xi) enter into good faith negotiations and document informed participation before proceeding with a project if relocation is necessary; (xii)if the project uses cultural resources, knowledge, innovations or practices of indigenous people, inform indigenous people (and document such negotiations and information) of their rights under national law, the scope and nature of the proposed development and the potential consequences of development.

- Cultural Heritage (IFC Performance Standard 8):
  - Provides procedures for inventorying, protecting and removing (only when unavoidable) cultural property. Communities should be engaged to determine the most culturally appropriate means to handle such assets. In areas where cultural heritage is prevalent, monitoring for artifacts should be conducted during land clearing, soil stripping and mining operations.
  - Requires that the project sponsor: (i) comply with relevant national laws on the protection of cultural heritage; (ii) undertake internationally recognized practices (including the retention of qualified and experienced experts where necessary) for the protection, field-based study and documentation of cultural heritage; (iii) carry out siting and design to avoid significant damage to cultural heritage; (iv)if the project is in an area where cultural heritage is expected to be found, establish chance find procedures through the social and environmental assessment which provide that chance find material shall not be disturbed until assessed by a competent specialist; (v) consult with affected communities and relevant national or local regulatory agencies to identify cultural heritage of importance and incorporate their views into the decision-making process; (vi) refrain from removing any cultural heritage, unless (x) there are no

technically or financially feasible alternatives to removal, (y) the overall benefits of the project outweigh the anticipated cultural heritage loss from removal, and (z) removal is conducted by the best available techniques; (vii) refrain from significantly altering, damaging or removing any critical cultural heritage except that, in exceptional circumstances, the project sponsor may consult with the affected community and conduct good faith negotiations (including documentation) in order to ensure that cultural heritage impacts are appropriately mitigated in conjunction with the informed participation of the affected community; (viii) when the proposed project is located within a legally protected area, ensure that the project sponsor (x) complies with defined national or local cultural heritage regulations, (y) consults with protected area sponsors, managers and local communities and other key stakeholders, and (z) implements additional programs to promote and enhance the conservation aims of the area; and (ix) ensure that any projected use of cultural heritage complies with the requirements for using indigenous people knowledge in IFC Performance Standard 7.

A2.2.3 Pollution Prevention and Abatement Handbook

In conjunction with IFC Performance Standard 3 referenced in Section A2.2.2, the Pollution Prevention and Abatement Handbook (PPAH) is a dynamic series of documents intended to provide policy guidance and specific guidelines for project and industry sectors to control pollution and emission levels. With respect to overall pollution management policy, the PPAH sets forth basic principles and best practices for project sponsors regarding the environmental assessment process, waste avoidance and use, efficient energy use, environmental quality monitoring, establishment of quality management models, developing a culture of environmental compliance and conduct of environmental audits. The PPAH also sets forth specific environmental, health and safety guidelines (EHS Guidelines), with technical compliance criteria and emission/pollution limits, for individual pollutants, particular pollutant control technologies and industry sectors.

The international lending institutions that fund the project likely will require that TFM adhere to the IFC Performance Standards, which require compliance with the PPAH. It should be noted that the IFC is in the process of revising the EHS Guidelines, although the IFC estimates that such revisions will not be finalized until some time in 2007. In particular, the following EHS Guidelines likely would apply to the project: (a) pollutant guidelines for (i) airborne particulate matter, (ii) arsenic, (iii) cadmium, (iv) lead, (v) mercury, (vi) nitrogen oxides, (vii) ground-level ozone, and (viii) sulfur oxides; (b) pollutant control technology guidelines for (i) airborne particulate matter, (ii) removal of lead from gasoline, (iii) nitrogen oxides, (iv) ozone-depleting substances, and (v) sulfur oxides; and

(c) industry sector guidelines for base metal and iron ore mining.[4] In the interim, the ESIA has been prepared based on existing base material and iron ore, mining and milling open pit, occupational health and safety and hazardous materials management guidelines (World Bank 1995, 1998, 2001, 2003); as well as the general EHS guidelines (World Bank 1998).

A2.3 TENKE FUNGURUME MINING POLICIES

TFM is committed to adhering to applicable environmental regulations described in Section A2.1 throughout the life of the project. Where there is no specific TFM policy in place, TFM will adopt the policies of the major sponsor for the project, Phelps Dodge Corporation (PD). As a leader in the world's mining and manufacturing companies, PD maintains world-class environmental, social and health and safety policies. These policies, including those related to land compensation and local employment, will be tailored to the project.

A2.3.1 Safety, Health and Environment Policy

TFM's Safety, Health and Environment Policy states:

TFM is committed to achieving a safe, healthy and productive work environment.

It is TFM's fundamental policy to conduct their business responsibly so as to protect the health and safety of all employees and that of surrounding communities with respect to our operations; and to provide sound controls on the environmental effects of our activities.

Specific goals are to:

- Comply with legal requirements as a minimum and go beyond those requirements where necessary to comply with our fundamental policy.
- Assess the potential safety, health and environmental effects of our activities and integrate these considerations into our planning, operational decisions and processes.
- Design, develop and operate our facilities with a view to reducing the impact of our operations; providing efficient use of energy, water and other resources; limiting waste generation and disposal; and where waste must be disposed of, doing so responsibly.

[4] Note that the proposed revised EHS Guidelines would consolidate all of the current mining-related EHS Guidelines into a single mining guideline.

- Progressively rehabilitate areas no longer required for efficient operation using proven practical methods.
- Strive for continuous improvement in our safety, health and environmental performance and monitor and audit that performance.
- Communicate with our employees, the community, regulators and other interested parties in relation to safety, health and environmental issues.
- Work with the community and governments in the formulation of safety, health and environmental policy and regulation which affect us.
- Advise and train our employees and contractors as necessary to meet our safety, health and environmental undertakings.
- Establish accountability of employees, especially managers, for their safety, health and environmental performance.

A2.3.2 Sustainable Development

TFM recognizes the needs of society and the value of economic prosperity, national security and a healthy environment. TFM is committed to integrating social, environmental and economic principles in its mining operations from exploration through development, operation, reclamation, closure and post-closure activities, and in facilities associated with preparing its products for further use.

At TFM, sustainable development is regarded as the interaction and balance between its operational activities and the social, political and economic dynamics within the regional settings where the project operates; the ability to provide society with access to recyclable mineral resources otherwise not accessible; the need to achieve an adequate profit on the invested capital for its shareholders while contributing to the improvement of quality of life in nearby communities and to the positive management of the environmental resources.

TFM aims to be a catalyst in development beyond its own operations. It works to ensure that its sites will operate in such a way that does not deter other development and that will contribute to a net positive impact to the host communities where it operates. This net impact embraces social, economic and environmental conditions and building capacities necessary to provide for the needs of current and future generations.

The sustainability approach that was taken for the ESIA is described in Section A5.

A2.3.3 Employment Policies

Approximately 2,000 jobs will be created during the two-year construction period. Many jobs are anticipated to be filled by people living in the Katanga area. During operations, TFM expects to create about 1,100 full-time jobs (of which 100 will be contractors), which are expected to be filled primarily by people living in the Tenke and Fungurume area. The number of local jobs created is expected to increase over time as the local workforce increases its capacity. The number of indirect jobs to be created is estimated to be around four times the number of direct construction or operations jobs (Appendix C4.1-I).

A TFM labor policy is being drafted that will contain the following provisions:

- Preference for employment of local people, when evaluating employees of otherwise equal skills and qualifications pursuant to the ARMC and the DRC law.
- Full compliance with the DRC labor and social security legislation.
- Full compliance with Collective Agreements entered into with TFM employees.

Payment levels will be established to attract skilled, competent workers. TFM has recently completed negotiations with the recognized unions representing its employees. Wages will be paid according to the agreed upon terms of these Collective Agreements and in full compliance with the DRC Labor Code.

A2.4 PUBLIC PARTICIPATION

The ESIA process has been conducted in compliance with the EP and their reference policies and guidelines, including those relevant to consultation, public participation and information disclosure. The EP require that consultation occurs throughout the life of a project. During the ESIA process, thorough consultations were undertaken in the form of three rounds of open houses that (i) introduced the TFM project and the ESIA process (ii) solicited input for use in scoping for the ESIA and before guidelines for the preparation of the ESIA were finalized; and (iii) once a draft ESIA report was available to be presented to and discussed with the project stakeholders.

A2.4.1 Objectives of Public Participation during the ESIA Process

The public participation process is designed to provide sufficient and accessible information to interested and affected parties in an objective manner, to assist them in the following ways:

- During the introductory phase to present the project, key players and approaches for public consultation.
- During the scoping phase, to:
  - Identify issues of concern and provide suggestions for alternatives and enhanced benefits.
  - Contribute local knowledge and experience.
  - Verify that the stakeholders' issues, comments and suggestions have been captured accurately and fully.
- During the impact assessment phase, to:
  - Verify that the stakeholders' issues, comments and suggestions have been considered by the technical investigations.
  - Provide an opportunity for the stakeholders to comment on the findings of the ESIA.

A2.4.2 STAKEHOLDERS

Stakeholders are persons who are affected by or can affect the outcome of the project. Stakeholders can include affected communities, local organizations, non-governmental organizations (NGOs), government authorities, politicians, military authorities, commercial and industrial enterprises, labor unions, academics, religious groups, national social and environmental public sector agencies and the media.

The current stakeholder database for the project consists of almost 470 individuals and organizations representing a broad spectrum of all sectors of society and situated in various regions, including the region in which the project will be constructed and will operate, such as:

- Central governmental regulatory bodies directly involved in the project and their local representatives.
- Central government bodies with potential collateral involvement in the project, such as the departments of health, agriculture and education.
- Provincial government.

- Local government institutions and officials, including:
  - Mayors (the highest ranking government officials in a district).
  - Local government technical departments supervised by the Mayor's office.
  - Chefs de Cité and Chefs de Poste, who are civil administrators of rural townships such as Fungurume and Tenke.
  - Chefs de Quartier, who are neighborhood representatives of the Chefs de Cité and Chefs de Poste offices.
  - Traditional village chiefs, who may be accountable to applicable government and/or customary authorities.
- People living near the project and all of its facilities, including people who use areas affected by the project for subsistence activity or use water or other resources that may be affected by the project.
- People who may potentially be affected in their livelihoods by the project development, specifically local people who may have relied in part on revenues from unauthorized artisanal mining on the concession.
- Community-based organizations such as development committees.
- Customary institutions, including:
  - Chefs de Terre, who manage land allocation in a given area under a customary land tenure regime.
  - Other traditional chiefs, including traditional kings of tribal or ethnic groups, or Chefs de Groupement, who supervise several village populations.
- Donor organizations, including:
  - Multilateral donor organizations, such as the World Bank Group and some United Nations agencies.
  - Bilateral donor organizations with potential or actual involvement in the project area, such as the United States Agency for International Development, Belgian Development Corporation and Corperation Technique Belge.
- NGOs currently involved in development activities in the project area or its neighborhood.
- Academic institutions in, for example, Lubumbashi, Likasi and Kolwezi, through which local academics can be mobilized to participate in the consultation process.
- Gécamines, the state-owned mining company, which is a partner in TFM, and other mining companies and industrial businesses in the project area and Katanga Province.
- Environmental and conservation organizations.

- TFM workers.
- Labor organizations.
- Media (print and broadcast).

Public participation meetings were held before the ESIA was conducted, during the scoping phase of the project, and before the ESIA was submitted as required by the EP and the IFC. During these phases, stakeholder issues were recorded according to disciplines and TFM's responses also were recorded and made available (see Issues and Response Report, Section E6).

It should also be noted that the baseline survey for the ESIA (Section B4.1) employed detailed questionnaires, village meetings, focus group discussions and key informant interviews. In aggregate, these contacts added several thousand additional de facto stakeholders to those identified in the formal database.

A2.5 COMMUNITY DEVELOPMENT PLAN

Mining operators are often required by the DRC to invest in social development and, with respect to the project, the ARMC requires that this is done in coordination with the State or local communities. In addition, TFM has adopted the voluntary environmental and social guidelines and safeguards known as the EP, which were developed by the World Bank Group, for the project. TFM is committed to investing with local government for the benefit of the surrounding communities above and beyond the statutory royalties, an additional amount that will be equivalent to 0.3 percent of net sales revenue from mine production. This commitment is reflected in the ARMC. TFM also is investing a dedicated amount ahead of production during the development phase to assure a sustainable start-up to social development and to foster a positive relationship with communities and the government of the DRC.

The short-term and long-term community development strategies proposed by TFM were prepared on the basis of the socio-economic baseline survey (Section B4.1), and with assistance from development-oriented and locally-active NGOs. The results of this effort was the production of a community development 'roadmap' that provides strategic guidance to the decisions on where and how to invest. The strategy behind the road map is to make the communities in the Fungurume and Tenke region independent from the mining operations within a 20-year timeframe. To attain this economic sustainability, the strategy will focus on the basic needs of the communities, income generation and livelihoods, social and community infrastructures and good governance.

A2.5.1 Corporate Communication Plan

In alignment with the Performance Standards on Environmental and Social Sustainability (IFC 2006b), TFM has in place a corporate communications plan, including an on-site communications team. The core of the communications plan is a reliance on accurate and transparent communications with stakeholders regarding the project. This plan is molded around the best practices for conduct of the ESIA, including multiple stakeholder consultations during the preparation of the ESIA. It will continue through the life of the mining operation. Specifically, the communication goals of the IFC Performance Standards, including those of Performance Standards 1 (Social and Environmental Assessment), 4 (Community Health, Safety and Security), 5 (Land Acquisition and Involuntary Resettlement) and 9 (Social and Environmental Management System), are integrated into the communications plan.

A2.6 LAND ACQUISITION AND INVOLUNTARY RESETTLEMENT

The resettlement program is being implemented in close consultation with the affected community, and in full compliance with the EP, IFC Performance Standard 5 (PS-5), and DRC law. Likewise, any economic losses resulting from the project, such as incidental damages to crops or structures, will be compensated according to the EP, PS5 and DRC law. TFM also has implemented a process to compensate local farmers for the project's impact on farm lands during early site activity, including any damage to crops caused by drilling.

TFM will (i) provide the affected people with assistance to restore lost livelihoods, including the sourcing, clearing and technical assistance needed to be reestablished on new agricultural land, and (ii) either build, or help the relocated individuals build, new residences of the same or better value as their existing house (Section D4.4).

A2.7 GUIDELINES FOR THE PROJECT

The project will be governed by applicable guidelines for air, noise and vibrations, water resources, environmentally sensitive areas and cultural areas. Guidelines for these aspects that the project may affect are based on DRC law, the ARMC and international guidelines. The latter are generally based on World Bank Group or IFC guidelines. Private Banks are expected to assess the project against the IFC's performance standards, or their own policies if they are more restrictive.

In addition, three other reference guidelines have been identified that the project proponent believes should be reviewed for relevancy, even though compliance with them is not legally required. These are the guidelines of the World Health Organization (WHO), the guidelines set forth in the New Mining Code of the DRC and its 2003 regulations, and the standards set forth by the United States Environmental Protection Agency (US EPA). The WHO guidelines are incorporated due to their broad international use and credibility. The DRC New Mining Code (NMC) regulations and numerical standards are incorporated as a reference due to their applicability in the DRC. The US EPA regulations are incorporated because they represent a set of comprehensive, internationally accepted standards familiar to Phelps Dodge, TFM's major shareholder. Other national guidelines may be referred to, on a parameter-by-parameter basis, if no applicable limit has been established for a critical parameter within the above listing of guidelines.

The project guidelines are intended to provide a basis on which to identify potentially adverse effects and incorporate changes to the project's design or implement steps to mitigate, minimize or eliminate adverse effects.

A2.7.1 Air Quality

A2.7.1.1 Air Emissions

There are currently no DRC emission guidelines specific to mining operations. However, the IFC has established several general emission guidelines in cooperation with the World Bank Group (World Bank Group 1998). The general emission guidelines provide limits on the primary combustion compounds of concern based on heat input to the source and the type of fuel being burned. All of the maximum levels should be achieved for at least 95 percent of the time that the plant or unit is operating, calculated as a proportion of annual operating hours.

Table A2.7-1 provides a summary of general air emissions limits for industries, including mineral processing and sulfuric acid plants. The applicable guidelines were based on the World Bank Group standards as no limits exist under DRC law. The reference guidelines were based on the US EPA, as no WHO or DRC NMC limits exist.

Table A2.7-1 Applicable and Reference Air Emission Limits for the TFM Project

Parameter	Units[(a)]	Applicable		Reference		
		DRC Law	World Bank Group	WHO	DRC NMC	US EPA
sulfur dioxide	variable	-	2,000 μg/m^3	-	-	2 kg/t[(b)]
acid mist (H_2SO_4)	kg/t	-	-	-	-	0.075[(b)]
PM_{10} (particulate matter less than 10 μm)	μg/m^3	-	50[(c)], 100[(d)]	-	-	-
oxides of nitrogen (NO_x)[(e)]	μg/m^3	-	750[(f)], 460[(g)], 320[(h)]	-	-	-

Note: '-' = No guidelines available.
(a) kg/t = kilograms of pollutant per tonne of sulfuric acid production; mg/m^3 = milligrams of pollutant per cubic meter of exhaust.
(b) Specific guideline for sulfuric acid plants (US Government 1998).
(c) This value is applicable to units that require >50 Megawatts of equivalent energy input (MWe).
(d) This value is applicable to units that require <50 Megawatts of equivalent energy input (MWe).
(e) NO_x is represented by nitrogen dioxide (NO_2).
(f) This value is applicable to coal-fired units.
(g) This value is applicable to oil-fired units.
(h) This value is applicable to natural gas-fired units.

A2.7.1.2 Ambient Air Quality Standards and Guidelines

Ambient air quality standards are available from several different regulatory agencies. Table A2.7-2 presents ambient air quality standards for the following pollutants: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter less than 10 microns in diameter (PM_{10}), and lead. Standards are from the DRC, the World Bank Group, the WHO (2000a) and the US EPA. In addition, a reference guideline from Ontario was identified for naptha, which is of similar chemical property to the diluent proposed to be used by the project in the solution extraction circuit. Guidelines for this pollutant were not found in the other reference ambient air quality guidelines.

Table A2.7-3 shows the applicable and reference occupational health guidelines from the DRC, World Bank Group and the US Occupational Safety and Health Administration (OSHA) and Table A2.7-3 shows the applicable and reference dust deposition guidelines for the US.

Table A2.7-2 Applicable and Reference Ambient Air Quality Limits for the TFM Project

Parameter	Applicable [µg/m³]		Reference Guidelines [µg/m³]			
	DRC Law	World Bank Group	WHO	DRC NMC[f]	US EPA	Ontario POI
sulfur dioxide	-	500[a] 100[b]	125[a] 50[b]	500[a] 100[b]	365[a] 80[b]	-
nitrogen dioxide	-	200[a] 100[b]	40[b]	200[a] 100 [b]	100[b]	-
PM_{10} (particulate matter less than 10 µm)	-	500[a] 100[b]	-	500[a] 100[b]	150[a] 50[b]	-
arsenic	-	-	-	-	-	-
carbon monoxide	-	-	-	-	40,000[c] 10,000[d]	-
copper	-	-	-	-	-	-
free silica	-	-	-	-	-	-
hydrogen cyanide	-	-	-	-	-	-
hydrogen sulfide	-	-	-	-	-	-
lead	-	-	0.5[b]	-	1.5[e]	-
naphtha	-	-	-	-	-	2,600

(a) 24-hour averaging period and outside the facility boundary.
(b) Annual averaging period and outside the facility boundary.
(c) 1-hour averaging period and outside the facility boundary.
(d) 8-hour averaging period and outside the facility boundary.
(e) Quarterly average period.
(f) In this case these are the same as the World Bank guidelines, so in effect these are applicable guidelines.

Note: '-' = No guidelines available.

µg/m³ = micrograms per cubic meter.

Sources: Refer to specific references for each guideline as provided in Appendix A-III.

Table A2.7-3 Applicable and Reference Occupational Health and Safety Guidelines for the TFM Project

Parameter	Applicable [μg/m³]		Reference Guidelines [μg/m³]		
	DRC Law	World Bank Group	WHO	DRC NMC[k]	US OSHA
sulfur dioxide	—	5,000	—	5,000	13,000
nitrogen dioxide	—	6,000	—	6,000	9,000
PM_{10} (particulate matter less than 10 μm)	—	10,000	—	10,000	—
arsenic	—	500	—	500	500
carbon monoxide	—	29,000	—	29,000	55,000
cobalt	—	—	—	—	100
copper	—	1,000	—	1,000	100[a] 1,000[b]
free silica	—	5,000	—	5,000	—
hydrogen sulfide	—	14,000	—	14,000	28,000[c] 70,000[d]
lead	—	150	—	150	50[j]
aluminum	—	—	—	—	15,000[e] 5,000[f]
zinc	—	—	—	—	15,000[g] 5,000 [h]
magnesium	—	—	—	—	15,000
manganese	—	—	—	—	5,000
iron	—	—	—	—	10,000
sulfuric acid	—	—	—	—	1,000[i]

(a) Fume as copper.
(b) Dusts and mists as copper.
(c) Acceptable ceiling concentration.
(d) Acceptable maximum peak above the acceptable ceiling concentration for a 8-hour shift with a maximum duration of 10 minutes once only if no other measured.
(e) Total dust as aluminum.
(f) Respirable fraction as aluminum.
(g) Total dust as zinc.
(h) Respirable fraction as zinc.
(i) Permissible exposure limit.
(j) Maximum average exposure over 8 hours.
(k) In this case these are the same as the World Bank guidelines, so in effect these are applicable guidelines.

Note: '-' = No guidelines available.

μg/m^3 = micrograms per cubic meter.

A2.7.1.3 Air Effects to Vegetation

World Health Organization (WHO) guidelines for ecological effects on terrestrial (land-based) vegetation include guidelines for sulfur dioxide (SO_2) and nitrogen oxides (NO_x). These guidelines are more stringent (strict) than air quality guidelines for human health because studies have shown that effects on vegetation from certain pollutants occur at lower concentrations (WHO 2000). Guideline values for assessing the long-term ecological effects of sulfur dioxide and nitrogen oxides on terrestrial vegetation are provided in Table A2.7-4. The low end of the range for sulfur dioxide (10 micrograms per cubic meter) has been established for lichens when visible effects are first observed. The mid-range for sulfur dioxide is applicable to natural forest vegetation (20 micrograms per cubic meter). The high end for sulfur dioxide is defined for agricultural crops at 30 micrograms per cubic meter.

These guidelines are supported by research and data from Europe (Whitmore and Freer-Smith 1982; Freer-Smith 1984; Mansfield et al. 1987; Innes and Skelly 1988). The effects can be both short and long term. Short-term exposure effects are usually restricted to a localized area. Short-term exposure effects can include chlorosis (iron deficiency) or necrosis (death) of plant tissues that may result in decreased growth rates or eventually, plant mortality (death). Recent evidence suggests that peak concentrations during short-term exposures (i.e., exposures over a 24-hour period) have no significant effect on vegetation compared with accumulated doses (WHO 2000).

Table A2.7-4 World Health Organization Guideline Values for the Effects of Individual Substances on Terrestrial Vegetation

Substance	Guideline Concentration Value (micrograms per cubic meter)	Averaging Time
sulfur dioxide	10 to 30	annual
nitrogen oxides	30	annual

Source: WHO (2000).

Plants exposed to low levels of nitrogen oxides may have reduced tolerance to heat, insects and pathogens (Hutchinson and Meema 1987; Rosen et al. 1992; Fangmier et al. 1994). It has also been shown that continuous exposure of sensitive plants to nitrogen oxides has caused visible injury to leaves, branches and flowers (foliar injury) (Taylor and MacLean 1970).

A2.7.1.4 Air Quality Criteria Summary

The applicable air quality standards for the project are:

- World Bank Group emission limits for industrial installations will be used as the applicable standard for air emissions (Table A2.7-1).
- World Bank Group ambient air quality standards will be used as the applicable standard (Table A2.7-2).
- World Bank Group standards will be used for occupational health and safety (Table A2.7-3).

The reference guidelines for the project are:

- US EPA (2004a) guidelines will be used as a reference for air emissions (Table A2.7-1).
- US EPA ambient air quality reference guidelines will be used for ambient air quality (Table A2.7-2).
- US OSHA guidelines will be used as the reference guidelines for occupational health and safety (Table A2.7-3).
- WHO guidelines will be used as the reference guidelines for terrestrial vegetation (Table A2.7-4).

A2.7.2 Noise and Vibrations

A2.7.2.1 Noise

The World Bank Group (WBG 1998) criteria regarding human noise for residential or other sensitive land uses are applicable to the project. Although TFM is not legally bound to meet any specific numerical standard beyond the World Bank Group criteria, the project used additional available reference standards for generating a comparison. Noise reference criteria include those of the DRC NMC for residential settings, and those of the US EPA for outdoor residential areas. Additionally, the WHO (1999) also provides internationally accepted guidelines for community noise. Table A2.7-5 provides a comparison of noise criteria for continuous sources for the above sources.

The World Bank Group and WHO do not have criteria for mixed land uses, as the intent is to determine or assess noise experienced by a receiver (residence) regardless of setting. These residential criteria are 55 A-weighted decibels during the day and 45 A-weighted decibels during the night. The DRC NMC has a more stringent maximum noise level of 40 A-weighted decibels during the night and 45 A-weighted decibels during the day for residential settings. However, ambient noise levels in village settings can be higher than these criteria.

Table A2.7-5 Comparison of Noise Criteria for Continuous Sources

Type of Land Use	Applicable Standards					Reference Guidelines				
	World Bank Group[(a)]			WHO[(b)]		DRC[(c)]			US EPA[(d)]	
	Land Use	Night [dBA]	Day [dBA]	Night [dBA]	Day [dBA]	Land Use[(e)]	Night [dBA]	Day [dBA]	L_{dn}[(f)]	L_{eq}[(g)]
residential	A [(h,i)]	45	55	45 [(j)]	55 [(k)]	I	40	45	55[(l)]	55[(m)]
residential/commercial mix	-	-	-	-	-	II	50	55	-	-
industrial	B	70	70	70	70	III	70	70	-	-

(a) (WBG 1998). Pollution, Prevention and Abatement Handbook (PPAH). General Environmental Guidelines. Night is defined as 22:00 to 07:00. Day is defined as the remaining hours, 07:00 to 22:00.

(b) (WHO 1999). Guidelines for Community Noise. Night is a period of at least 8 hours over which sleep disturbance is of concern. Day comprises the remaining 16 hours of any 24-hour period.

(c) (DRC 2003c). NMC Mining Regulations, Annex IX. The definition of night and day time periods are as defined in Annex IX.

(d) (US EPA 1974). Information on levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety.

(e) Category I: Lands having several residences that constitute a community or village, a school or hospital of any other establishment for teaching, health care or convalescence.

Category II: Lands where permanent commercial activities are undertaken, where hunting fishing or recreational activities take place. The nighttime noise level only applies to the interior of any inhabited residences; otherwise the maximum daytime level can continue to be applied at night.

Category III: Lands within which industrial or agricultural activities are primarily undertaken. If there are permanent residences within this type of terrain, the thresholds must be 50 dB(A) at night and 55 dB(A) during the day.

(f) L_{dn} represents L_{eq} with 10 dB night-time penalty over 24-hour period.

(g) $L_{eq(24)}$ represents sound energy average over a 24-hour period.

(h) Category A: Residential, institutional and educational.

Category B: Industrial, commercial.

(i) If ambient noise is greater than the criteria, a maximum increase of 3 dBA over ambient is allowed. PPAH and WHO criteria apply for any residence, regardless of whether it is in a primarily residential development or in an area of mixed land use.

(j) The WHO Night criteria is the recommended noise level outside bedrooms.

(k) The WHO Day criteria is the recommended noise level in outdoor living areas.

(l) Outdoors in residential areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.

(m) Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.

Human response to noise also will depend on the nature of the noise source in terms of tone or pitch and duration of the sound. The PPAH indicates that noise events or disturbance from activities such as blasting should be minimized; however, criteria are not provided. The WHO recommends the following criteria for short-term noise events:

- 60 A-weighted decibels night: this criteria is the maximum instantaneous noise level for an event such as blasting based on potential for sleep disturbance.
- 110 dBA day: this criterion is the maximum instantaneous noise level for an event such as blasting based on human hearing preservation.

The project will attempt to meet these criteria at the nearest residences to the open pits.

A2.7.2.2 Noise Summary

- The applicable continuous noise standards shall be the World Bank Group standards.
- The reference guideline for continuous source noise shall be the DRC NMC Regulations.
- The reference guideline for short-term noise events shall be the WHO criteria.

A2.7.2.3 Vibrations

There are no applicable standards or limits in place for vibration exposures in the DRC. Blasting regulations exist in most countries to regulate and control blast energy to prevent structural damage at neighboring properties. In the absence of World Bank and IFC limits for vibration, the US, Canadian and DRC limits were used as guidelines. These regulations address both ground and airborne vibration.

Ground Vibration

Ground vibration is typically measured in terms of particle velocity in millimeters per second. Criteria are established to prevent cosmetic and structural damage to structures. Criteria for project assessment are from Section 48 of Annex IX of the DRC Mining Code and have been developed based on vibration criteria for the United States (US) (Table A2.7-6).

Table A2.7-6 Ground Vibration Criteria for the DRC

Type of Building	DRC Mining Code and US Standards [(a)]
	Structural [mm/s]
residential (light frame)	12.5
industrial (concrete or steel frame)	12.5

[(a)] (OSMRE 2001) Federal Office of Surface Mining Reclamation and Enforcement.
mm/s = millimeters per second.

Airborne Vibration

Air vibration limits commonly used for surface mining operations where blasting can be expected to occur over many years typically fall in the range of 120 to 133 linear decibels, as seen in Table A2.7-7.

Table A2.7-7 Air Vibration Guidelines for the TFM Project

	DRC[a]	United States[b]	Canada[c]
air vibration limit	120 dBL	129 – 134 dBL[d]	120 – 128 dBL[e]

(a) Section 48 of DRC Mine Regulation 2003 Annex IX.
(b) Office of Surface Mining Reclamation and Enforcement.
(c) Ontario Ministry of Environment Publication NPC 119.
(d) Limit dependent on frequency range of instrumentation.
(e) Limit dependent on whether monitoring is carried out continually.
dBL = linear decibels.

A2.7.3 Water

A2.7.3.1 Process Effluent Discharges

The project mine and processing plant effluent management system is being designed under a zero discharge concept, which will mean using proven and feasible state-of-the-art engineering and technology for the design, construction, operation and closure of a facility, to eliminate or minimize discharges from the facilities to the environment. No mine or processing plant effluents are expected to be released to receiving waters during normal operations. Therefore, effluent limits are not applicable. Limits that would normally apply to process effluent discharges are World Bank Group effluent limits for mining and milling operations (WBG 1995a) and base metal and iron ore mining (WBG 1998). These are presented in Table A2.7-8.

A2.7.3.2 Storm Water Discharges

The project storm water management plan will assure that storm water discharges will have no significant effect on receiving water qualities and downstream uses. Project facilities such as the waste rock storage facilities and other disturbed areas will be managed in accordance with the principles set forth in Section A2.7.5. Additionally, predictive geochemical testing of mine and process materials, detention of storm water in containment structures, and confirmatory storm water quality testing will be conducted. The storm water management strategy and the water quality guidelines that will be used are set forth below:

a) All storm water discharges during normal operations will meet the standards established as applicable standards for effluent, as described in Section A2.7.3.1 or will be within the range of natural background variation.

Table A2.7-8 TFM Project Applicable and Reference Water Quality Effluent Limits

Parameter	Units	Applicable World Bank Group Effluent Standards	Reference Effluent Standards	
			DRC[e]	US EPA[f]
Field Parameters				
pH	pH Units	6-9[a,b,c,d]	6-9	6-9
temperature	°C	3°C above ambient[b,c,d]	5°C above ambient	-
conductivity	mS/cm	-	-	-
dissolved oxygen	mg/L	-	-	-
Conventional Parameters				
total alkalinity	mg/L	-	-	-
total dissolved solids	mg/L	-	-	-
total suspended solids	mg/L	50[a,b,c]	100	30
total organic carbon	mg/L	-	-	-
dissolved organic carbon	mg/L	-	-	-
chemical oxygen demand	mg/L	-	-	-
biochemical oxygen demand	mg/L	50[b,d]	50	-
hardness	mg/L	-	-	-
color	TCU	-	-	-
Organics				
phenolics	mg/L	-	-	-
oil and grease	mg/L	10[a]	-	-
Nutrients				
ammonia	mg/L	10[d]	-	-
total Kjeldahl nitrogen	mg/L	-	-	-
nitrate + nitrite	mg/L	-	-	-
total phosphorus	µg/L	2[d]	-	-
Major Ions				
bicarbonate	mg/L	-	-	-
calcium	mg/L	-	-	-
chloride	mg/L	-	-	-
fluoride	mg/L	20[d]	-	-
magnesium	mg/L	-	-	-
potassium	mg/L	-	-	-
sodium	mg/L	-	-	-
sulfate	mg/L	-	-	-
Metals				
aluminum	µg/L	-	-	-
antimony	µg/L	-	-	-
arsenic	µg/L	100[a,c,d]	400	-
barium	µg/L	-	-	-
beryllium	µg/L	-	-	-
boron	µg/L	-	-	-
cadmium	µg/L	100[a,b,c,d]	-	100
chromium VI	µg/L	50[b]	-	-
chromium	µg/L	500[d]	-	-
cobalt	µg/L	-	-	-
copper	µg/L	300[b]	1,500	300
iron	µg/L	2,000[b]	6,000	-
lead	µg/L	100[c,d]	500	600
manganese	µg/L	-	-	-
mercury	µg/L	2[b]	2	-

Table A2.7-8 TFM Project Applicable and Reference Water Quality Effluent Limits (continued)

Parameter	Units	Applicable World Bank Group Effluent Standards	Reference Effluent Standards	
			DRC[e]	US EPA[f]
molybdenum	µg/L	-	-	-
nickel	µg/L	500[a,b,c]	1,000	600
selenium	µg/L	100[d]	-	-
silver	µg/L	500[d]	-	-
titanium	µg/L	-	-	-
thallium	µg/L	-	-	-
thorium	µg/L	-	-	-
tin	µg/L	-	-	-
strontium	µg/L	-	-	-
uranium	µg/L	-	-	-
vanadium	µg/L	-	-	-
zinc	µg/L	1,000[b,c]	10,000	1,500
Radioactivity				
alpha particles	-	-	-	-
beta particles and photon emitters	-	-	-	-
Microbiological				
total coliforms	CFU/ 100 ml	-	-	-
E. coli	CFU/ 100 ml	-	-	-

(a) National Secondary Drinking Water Regulations.
(b) No more than 5.0 percent samples total coliform-positive in a month. (For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive per month.) Every sample that has total coliform must be analyzed for either fecal coliforms or E. coli, if two consecutive TC-positive samples, and one is also positive for E. coli or fecal coliforms, system has an acute MCL violation.
(c) Guidelines for irrigation equipment.
(d) Narrative guidelines are as follows:
US EPA hardness guideline: (Appendix B2.12-III).
US EPA color guideline: Waters shall be virtually free from substances producing objectionable color for aesthetic purposes. Increased color (in combination with turbidity) should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life.
US EPA suspended solids and turbidity guideline: Settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10percent from the seasonally established norm for aquatic life (for solids – suspended, settleable, and turbidity).
US EPA total phosphorus guideline: (Appendix B2.12-III).
US EPA temperature guideline: (Appendix B2.12-III).
(e) Guidelines are hardness-dependent and were calculated for the range of hardness observed in the study area.
(f) Guidelines are pH (acute and chronic) and temperature (chronic) dependent and were calculated for the range of pH and temperature observed in the study area.

TCU = True Color Unit.
µg/L = micrograms per liter.
TT = treatment technology.
pCi = picocurie.
Bq = bequerel.
CFU = colony forming units.

b) In addition, three additional reference standards will be used as guidelines for determining whether storm waters from specific source areas will be allowed to flow to natural waterways or whether the collected storm water will be incorporated into the process water circuit. There are currently no ambient water quality guidelines for the protection of aquatic life, drinking water quality or agricultural uses in the DRC. Therefore, the following reference standards were selected based on the present uses of water downgradient of the proposed project:

- US EPA guidelines for the protection of aquatic life and for drinking water (US EPA 2002a, 2002b).
- WHO drinking water guidelines (WHO 2004).
- South African guidelines for the protection of health effects to crops and livestock (SADWAF 1996a, 1996b and 1996c). Guidelines for use in irrigation equipment were not considered in the assessment.

c) The reference standards will be used as ambient water quality guidelines. Routine surface water quality monitoring points will be established as part of the project surface water resources action plan (Section D3.1.5). Tested water qualities will be compared to the ambient water quality guidelines, and adjustments made to the storm water management plan, if the guidelines are not being achieved due to project activities.

A summary of reference standards used for describing current water quality in the concession and potential changes resulting from mine-related activities is provided in Table A2.7-9.

A2.7.3.3 Sediment Discharges

Storm water management from disturbed or processing areas will be managed in accordance with international best management practices to minimize sediment transport. Current sediment conditions were determined within surface waters downstream of the project. The project environmental action plan will include a sediment monitoring program to track any significant changes in sediment quality (Section D3.1.5). Observed impacts on sediment quality will be used to guide improvements to the storm water management practices.

Table A2.7-9 TFM Project Water Quality Guidelines

Parameter	Units	US EPA Drinking Water (USEPA 2006)	WHO Drinking Water (WHO 2004)	South Africa Guidelines for Agricultural Purposes (SADWAF 1996c,d)	Protection of Aquatic Life (USEPA 2002a)	
					Acute	Chronic
Field Parameters						
pH	pH	6.5-8.5[a]	6.5-8.5	6.5-8.4[h]	-	6.5-9.0
temperature	°C	-	-	-	narrative[d]	narrative[d]
conductivity	mS/cm	-	-	-	-	-
dissolved oxygen	mg/L	-	-	-	narrative[d]	narrative[d]
Conventional Parameters						
total alkalinity	mg/L	-	-	-	-	-
total dissolved solids	mg/L	500[a]		260[h]	-	-
total suspended solids	mg/L	-	-	50[c]	narrative[d]	narrative[d]
total organic carbon	mg/L	-	-	-	-	-
dissolved organic carbon	mg/L	-	-	-	-	-
chemical oxygen demand	mg/L	-	-	-	-	-
biochemical oxygen demand	mg/L	-	-	-	-	-
hardness	mg/L	-	-	-	narrative[d]	narrative[d]
color	TCU	15[a]	-	-	narrative[d]	narrative[d]
Organics						
phenolics	mg/L	-	-	-	-	-
oil and grease	mg/L	-	-	-	narrative[d]	narrative[d]
Nutrients						
ammonia	mg/l	-		-	3.8 - 38.7[f]	1.01 - 3.97[f]
total kjeldahl nitrogen	mg/L	-	-	-	-	-
nitrate + nitrite	mg/L	10	11.3	100	-	-
total phosphorus	µg/L	-	-	-	-	narrative[d]
Major Ions						
bicarbonate	mg/L	-	-	-	-	-
calcium	mg/L	-	-	1,000[i]	-	-
chloride	mg/L	250[a]	-	100[h]	860	230
fluoride	mg/L	2[a]	-	2[i,h]	-	-
magnesium	mg/L	-	-	500[i]	-	-
potassium	mg/L	-	-	-	-	-

Table A2.7-9 TFM Project Water Quality Guidelines (continued)

Parameter	Units	US EPA Drinking Water (USEPA 2006)	WHO Drinking Water (WHO 2004)	South Africa Guidelines for Agricultural Purposes (SADWAF 1996c,d)	Protection of Aquatic Life (USEPA 2002a)	
					Acute	Chronic
sodium	mg/L	-	-	70[h]	-	-
sulfate	mg/L	250[a]	-	-	-	-
Metals						
aluminum	µg/L	50–200[g]	-	5,000[h,i]	750	87
antimony	µg/L	6	20	-	-	-
arsenic	µg/L	10	10	100[h]	340	150
barium	µg/L	2,000	700	-	-	-
beryllium	µg/L	4	-	100[h]	-	-
boron	µg/L	-	50	500[h]	-	-
cadmium	µg/L	5	3	10[h,i]	1.2 - 10.2[e]	0.18 - 0.85[e]
chromium VI	µg/L	-	-	100[h]	16	11
chromium	µg/L	100	50	-	-	-
cobalt	µg/L	-	-	50[h]	-	-
copper	µg/L	1,000	2,000	200[h]	8 - 60[e]	2 - 4[e]
iron	µg/L	300[h]	-	5,000[h]	-	1,000
lead	µg/L	TT	10	200[h]	41 - 579[e]	1.6 - 22.6[e]
manganese	µg/L	50[h]	400	20[h]	-	-
mercury	µg/L	2	1	1[i]	1.4	0.77
molybdenum	µg/L	-	70	10[h,i]	-	-
nickel	µg/L	-	20	200[h]	296 - 1725[e]	33 - 192[e]
selenium	µg/L	50	10	20[h]	-	5
silver	µg/L	100[a]	-	-	1.5 - 53.4[e]	-
titanium	µg/L	-	-	-	-	-
thallium	µg/L	2	-	-	-	-
thorium	µg/L	-	-	-	-	-
tin	µg/L	-	-	-	-	-
strontium	µg/L	-	-	-	-	-
uranium	µg/L	30	15	10[h]	-	-
vanadium	µg/L	-	-	100[h]	-	-
zinc	µg/L	5,000[a]	-	1,000[h]	76 - 441[e]	76 - 441[e]

Table A2.7-9 TFM Project Water Quality Guidelines (continued)

Parameter	Units	US EPA Drinking Water (USEPA 2006)	WHO Drinking Water (WHO 2004)	South Africa Guidelines for Agricultural Purposes (SADWAF 1996c,d)	Protection of Aquatic Life (USEPA 2002a)	
					Acute	Chronic
Radioactivity						
alpha particles	-	15 pCi/L	0.5 Bq/L	-	-	-
beta particles and photon emitters	-	4 millirems/yr	1 Bq/L	-	-	-
Microbiological						
total coliforms	CFU/100 ml	5%[b]	-	1	-	-
e. coli	CFU/100 ml	none	-	1	-	-

(a) National Secondary Drinking Water Regulations.
(b) No more than 5.0 percent samples total coliform-positive in a month. (For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive per month.) Every sample that has total coliform must be analyzed for either fecal coliforms or E. coli, if two consecutive TC-positive samples, and one is also positive for E. coli or fecal coliforms, system has an acute MCL violation.
(c) Guidelines for irrigation equipment.
(d) Narrative guidelines are as follows:
US EPA hardness guideline: (Appendix B2.12-III).
US EPA color guideline: Waters shall be virtually free from substances producing objectionable color for aesthetic purposes. Increased color (in combination with turbidity) should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life.
US EPA suspended solids and turbidity guideline: Settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life (for solids – suspended, settleable, and turbidity).
US EPA total phosphorus guideline: (Appendix B2.12-III).
US EPA temperature guideline: (Appendix B2.12-III).
(e) Guidelines are hardness-dependent and were calculated for the range of hardness observed in the study area.
(f) Guidelines are pH (acute and chronic) and temperature (chronic) dependent and were calculated for the range of pH and temperature observed in the study area.
(g) The drinking water guideline for aluminum was based on water treatment with alum and therefore was not used in the water quality assessment.
(h) South African Plant Health guideline for agricultural use.
(i) South African Livestock guideline for agricultural use.
TCU = True Color Unit.
μg/L = micrograms per liter.
TT = treatment technology.
pCi = picocurie.
Bq = bequerel.
CFU = colony forming units.

Sediment quality reference standards chosen to be used to gauge the significance of changes in ambient sediment quality are from the United States National Oceanographic and Atmospheric Association (NOAA 1999), which are summarized in Table A2.7-10. NOAA has several sets of sediment standards and two sets were selected for comparison to sediment quality data. The threshold effect level (TEL) represents the upper limit in the range of sediment chemical concentrations that is dominated by no-effect results. Sediment quality values within the TEL are not considered to represent significant hazards to aquatic organisms. The probable effect level (PEL) represents the lower limit of the range in sediment chemical concentrations that is usually or always associated with adverse biological effects.

Table A2.7-10 TFM Project Sediment Quality Criteria[(a)]

Parameter	Unit	Threshold Effect Level (TEL)	Probable Effect Level (PEL)
arsenic	mg/kg	5.9	17
nickel	mg/kg	18	35.9
zinc	mg/kg	123.1	315
lead	mg/kg	35	91.3
copper	mg/kg	35.7	197
chromium	mg/kg	37.3	90
cadmium	mg/kg	0.596	3.53
phenanthrene	µg/kg	41.9	515
fluoranthene	µg/kg	111	2355
pyrene	µg/kg	53	875
benzo(a)anthracene	µg/kg	31.7	385
chrysene	µg/kg	57.1	862

(a) US National Oceanographic and Atmospheric Associations (NOAA) 1999.

A2.7.4 Domestic, Industrial, Hazardous and Medical Waste

Solid wastes generated by the TFM project will include domestic, industrial,[5] hazardous and medical wastes.

There are currently no standards that specifically govern waste management in the DRC. The 1998 South African Waste Management Series (SAWMS-1998)

5 Industrial waste is the waste generated by the processing plant, mechanical and electrical workshops and other ancillary facilities. Industrial waste does not include waste rock, tailings, Fe-Al-Mn (FAM) residue (iron, aluminum, manganese) and magnesium hydroxide.

was used as the principal guideline for this action plan. This series of published documents outline the minimum requirements for waste management, as follows:

- **Document 1**: Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste.
- **Document 2**: Minimum Requirements for Waste Disposal by Landfill.
- **Document 3**: Minimum Requirements for Water Monitoring at Waste Management Facilities.

Regulations promulgated by the US EPA may be used as guidelines on issues that may not be addressed by the SAWMS-1998. These standards may also be used if TFM desires to implement an alternate standard if the alternate standard is more conservative than the SAWMS-1998 standard. These regulations are contained in Title 40 (Protection of the Environment) of the United States Code of Federal Regulations (40 CFR). Subtitle C of 40 CFR addresses hazardous waste management, and comprises Parts 260 through 299. Subtitle D of 40 CFR addresses non-hazardous solid waste, and comprises Parts 239 to 259. Other appropriate, reasonable, and applicable regulations may also be considered as needed. In any case, the minimum SAWMS-1998 standards must be met.

In addition, the IFC's "Hazardous Materials Management Guidelines" (HMMG) are of relevance for this action plan. These IFC guidelines have the following key requirements:

- Screening.
- Hazardous Materials Management Program.
- Community involvement and awareness.

The South African Waste Management Service has similar key requirements but provides very specific guidelines for the design and lining of land fills.

The South African approach is to classify a waste in terms of the toxicity of its components, to determine their leachability (US EPA TCLP test and Acid Rain leach test are used) and to limit the calculated load (measured in g/ha/month) of hazardous substances released to the environment by prescribing the engineering design and construction requirements of the waste disposal site (e.g., liner specifications).

The South African landfill classes are summarized in Table A2.7-11.

Table A2.7-11 South African Landfill Classification System

Waste Type	G General Waste								H Hazardous Waste	
landfill size	C communal landfill		S small landfill		M medium landfill		L large landfill		h hazard ratings 3 & 4	H hazard ratings 1 & 2
climatic water balance	B^-	B^+	B^-	B^+	B^-	B^+	B^-	B^+	n/a	n/a
landfill size maximum rate of deposition	<25 tonnes/day		>25 <150 tonnes/day		>150 <500 tonnes/day		>500 tonnes/day		n/a	n/a

n/a = Not applicable.

A landfill that is expected to generate leachate due to the overall climatic water balance, i.e., the rainfall is greater than the evaporation rate, is designated as a B^+ landfill, whereas a landfill that is expected to generate only sporadic leachate, i.e., less than once in five years, is termed a B^- landfill. Thus, a GLB^+ landfill is permitted to accept General Waste (G), is large (L) and will generate leachate (B^+).

A2.7.5 Materials Management

International standards for hazardous and non-hazardous materials management include:

- US EPA Waste Management Branch Guidelines for Toxic/Hazardous Substances Management.
- IFC Hazardous Materials Management Guidelines, December 2001 (IFC 2001).
- Title 49 Code of US Federal Regulations, Hazardous Materials Regulations, Office of the Federal Register 2002.
- United Nations Recommendations of the Committee of Experts on the Transport of Dangerous Goods, Chapter 6, Eleventh revised edition, US 49 CFR Section 178-608.

Materials (including mixtures and solutions) are classified by international classification systems (UN 1993) in hazard classes according to the hazards they represent, as follows:

- Class 1 – Explosives.
  - Division 1.1 Explosives with a mass explosion hazard.

- Division 1.2 Explosives with projection hazard.
- Division 1.3 Explosives with predominantly fire hazard.
- Division 1.4 Explosives with no significant blast hazard.
- Division 1.5 Very insensitive explosives, blasting agents.
- Division 1.6 Extremely insensitive detonating articles.

- Class 2 – Gases.
  - Division 2.1 Flammable gases.
  - Division 2.2 Non-flammable, non-poisonous compressed gas.
  - Division 2.3 Gases poisonous by inhalation.
- Class 3 – Flammable Liquids and Combustible Liquids.
- Class 4 – Flammable Solids, Spontaneously Combustible Materials and Dangerous when wet materials.
  - Division 4.1 Flammable solids.
  - Division 4.2 Spontaneously combustible material.
  - Division 4.3 Dangerous when wet material.
- Class 5 – Oxidizers and Organic Peroxides.
  - Division 5.1 Oxidizer.
  - Division 5.2 Organic peroxide.
- Class 6 – Toxic Materials and Infectious Substances.
  - Division 6.1 Toxic materials.
  - Division 6.2 Infectious substance.
- Class 7 – Radioactive Materials.
- Class 8 – Corrosive Materials.
- Class 9 – Miscellaneous Hazardous Materials.

Management of the above materials will be conducted in accordance with the standards listed at the front of this section.

A2.7.6 Environmentally Sensitive Areas

As a reference guideline, Sensitive Areas are defined in the DRC NMC regulations (Annex XII) as ambient environments or ecosystems whose characteristics make them particularly sensitive to the negative impacts of mining or quarrying operations. Types of Sensitive Areas as defined in the regulations include:

- A marsh located less than 10 kilometers from the project area.
- A lake.
- An area where threatened protected plant or animal species live or migrate.
- An area subject to erosion.
- A source of potable water.

Potential Sensitive Areas occur in the project area. Sensitive Areas are not specifically protected, but may require TFM to undertake special mitigation measures. These are addressed in the flora, fauna, hydrology and soils sections of the ESIA.

A2.7.7 Water Management Plans

The project's water management system should reflect specific project and site conditions, such as process water requirements, proposed mining and processing infrastructure, and baseline environmental conditions. The following water management design criteria were used to develop the mine water action plan for the project (Section D3.1.7):

- Maximize diversion of natural runoff away from the disturbed areas and discharge the diverted runoff directly to receiving streams.
- Eliminate or minimize uncontrolled surface water drainage from the areas affected by mining activities. Surface runoff should be collected and treated in sedimentation ponds and integrated into the process water circuit.
- The design criteria for the storm water control system should be based on the specific site conditions and a consideration of the potential results of any failure of the system. Some suggested design criteria are as follows:
    - The waste rock facility runoff collection pond capacity will be designed to contain a 10-year storm without discharge into the environment.
    - Runoff from the plant site and infrastructure is likely to contain high concentrations of suspended solids. The plant site storm water control ponds should be designed to contain runoff from a 10-year storm.

- For closure, a sustainable drainage system that requires no maintenance after a period of monitoring should be developed. Dam structures at closure should be avoided, if feasible. If possible, pre-development drainage conditions (drainage areas, flow direction, etc.) should be maintained.

A2.7.8 Cultural Areas

As a reference guideline, sites of cultural heritage (archaeological sites, historical sites and other cultural resources) must be excavated by the appropriate authority prior to any disturbance (DRC Mining Law 007/2002 Articles 489 to 491). If, during exploration or other work, a significant archaeological, cultural or historic finding is made, work shall cease immediately and the competent authorities shall be notified. The on-site representative of TFM will lend assistance to the competent authorities and, if necessary, move the operation to another site. The competent authority has to be notified as soon as a cultural heritage resource is discovered. The authority has 60 days to remove the resource, after which TFM can remove and put the artifact in safe keeping. An additional reference guideline applicable to cultural property is IFC Performance Standard 8. Full details of the cultural resources action plan are provided in Section D4.3.

A3 ANALYSIS OF ALTERNATIVES

A3.1 INTRODUCTION

An analysis of alternatives was conducted for the Tenke Fungurume Mining (TFM) project for major project components. For mining projects, options or alternatives are often limited. Economic factors, such as the cost of hauling waste rock or ore over long distances, and local conditions, such as topography and geotechnical factors, will dictate or limit certain characteristics of the project. One major project decision that can be made for the TFM project, without conducting a formal analysis of alternatives, is for the mining method to be open pit. The proximity of the ore close to the surface makes underground mining impractical to consider.

Several other major project decisions are best made through an evaluation of the relative merits of alternatives. Alternatives (options) for the following mine components were evaluated during design of the project:

- Operations configuration (what ore bodies to mine and location of the processing plant relative to the ore bodies).
- Tailings storage facility location.
- Waste rock facility locations.
- Processing plant location.
- Process type.
- Final copper and cobalt products.
- Construction village location.
- Growth center location.
- Main access road location within the concession.
- Water source.
- Power source.
- Transport of raw materials and product.

In addition, the “no project” alternative was considered.

This report describes, for each component:

- Different alternatives that were considered.

- Advantages and disadvantages of each alternative.
- Factors that were assessed.
- Analysis of alternatives.

Technical, environmental and social factors, as well as sustainability, were considered in selecting the preferred alternatives.

The selection of a preferred alternative in some cases eliminated or reduced options for other project components. For example, the choice of what orebody to mine was considered first as the results of that analysis significantly influenced facility placement. As a result, the broader and over-reaching alternative analyses are presented first.

A3.2 METHODS

Methods for most of the analyses followed the “K-T analysis” approach described by Kepner and Tregoe (1997). In this approach, criteria that are evaluated for each alternatives analysis are weighted relative to each other. Then each alternative is scored for each criteria relative to the other alternatives. The sum of the products of the criteria weights and the scores for each alternative are then used to compare alternatives. This semi-quantitative method requires that all assumptions used in comparing alternatives are clearly presented so that readers can follow the steps and thought processes leading to the decision made.

The analysis of alternatives for the TFM project was done by an interdisciplinary team of technical, environmental and social experts. Some analyses were conducted in a workshop environment while others were conducted initially by one or two persons and then reviewed by a larger group via e-mail or meetings.

Steps in the K-T analysis approach are described further below.

Problem Statement

The first step in an analysis of alternatives is to clearly state the objective for the exercise. The objective should clearly state what action is being considered (e.g., decision to locate a plant site), and what implied prior decisions are essential to the choice (e.g., assumes that the plant will be operational for at least 20 years, and that it will have both copper and cobalt processing facilities).

Identify Musts and Wants

The next step is to identify what each alternative has to have (the "musts") before it can be considered as a feasible alternative. The type of criteria that can be used to compare the alternatives (the "wants") is also needed. Both musts and wants have to be measurable.

Musts should be considered at the start of the exercise to limit the analysis to feasible alternatives. Musts should be clearly stated so that the rationale for selecting the alternatives to be considered is understood, and so that time is not wasted in considering alternatives that have characteristics making them infeasible (e.g., "fatal flaws"). In the example of locating a processing plant site, musts could be:

- Locations must have sufficiently level ground to situate a plant.
- Locations must be near the ore bodies to be mined.

Wants are the criteria to be used to compare the relative merits of the selected alternatives. Wants were selected for each analysis from four separate categories:

- Environmental.
- Social.
- Technical.
- Sustainability.

Environmental criteria pertained to key physical (e.g., air, noise, water) and biological (e.g., flora, biodiversity) resources that could be affected by the decision to choose one alternative over another. Similarly, social criteria were selected based on key socio-economic and cultural resource factors, including land use and the potential for relocating people. Technical criteria were based on the engineering constraints that each alternative was subject to, including factors such as transport distance, cut and fill requirements or technical feasibility.

In many cases sustainability is inherent to the environmental and social criteria. Sustainability was identified as a separate category for criteria to ensure that this issue was addressed. Sustainability criteria were selected based on how effective the alternatives would be in providing useful services after mine closure, and in terms of their energy efficiency or degree of recycling. Cost was not considered as separate criteria as it was essential to those criteria that had cost as the measurable differentiating factor (e.g., transport distance is relative to cost).

Consideration in selecting wants was to restrict them to criteria that were different between the alternatives. In other words, if a criterion is considered to be identical for each alternative then it serves no purpose in the analysis. Achieving a balance of wants between the environmental, social, technical and sustainability categories was also important, so as not to overly bias one category over another. This potential for bias was further reduced by means of sensitivity analyses, as described later in this section.

Scoring the Wants

The “wants” selected for each alternatives analysis were then evaluated relative to one another on a scale of one to ten where ten is the most important criterion All other criteria are scored relative to this criteria. These ratings were applied across all wants, i.e., environmental, social, technical and sustainability wants were considered together. In other words, a score of three would mean the criterion is three-tenths the importance of the most important criterion when distinguishing between alternatives. Note that criteria were not ranked in order of importance and that more than one criterion can receive the same score.

Identify Alternatives that Meet the Musts

Alternatives that met the musts were selected for each alternatives analysis. In the case of the processing plant example, alternatives would be selected based on:

- Sites located based on the operational configuration of the project (i.e., overall determination of what ore bodies to mine and where to generally locate the processing plant).
- Sites with sufficiently gentle topography to allow construction of a processing plant.
- Sites with sufficient space to accommodate all of the processing plant and its additional facilities, including road and rail transportation routes.

Collect Field Data and/or Conduct Analyses

Once potential alternatives were identified, field studies were conducted to determine the physical, biological and social conditions at each site or route. Sites and routes were visited, observations of importance were recorded, photographs were taken and global positioning systems (GPS) were used to record coordinates. In some cases, more formal plots (e.g., flora, timber), transects (corridors, e.g., wildlife, fish), or pits (e.g., soils) were conducted. The area surrounding the potential alternatives was mapped for vegetation/land use using Quick Bird satellite imagery. Overlays were prepared within a geographical information system (GIS) to determine the vegetation/land use composition of alternative sites. Air quality and noise models were also run to determine if the processing plant site, mine, or transport route would have an effect on nearby inhabitants.

Evaluate the Alternatives Based on Wants

Once the wants have been scored and the feasible alternatives selected, each want is scored from one to ten relative to the different alternatives. The alternative with the best outcome for any criteria is scored ten, and other alternatives are scored relative to that maximum.

Following completion of the scoring, the weighted scores for each alternative are calculated by summing the products of the want weights, then multiplying by the respective alternative scores for each criteria. An example scoring is provided in Table A3.2-1.

Table A3.2-1 Sample Calculation of Weighted Scores

Wants		Option 1		Option 2	
Criteria	**Weight**	**Score**	**Weighted Product**	**Score**	**Weighted Product**
A	10	3	10 x 3	10	10 x 10
B	6	10	6 x 10	5	6 x 5
C	7	1	7 x 1	10	7 x 10
Sum			**97**		**200**

In this example, option 2 receives a higher score than option 1. As a result, option 2 is considered to be preferred, at least at this stage of the analysis.

Conduct Sensitivity Analyses

The K-T analyses are only as good as the assumptions that the team makes in coming up with the scoring. The outcome is influenced by the perceived importance of each want in relation to the other wants. The greatest source of potential variation is created when assigning importance (weighting) to each of the four overall categories of wants.

To reduce the potential for variation in scoring, the weighted scores were computed using three methods:

1. Simple weighted score, as described above.

2. "Normalized" score, where only environmental, social and technical issues were considered, with equal weighting (0.33) assigned to each category.
3. Normalized score, with more weight being given to environmental (0.3) and social (0.3) than technical (0.2) and sustainability (0.2).

The total scores for each of these three scoring methods were then compared between alternatives to determine how the ranking of the alternative varied between methods. Alternatives that were consistently ranked first using all three methods were considered to be strong alternatives.

Identify Adverse Consequences of Highest Ranking Alternative

Following ranking of the alternatives, a separate exercise is required to confirm that the highest ranking alternative is truly the one to select. As stated by Kepner and Tregoe (1997), questions to ask of each alternative at this stage include:

- What might happen if the alternative is close to a must limit?
- Is all of the information about this alternative valid, and what are the implications of some information being wrong?
- What are the short- and long-term implications of selecting this alternative?
- What could keep this alternative from being successfully implemented?

An additional question pertaining to the TFM project is:

- How acceptable is the alternative to local stakeholders?

The potential risks of selecting the alternative are evaluated based on the probability of something negative happening and the severity of the event if it does. Multiplied together, probability times severity equals the degree of risk that the alternative may face.

For the TFM project, probability and severity were both scored on a scale of low, moderate and high.

Make Best Balanced Choice

With all of the K-T analysis scores, results of the sensitivity analysis, and consideration of the potential for adverse implications considered, it is possible to make the best balanced choice using professional judgment. Providing all of this information makes the decision-making process transparent and should lead to selection of the best, or "preferred", alternative.

A3.3 OPERATIONS CONFIGURATION

Project designs were considered in two phases. The primary decision-driver for the first phase was the selection of the orebody that will be mined from among the numerous mineralized areas in the TFM concession and the location of the first plant site (operations configuration). In this selection process the availability of data on orebody mineralogy, geometry and size was a primary decision-driver, since this information would greatly expedite the FS analysis. However social factors were also a strong consideration in selecting among ore bodies for which geologic data were available; with specific emphasis on the future mine's proximity to human settlement.

A3.3.1 Introduction and Problem Statement

Numerous mineable ore bodies and several identified potential processing plant sites exist in the project area. While most of the mineable ore bodies will eventually be mined, the sequencing of each orebody and the locations of plant sites and access roads can have different effects before full build out. The first major alternative considered for the TFM project was which overall project layout to employ. The primary goal of this selection was to minimize negative effects during the first years of production.

The problem statement for the operations configuration is:

> Where will ore initially be mined, and in what general area will the processing plant site be located?

Start up for the mine requires a large and reliable source of ore. As a result, the analysis is restricted to consideration of the Kwatebala and Fungurume ore bodies only, the two largest deposits on the concession.

Once a general location for the processing plant was determined in this analysis, the specific site was evaluated in a subsequent analysis (Section A3.7).

A3.3.2 Issues (Wants)

The wants were identified and ranked for each of the four overall categories (environmental, social, technical and sustainability).

Environmental

- Noise from the mine, plant and roads should be minimized, especially near important environmental and social receptors (10).
- Air quality effects should be minimized, especially near important environmental and social receptors (10).
- Surface water quality should not be reduced (3).[6]
- Loss of natural habitats should be minimized (6).
- Fragmentation of habitats (effects on biodiversity) should be minimized (4).

Social

- The amount and quality of agricultural land affected should be minimized (10).
- The number of people potentially required to relocate should be minimized (10).
- The potential for traffic accidents in public areas and other impacts on safety should be minimized (10).
- Effects on cultural resources should be minimized. This was given a low weight as cultural resources in the concession are not prevalent on the ore bodies (Section C4.2) and as mitigation measures could be successfully employed if any artifacts are encountered (1).

Technical

- Options incorporating efficiencies which allow for a lower cost of construction and mitigation are desirable (10).
- Alternatives requiring construction on more difficult topography are less desirable (4).

Sustainability

- Alternatives having a smaller permanent footprint respecting the length of the road are desirable (4).

---

[6] While preservation of water quality is highly important for mining projects, there should not be major differences in the effect on surface water quality between alternatives. One exception to this is the potential impact of access roads and material transportation on surface water qualities. However, the potential impact to water quality due to traffic (spills, dust) was considered to be less important than effects related to noise and air quality.

- Alternatives which have features that are of more use to the population in the long term, including post-closure, are desirable (10).

A3.3.3 Alternatives Considered

It is feasible to consider placing the processing plant site at a distance from the orebody. Various combinations of orebody location and processing plant locations were considered as alternatives. These alternatives were evaluated based on environmental and social issues, technical issues and issues of sustainability. Three alternatives were considered in this analysis (Figure A3.3-1).

Option 1 Fungurume-Fungurume. For this alternative, mining of the orebody at Fungurume and situating the plant at the existing, abandoned plant site near Fungurume was considered.

Option 2 Kwatebala-Fungurume. For this alternative, mining of the orebody at Kwatebala would occur and the plant would be located at the abandoned plant site near Fungurume.

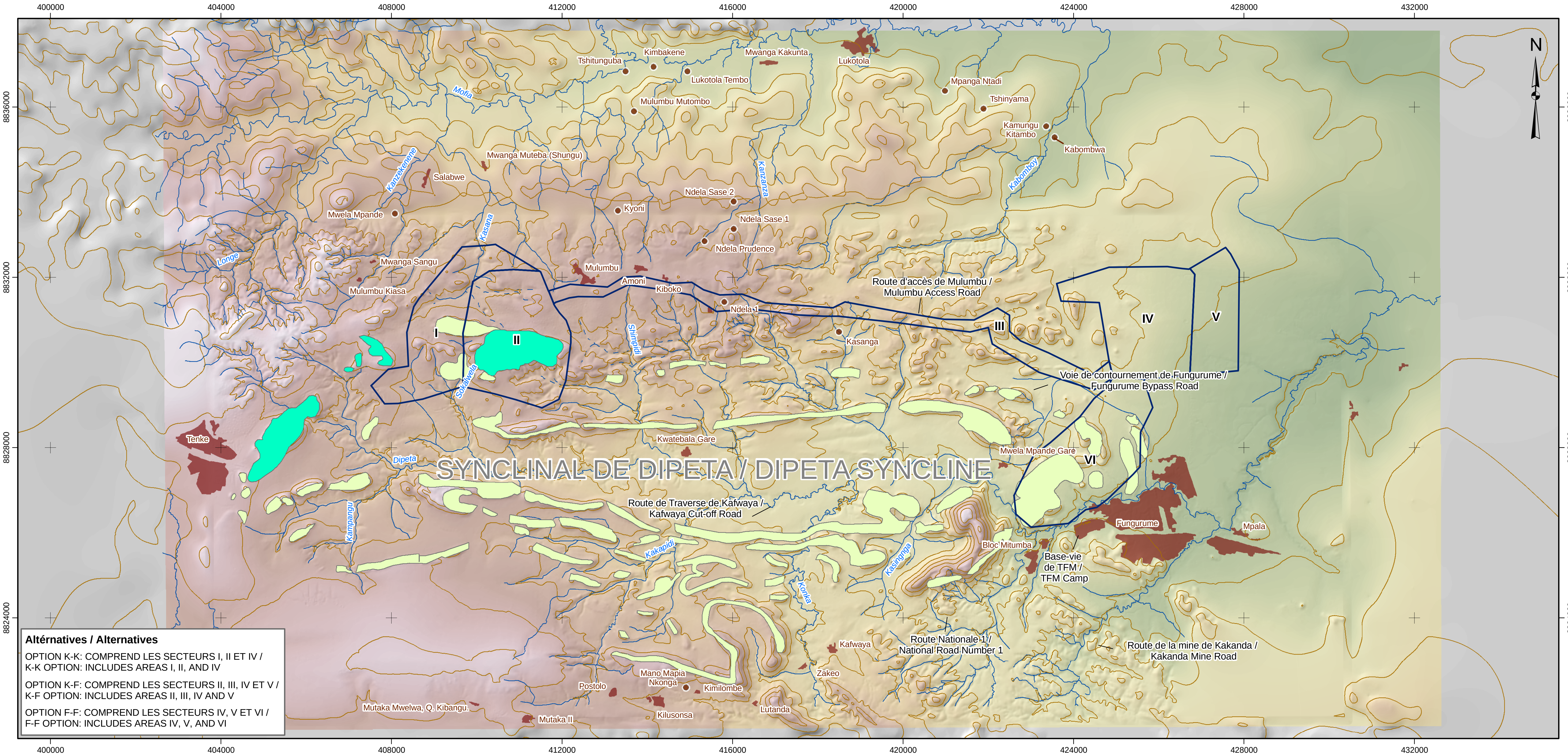
Option 3 Kwatebala-Kwatebala. For this alternative, both the initial mine and the plant site would be situated at Kwatebala.

The Kwatebala option includes mining of the nearby smaller orebodies at Goma and Kaviwafwaulu (Fwaulu) in addition to the Kwatebala orebody.

A3.3.4 Evaluation of Alternatives

Option 1, the Fungurume-Fungurume alternative, has the advantage of some existing infrastructure, although substantial expenditures would still be required to construct additional buildings (Table A3.3-1). The environmental impact of option 1 is low due to the existing cleared areas and disturbed baseline condition. The short haul distance from the mine to the processing plant results in a relatively compact footprint, and less disturbance effects to the environment and to people from dust and noise. However, the negative social effects are greatest or this alternative, as 1,033 hectares of agricultural and 740 households would be disturbed, requiring resettlement (Table A3.3-1).

Project: I:\CLIENTS\PHELPS_DODGE\05-1334-035\mapping\mxd\Tenke_ESIA\Volume_A\FigureA3.3-1_Alternative_Operations.mxd - Plot: I:\CLIENTS\PHELPS_DODGE\05-1334-035\pdf\Tenke_ESIA\Volume_A\FigureA3.3-1_Alternative_Operations.pdf



LÉGENDE / LEGEND

- VILLAGE
- COURBE DE NIVEAU (INTERVALLE DE 40 METRES) / CONTOUR (40M INTERVAL)
- RIVIÈRE / RIVER
- RIVIÈRE INTERMITTENTE / SEASONAL RIVER
- OPTIONS DES OPÉRATIONS / ALTERNATIVE OPERATIONS
- ÉTABLISSEMENT HUMAIN / SETTLEMENT
- FUTURE ZONE D'EXPLOITATION MINIÈRE / ZONE TO BE MINED
- ZONE MINÉRALISÉE / MINERALIZED ZONE

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S / Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

3 0 3

ÉCHELLE 1:90000 KILOMÈTRES
SCALE 1:90000 KILOMETERS

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE
TITLE

OPTIONS DES CONFIGURATIONS DES OPÉRATIONS / ALTERNATIVE OPERATIONS CONFIGURATIONS

Golder Associates
Calgary, Alberta

N° PROJET / PROJECT NO. 05-1334-035		ÉCHELLE TELLE QU'INDIQUÉE SCALE AS SHOWN	REV. 0
DESSIN / DESIGN	RT	10 Jul. 2006	
GIS / SIG	CW	02 Jan. 2007	
VÉRIFIÉ / CHECK	MR	19 Oct. 2006	
APPROUVÉ REVIEW	MR	19 Oct. 2006	

FIGURE: A3.3-1

Table A3.3-1 Analysis of Alternatives – Operation Configurations

Alternative	Technical	Environmental	Social
1. Fungurume-Fungurume	existing infrastructure current court claim on existing facilities process testing of Fungurume ore has not been done	use of existing site infrastructure beneficial short haul distance	1,033 ha of agricultural land disturbed 740 households short haul distance close to town of Fungurume
2. Kwatebala-Fungurume	long haul distance (20 to 25 km) requires 25 to 30 km power line extension requires drilling and well installation for water supply requires site preparation requires communications system	long haul distance (20 to 25 km) results in greater disturbance areas to be disturbed have more natural vegetation	1,240 ha of agricultural land disturbed 390 households long haul distance (20 to 25 km)
3. Kwatebala-Kwatebala	short haul distance requires 25 to 30 km power line extension requires drilling and well installation for water supply requires site preparation requires communications system	short haul distance areas to be disturbed have more natural vegetation	765 ha of agricultural land disturbed 390 households short haul distance

km = kilometers.
ha = hectares.

Option 2, the Kwatebala-Fungurume alternative, would require the development of additional infrastructure as compared to the other options, including a 13 kilometer power line extension and a 20 to 25 kilometer haul road. Option 2 requires site clearing for these developments and the development of areas that are presently less disturbed than those at Kwatebala. Drilling to find and develop a water supply is also needed for option 2. The location of the project over two sites would result in the greatest direct disturbance to agricultural land (1,240 hectares) and 390 households (assuming that the villages of Mulumbu, Amoni and Kiboko are relocated).[7] The long haul distance would also affect people through noise, vibration, dust and potential traffic-related mortality.

Option 3, the Kwatebala-Kwatebala alternative, would require the same power line extension, development of a water supply and size for the Kwatebala-Fungurume alternative, but the haul road would be much reduced. A main access road would still be required from Fungurume to Kwatebala, but traffic on this

[7] Note that the decision to relocate these villages was made taking into account other factors than just roads as described under Section A3.7 Processing Plant Location.

road would not include ore trucks. Option 3 would have a relatively lower impact on agricultural land and a similar impact to residences as for option 2 (390). In addition, option 3 has the lowest overall cost of the three considered alternatives.

These alternatives are evaluated quantitatively in Table 1 in Appendix A-IV.

The summary of the quantitative results (Table A3.3-2) indicates that option 3, the Kwatebala-Kwatebala alternative, is preferred by all three scoring methods. The main contributing factors to the high scores for option 3 were that this alternative:

- Would disturb the least amount of agricultural land.
- Has a short haul route for ore and waste rock (similar to the Fungurume-Fungurume option).
- Would relocate less people than the Fungurume-Fungurume option.
- Has the lowest cost.

Table A3.3-2 Summary of Scoring for the Alternative Operational Configurations

Alternative	Weighted Score (Rank)	Normalized for Equal Weight by Environmental, Social and Technical (Rank)	Normalized for Environmental (.3), Social (.3), Technical (.2) and Sustainability (.2) (Rank)
1. Fungurume-Fungurume	720 (2)	564 (2)	691 (2)
2. Kwatebala-Fungurume	492 (3)	372 (3)	510 (3)
3. Kwatebala-Kwatebala	734 (1)	623 (1)	743 (1)

A3.3.5 Evaluation of Adverse Consequences

The alternatives investigated would have different potentials for adverse impacts (Table A3.3-3). Option 1 (Fungurume-Fungurume) has a disadvantage in that all activity and most of the economic benefits would flow to Fungurume. It was considered a possibility that Tenke residents would be unhappy with such a scenario. The severity of this issue, should it materialize, was considered to be low.

No adverse consequences were identified for option 2 (Kwatebala-Fungurume). A potential adverse consequence of option 3 (Kwatebala-Kwatebala) is that future uncontrolled growth near Fungurume would likely make it more difficult to access that orebody in the future, unless growth can be controlled. This issue was considered to have a moderate probability and a moderate severity.

Table A3.3-3 Potential for Adverse Consequences with Alternative Project Layouts

Alternative	Consequence	Probability	Severity
1 Fungurume-Fungurume	Tenke residents could feel disadvantaged if all perceived project benefits are close to Fungurume	moderate	low
2 Kwatebala-Fungurume	none	n/a	n/a
3 Kwatebala-Kwatebala	uncontrolled growth near Fungurume may make accessing the Fungurume orebody more difficult in the future	moderate	moderate

n/a = Not applicable.

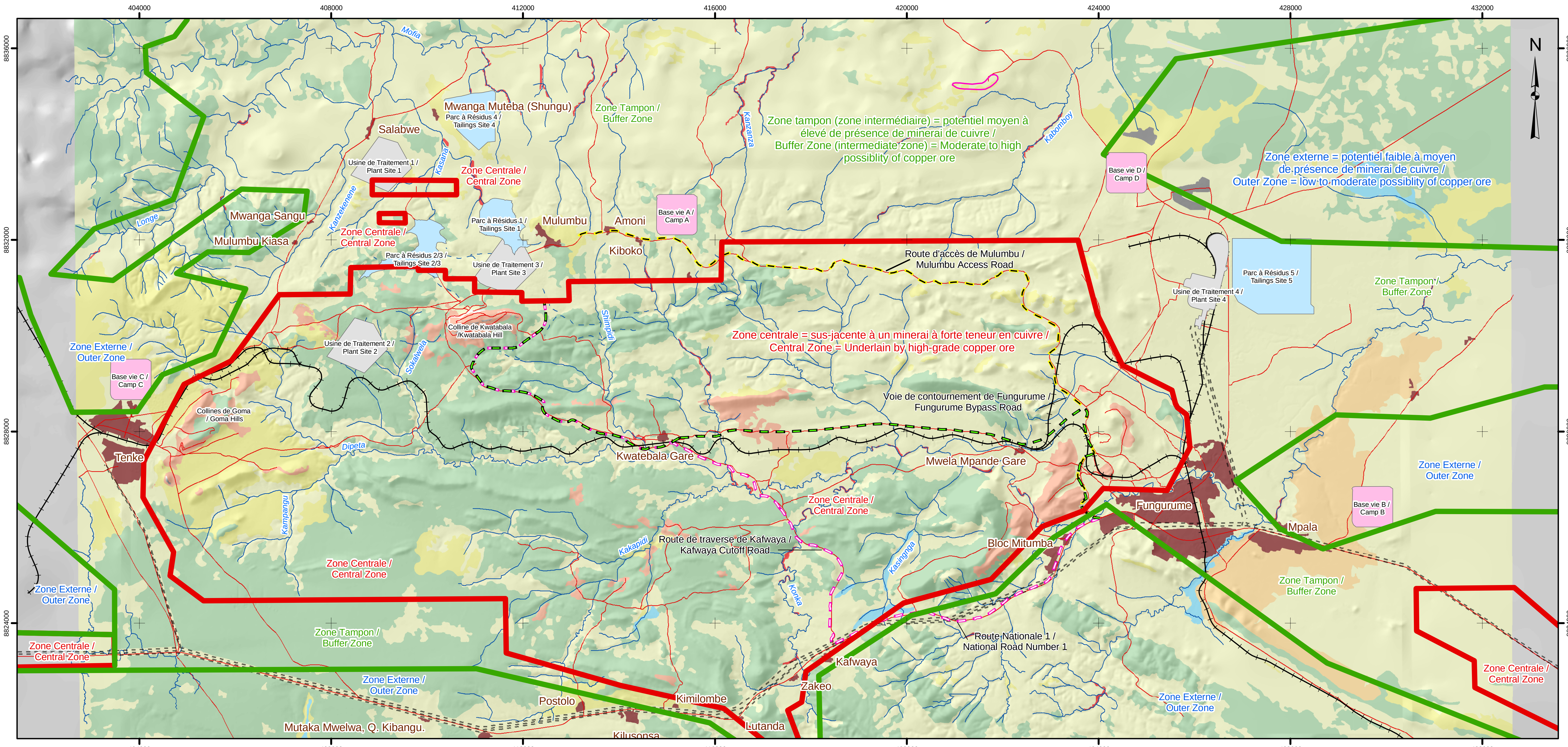
A3.3.6 Preferred Alternative

It was considered that the potential adverse implications for option 3 (Kwatebala-Kwatebala) could be minimized. Based on an analysis of alternatives giving weights of 30 percent to environmental factors, 30 percent to social factors, 20 percent to technical factors and 20 percent to sustainability Kwatebala-Kwatebala received the highest score (743) (Table A3.3-2). Option 3 is recommended. Option 1, the Fungurume-Fungurume alternative, scores second highest at 691. Option 2, the Kwatebala-Fungurume alternative, scores lowest at 510.

A3.4 SITING OF FACILITIES RELATIVE TO ORE BODIES

The next step in the analysis of alternatives was to evaluate sites for the major facilities, assuming the Kwatebala-Kwatebala alternative is preferred. A primary limitation on the placement of the major facilities is avoidance of the mineable orebody and its likely subsurface extent. Placement of major facilities on a potentially mineable orebody may make that portion of the orebody uneconomic to mine, or require the movement of major facilities at a later date. In this context, mineable ore refers to ore that can be economically mined based on current prices and forecasted future prices. While facilities such as roads could be moved at a later date to mine ore beneath them, the cost of moving the processing plant site, tailings storage and waste rock facilities would likely prevent such activity.

A map was prepared of all known, potential ore bodies within the Dipeta syncline (Figure A3.4-1). A syncline is a U-shaped geologic structure where the same strata fold downward and then turn upwards after some distance. In the Dipeta syncline, high-grade ore was observed and drill-tested in the south dips under the center of the Dipeta valley. The ore reappears on the north side where it has been confirmed by drilling. Examples of significant ore-grades were found during drilling at 13 meters (3.2 percent copper plus cobalt credits) in the north portion of the Dipeta, and at 14.5 meters (4.3 percent copper plus cobalt credits) on its corresponding south continuation. To the best knowledge, this high-grade mineable ore bed continues at shallow depth under the Dipeta valley. Developing any infrastructure on top of this ore will render it un-mineable in the future.



LÉGENDE / LEGEND

- LIGNE DE TRANSPORT D'ÉNERGIE / POWER LINE
- OPTION DE ROUTE 1 / ROAD OPTION 1
- OPTION DE ROUTE 2 / ROAD OPTION 2
- OPTION DE ROUTE 3 / ROAD OPTION 3
- RIVIÈRE / RIVER
- RIVIÈRE INTERMITTENTE / SEASONAL RIVER
- ROUTE / ROAD
- VOIE FERRÉE / RAILWAY
- ZONE CENTRALE / CENTRAL ZONE
- ZONE TAMPON / BUFFER ZONE
- CARRIÈRE / QUARRY
- BASE VIE DU CHANTIER DE CONSTRUCTION / CONSTRUCTION CAMP
- PARC À RÉSIDUS / TAILINGS SITE
- USINE DE TRAITEMENT / PLANT SITE

COUVERTURE VÉGÉTALE / UTILISATION DU TERRAIN / LANDCOVER

- AFFLEUREMENT ROCHEUX DE MINERAI CUIVRE-COBALT - COMPLEXE EXPLOITÉ PAR L'ACTIVITÉ MINIÈRE INFORMELLE / COPPER-COBALT ROCK OUTCROP - INFORMAL MINING COMPLEX
- STEPPE-SAVANE SUR SUBSTRAT CUPRO-COBALTIFÈRE / COPPER-COBALT STEPPE-SAVANNA
- FORÊT DE MIOMBO / MIOMBO WOODLAND
- FORÊT DE MIOMBO DÉGRADÉE / MIOMBO WOODLAND DEGRADED
- FORÊT GALERIE / GALLERY FOREST
- ZONE HUMIDE / WETLAND
- MOSAÏQUE AGRICOLE / AGRICULTURAL MOSAIC
- ANCIENNE JACHÈRE / OLD FALLOW FIELD
- AÉROPORT / AIRFIELD
- PERTURBATION / DISTURBANCE
- ÉTABLISSEMENT HUMAIN / SETTLEMENT

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S / Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

3 0 3
ÉCHELLE 1:80000 KILOMÈTRES
SCALE 1:80000 KILOMETERS

PROJET / PROJECT

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE
TITLE

PROBABILITÉ DE PRÉSENCE DE MINERAI DE CUIVRE SOUS LA SURFACE DU TERRAIN / PROBABILITY OF LAND BEING UNDERLAIN BY COPPER ORE

Golder Associates
Calgary, Alberta

N° PROJET / PROJECT NO. 05-1334-035		ÉCHELLE TELLE QU'INDIQUÉE / SCALE AS SHOWN	REV. 0
DESSIN / DESIGN	MR	1 Feb. 2006	
GIS / SIG	CW	02 Jan. 2007	
VÉRIFIÉ / CHECK	MR	31 Jul. 2006	
APPROUVÉ / REVIEW	MR	31 Jul. 2006	

FIGURE: A3.4-1

A buffer zone was drawn around the ore bodies to represent where mineable ore is likely to occur, as drilling to confirm ore presence (condemnation drilling) over the entire area is beyond the scope of the feasibility study and environmental and social impact assessment (ESIA).

In summary, the main mine facilities are required to be located away from the Dipeta syncline. This conclusion was used to assist in analyses of alternatives for project facilities.

A3.5 TAILINGS STORAGE FACILITY LOCATION

A3.5.1 Introduction and Problem Statement

The prior analyses of alternatives determined that:

- The Kwatebala and Goma ore bodies would be mined first (it was later decided to mine the Fwaulu orebody as well).
- A processing plant would be situated near the Kwatebala orebody (Kwatebala-Kwatebala configuration).

The problem statement for the tailings storage facility location is:

> What is the preferred alternative for the tailings storage facility given that the Kwatebala and Goma ore bodies are to be mined first?

Basic design issues were addressed by adopting conservative environmental and safety design criteria for the tailings storage facility. Musts for design components included:

- Selection of waste rock and natural soil embankments, instead of using embankments constructed of the tailings materials. The justification for this choice is the creation of a highly stable embankment, having physically and chemically stable outer slopes.
- Selection of slurry deposition over filtered tailings deposition. The justification for this choice is largely based on the desire to avoid belt filtrations of the tailings. Case studies conducted on these filtration systems in similar settings indicated that the technology is not reliable.

  There is an important environmental reason to use slurry deposition for the TFM project. Slurry deposition consumes water, enabling the site to achievement a negative site-wide water balance. This eliminates the routine need to discharge process waters from the tailings storage facility or the processing plant to the environment. Slurried tailings indefinitely retain higher pore water content within the stored tailings material. This retained water allows a greater degree of safety for handling storm waters within the overall facility (tailings, waste rock facilities, processing plant, open pit). All storm waters impacted by process materials can be integrated into the process water circuit without the need for release of these waters from the facility, except under situations of extreme rainfall.[8]

- Selection of a lined impoundment over an unlined impoundment. The justification for this choice is based on the desire to almost eliminate seepage from the tailings storage facility and almost eliminate subsequent impacts to downstream surface water or groundwater resources.

A K-T analysis was not conducted for the tailings storage facility location analysis of alternatives because of the limited location options available and the design decisions that were made (liner, rock embankment, etc.). However, the same considerations as used in the K-T analyses were studied and are reported on here.

The geological setting for the tailings storage facility location is one where the karst terrain and deep weathering and/or fracturing along linear features (which may or may not be faults) is near ubiquitous. Thus, geological or hydrogeological conditions in the TSF site are likely to be replicated in other possible valley sites. These were not differentiators in possible site selection and therefore not included in the analysis of alternatives.

Further discussion is provided in a tailings storage facility report (MinProc 2007) (summary provided in Appendix E9 to this ESIA).

A3.5.2 Issues (Wants)

If the above tailings storage facility design criteria are assumed, the remaining decision to be made is the preferred location of the tailings storage facility. The following environmental, social, technical and sustainability wants were identified.

[8] See Section C2.12.

Environmental

- The footprint of the tailings storage facility should be minimized. This is a general want to minimize impact on valued environmental resources.
- Areas with potential occurrences of threatened or endemic (native) species should be avoided, if possible.
- Sites overlying or within the flood plain of significant watercourses should be avoided. Sites overlying waterbodies or riparian (land associated with banks of rivers or streams) areas should be avoided.
- Long tailings discharge pipelines or process water return pipelines, with the potential of breakage or vandalism, should be avoided to reduce the likelihood of uncontrolled discharges.

Social

- Effects on agricultural land should be minimized.
- The number of people potentially required to relocate should be minimized.
- The potential for danger to the public should be minimized.
- Distance from villages should be maximized to reduce the nuisance effects of noise and dust on people.

Technical

- Proximity to the processing plant is preferred to reduce pumping and piping cost and complexity.
- The site should be downslope of the processing plant. Topography should help to provide natural basin areas with capacity capable of storing the tailings without large constructed embankments.
- The safety consequences of dam failure must be considered and minimized.
- The capital costs and operating costs of the tailings storage facility should be minimized, after other conditions have been met.
- Construction above mineralized ground should be avoided, if possible.

Sustainability

The site should be capable of being decommissioned and rehabilitated in an environmentally acceptable manner. The site should be used to best productive purpose, as defined by local stake holders, after closure.

A3.5.3 Alternatives Considered

In the selection of tailings storage facility alternatives, it was decided that any site within the Dipeta Syncline was fatally flawed for tailings facility construction. The Dipeta Syncline, in the area of Kwatebala, is known to be mineralized over a large area. The large footprint of the proposed tailing storage facility would make avoiding potential ore zones nearly impossible. Moving a tailing storage facility after construction is also not feasible. Additionally, the roughness of the terrain and proximity to the Dipeta River and its tributaries creates construction challenges and risks that should be avoided, if possible. Five possible tailings storage facility sites were initially identified outside of the Dipeta syncline, before the analysis of alternatives process was initiated. These sites were later reduced to four by combining sites 2 and 3. Thus, sites 1, 2/3, 4 and 5 were considered (Figure A3.5-1). Because the Kwatebala-Kwatebala operations configuration was chosen for the project as the first step on the analysis of alternatives process (Section A3.3), site 5 (located north of Fungurume) was eliminated from consideration.

Option 1 – Site 1

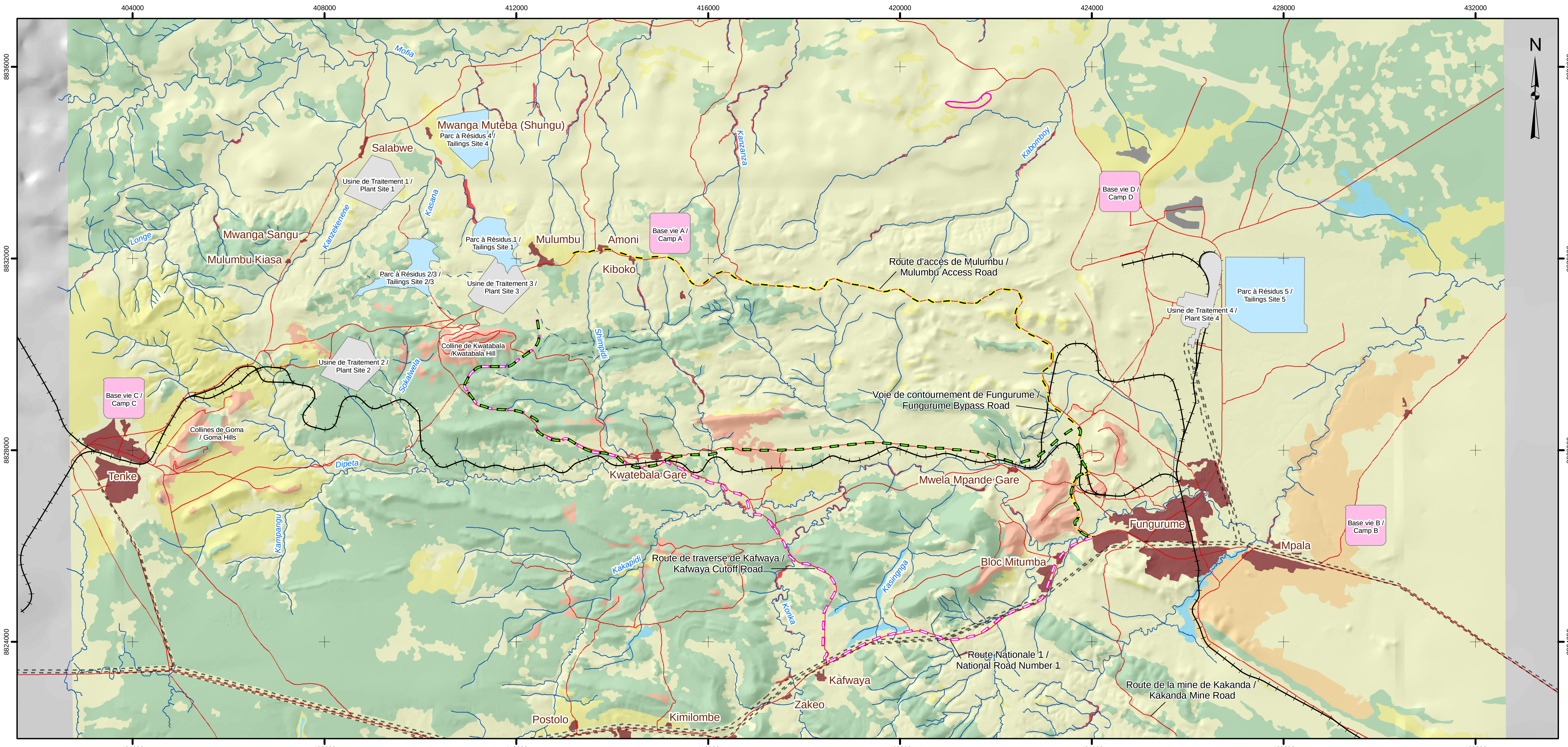
This site is located just west of the village of Mulumbu in the upper reach of a tributary of the Kasana River (Figure A3.5-1). Larger dams would be required at this site. This site does not overlap woodlands.

Option 2 – Site 2/3

This site is located in the upper reaches of the Kasana River to the northwest of Kwatebala Hill. It overlaps 16 hectares of (non-degraded) woodlands.

Option 3 – Site 4

Option 3 is situated to the east of the village of Mwanga Muteba in the upper reach of a tributary to the Mofia River. It overlaps 19 hectares of degraded woodlands.



LÉGENDE / LEGEND

- LIGNE DE TRANSPORT D'ÉNERGIE / POWER LINE
- OPTION DE ROUTE 1 / ROAD OPTION 1
- OPTION DE ROUTE 2 / ROAD OPTION 2
- OPTION DE ROUTE 3 / ROAD OPTION 3
- RIVIÈRE / RIVER
- RIVIÈRE INTERMITTENTE / SEASONAL RIVER
- ROUTE / ROAD
- VOIE FERRÉE / RAILWAY
- CARRIÈRE / QUARRY
- BASE VIE DU CHANTIER DE CONSTRUCTION / CONSTRUCTION CAMP
- PARC À RÉSIDUS / TAILINGS SITE
- USINE DE TRAITEMENT / PLANT SITE

COUVERTURE VÉGÉTALE / UTILISATION DU TERRAIN / LANDCOVER

- AFFLEUREMENT ROCHEUX DE MINERAI CUIVRE-COBALT - COMPLEXE EXPLOITÉ PAR L'ACTIVITÉ MINIÈRE INFORMELLE / COPPER-COBALT ROCK OUTCROP - INFORMAL MINING COMPLEX
- STEPPE-SAVANE SUR SUBSTRAT CUPRO-COBALTIFÈRE / COPPER-COBALT STEPPE-SAVANNA
- FORÊT DE MIOMBO / MIOMBO WOODLAND
- FORÊT DE MIOMBO DÉGRADÉE / MIOMBO WOODLAND DEGRADED
- FORÊT GALERIE / GALLERY FOREST
- ZONE HUMIDE / WETLAND
- MOSAÏQUE AGRICOLE / AGRICULTURAL MOSAIC
- ANCIENNE JACHÈRE / OLD FALLOW FIELD
- AÉROPORT / AIRFIELD
- PERTURBATION / DISTURBANCE
- ÉTABLISSEMENT HUMAIN / SETTLEMENT

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S / Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE / TITLE

ANALYSE DES OPTIONS DE RECHANGE DES BASE VIE DU CHANTIER DE CONSTRUCTION DE CHANTIER, DE L'USINE DE TRAITEMENT ET DU PARC À RÉSIDUS MINIERS / ALTERNATIVE ANALYSES OF CONSTRUCTION CAMP, PLANT AND TAILINGS FACILITIES

Golder Associates
Calgary, Alberta

N° PROJET / PROJECT NO. 05-1334-035			ÉCHELLE TELLE QU'INDIQUÉE SCALE AS SHOWN	REV. 0
DESSIN / DESIGN	MR	1 Feb. 2006		
GIS / SIG	CW	02 Jan. 2007		
VÉRIFIÉ / CHECK	MR	26 Jul. 2006		
APPROUVÉ / REVIEW	MR	26 Jul. 2006		

FIGURE: A3.5-1

A3.5.4 Evaluation of Alternatives

Option 1 (site 1) was eliminated due to the larger volume of earthworks required to achieve the same capacity as site 2/3. From an ecological perspective, options 2 and 3 respectively (sites 2/3 and 4) affect a slightly higher density of miombo woodland. This was not considered a significant difference due to the common nature of miombo woodland throughout much of Africa. No major difference exists between options 1, 2 or 3 for water use or impacts on aquatic systems. Option 2 (site 2/3) was preferred due to:

- Larger natural storage capacity.
- Slightly longer distance from local villages compared to all other sites (minimizing risks of noise, dust and safety impacts).
- Better reclamation potential (minimizing surface areas of hillside being exposed to erosion and requiring rehabilitation).

A3.5.5 Evaluation of Adverse Consequences

Each of the alternatives investigated were considered to have the same potential for adverse consequences (Table A3.5-1). The likelihood of dam breach or failure was ranked low as waste rock will be used to support the dam under any of the three alternatives. The severity of the consequence would be moderate in all cases.

Table A3.5-1 Potential for Adverse Consequences with Alternative Tailings Storage Facilities

Alternative	Consequence	Probability	Severity
1. site 1	dam breach or failure	low	moderate
2. site 2/3	dam breach or failure	low	moderate
3. site 4	dam breach or failure	low	moderate

A3.5.6 Preferred Alternative

Option 2 (site 2/3) was selected as the preferred alternative. Option 2 has a larger capacity, is farther from local villages and had similar adverse consequences as the other two options.

A3.6 WASTE ROCK FACILITY LOCATIONS

A3.6.1 Introduction and Problem Statement

The prior analyses of alternatives determined that:

- The Kwatebala and Goma ore bodies would be mined first (it was later decided to mine the Fwaulu orebody as well).
- A processing plant would be situated near the Kwatebala and Goma orebody (the Kwatebala-Kwatebala configuration).
- The preferred tailings storage facility site is site 2/3.
- The villages of Mulumbu, Amoni and Kiboko would be relocated.[9]

The problem statement for the waste rock facility location is:

> What is the preferred alternative for the waste rock facility given that the Kwatebala orebody is to be mined first, the preferred tailings storage facility location is site 2/3, and the communities of Mulumbu, Amoni and Kiboko would be resettled?

Musts for the waste rock facility sites include:

- Minimum surface area of 130 hectares.
- Provide a level working and storage area for the short-term blending stockpiles that will be rehandled and fed to the mill.
- Close proximity to the mine pit to minimize haul distances for waste rock.
- Topography and terrain must provide sufficient capacity to store 250 million tonnes of waste rock.
- The waste rock facilities should not be underlain by mineable ore. At the time initial options were selected, this assumption was not known for any of the alternatives. However, condemnation drilling has further delineated the probable ore zones and this information is reflected in the decision matrices developed in these alternative analyses.

[9] In actuality, the decision to relocate these villages included a variety of considerations, as described in Section A3.7.

A3.6.2 Issues (Wants)

The following wants for the waste rock facility locations were identified and ranked as indicated below (Table 2, Appendix A-IV). The Kwatebala waste rock has been tested and found to be non-acid generating (Section B2.3).

Environmental

- Noise from the waste rock facility and associated roads should be minimized, especially near important environmental and social receptors (10).
- Air quality effects, including effects of dust, should be minimized, especially near important environmental and social receptors (10).
- Total surface disturbance should be minimized (7).
- Effects on surface water quantity (flows) should be minimized (5).
- Surface water quality for downstream communities should be maintained. This want is given a relatively low score because the effects (e.g., of impacts to surface water from dust, impact to surface water from waste rock run off) can be mitigated. For example, waste rock runoff will be collected and integrated into the process water circuit, unless testing shows that it can be released to the environment. However, during extreme storm events uncontrolled releases may occur. Such effects are predicted to be within applicable guidelines (see Section C2.12) (3).
- Loss of natural habitats should be minimized. This was given a low weighting because the project area has already been degraded by land clearing for agriculture. Some miombo woodland remains but it is not pristine (2).
- Fragmentation of habitats (effects on biodiversity) should be minimized. The main focus of biodiversity conservation should be the copper-cobalt flora and, to a lesser extent, the remaining miombo woodland. Impacts to copper-cobalt flora from the waste rock facilities should be minimal as none of the options exist on copper-cobalt areas (2).

Social

- Loss of agricultural lands should be minimized (10).
- Relocation of local inhabitants should only be considered as a last resort. Relocation may be necessary due to air quality and/or noise effects, and due to loss of agricultural land (10).
- The waste rock facilities should be located away from local inhabitants so that human injury or death from traffic is minimized (10).

- Visual impact of the waste rock facilities on the landscape should be minimized (4).
- Loss of cultural resources should be minimized. This want was given a low score as the mining area is not near the main river valleys where archaeological artifacts are concentrated. Effects can be successfully mitigated if proper attention is given to archaeology (2).

Technical

- Mineable ore should not lie underneath the waste rock facilities. The latest condemnation drilling is used to estimate the likelihood of any portion of a waste rock alternative location overlying ore. This want was scored for all alternatives based on the likelihood that ore is present (10).
- The amount of outside edges or slopes should be minimized. This keeps the height of the waste facilities low (which reduces visual impact), reduces the amount of slopes exposed to the elements (which decreases dust and erosion), reduces the amount of slopes which might have to be reduced as a part of reclamation, and provides large broad areas for potential agricultural use after closure (10).
- Haulage of waste rock should be over the shortest horizontal distances possible. This saves on costs by reducing fuel use, truck hours and road lengths. Haulage costs can be substantial (8).
- Haulage of waste rock should be over the shortest vertical distances possible. Similar to horizontal haulage distances, costs (fuel, truck hours) for hauling up and down hills can be substantial (8).

Sustainability

- Large broad areas are more suitable than side slopes for post-closure uses such as agriculture (10).
- Energy costs should be minimized. Fuel costs are related to haul distance (7).
- Post-closure use of waste rock may be desired by local communities. Communities near the waste rock may benefit more than those farther away (5).

A3.6.3 Alternatives Considered

A total of six alternatives were initially considered. However, three of these alternatives did not meet the must criteria (mainly due to failure to meet capacity needs, and likelihood of ore bodies present). As a result they were not carried over into the detailed alternatives analyses. The detailed analyses described here consider three alternatives for the storage of waste rock.

All three alternatives incorporate areas west of Mulumbu, on the south side of the existing road, which will be used as a storage area for the short-term blending run-of-mine (ROM) stockpiles that will be rehandled and fed to the mill (this area is common to all three options, see Figure A3.6-1). All three options also use low-grade ore stockpiles immediately south of Mulumbu, and all three use waste rock to the north of the tailings facility to support the tailings dams.

Option 1 – Kasana (Large Footprint)

This site includes two separate footprints. One part of the footprint is located north of the Mulumbu access road and occupies two valleys. It overlaps with tailings storage facility site 1 and is immediately north of tailings storage facility site 2/3. This area includes two main headwater drainages of the Kasana River. In the southeast corner, it is adjacent to the community of Mulumbu. The second part of the footprint of option 1 is located south of the Mulumbu access road. This area is for a low-grade ore stockpile and includes a headwater drainage of the Shimpidi River and is common to all options. Land use for option 1 is largely agricultural land, with a very small proportion of miombo woodland. The total area for option 1 is 399 hectares (Table A3.6-1).

Table A3.6-1 Land Use at Alternative Waste Rock Facility Sites

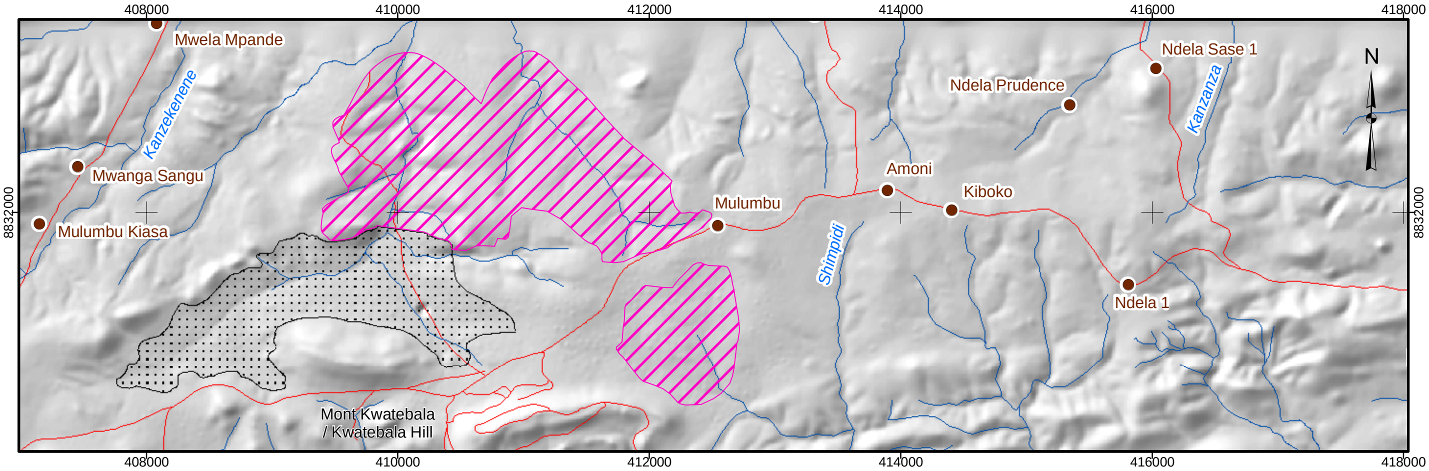
Alternative	Area (ha)	Agricultural Land (ha)	Miombo Woodland (ha)
1 – Kasana (large footprint)	399	370 (92.7%)	29 (7.3%)
2 – Kasana (small, high footprint)	232	207 (89.1%)	25 (10.9%)
3 – Kasana-Shimpidi	445	375 (84.2%)	70 (15.8%)

ha = hectares.

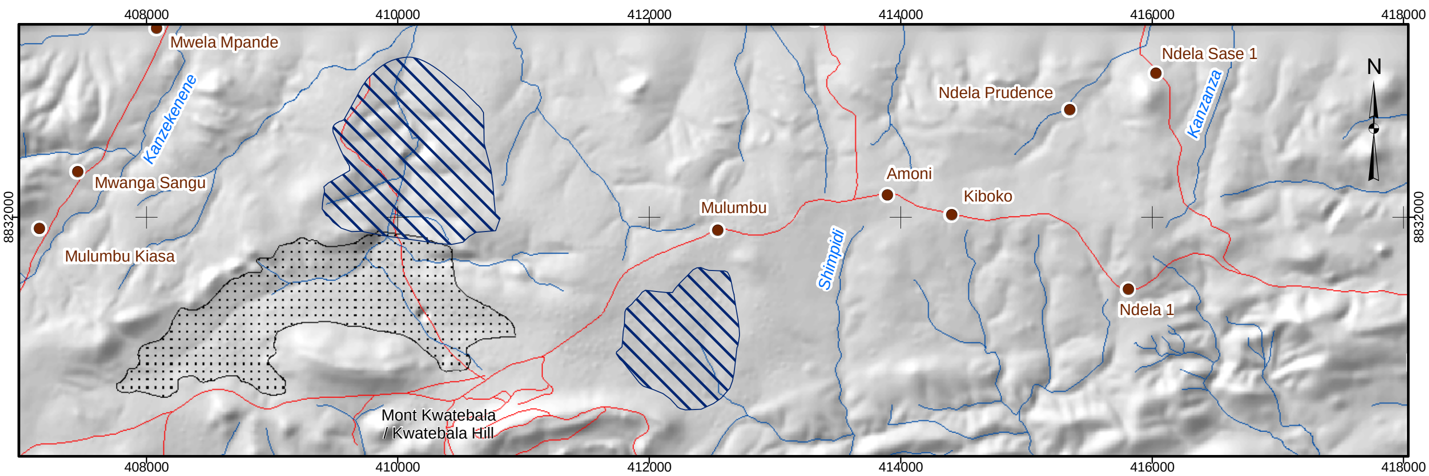
Option 2 – Kasana (Small, High Footprint)

This site is similar to, but smaller in footprint than, option 1. It does not include the area overlapping tailings storage facility site 1, but it does include an area to the north of tailings storage facility site 2/3. It includes the same low-grade ore stockpile south of Mulumbu, as in option 1. Option 2 occupies one valley that contains a headwater drainage of the Kasana River. In this option, waste rock in the northern part of the footprint would be stacked higher than in option 1 or option 3. Option 2 is dominated by agricultural land with a very small proportion of closed miombo woodland. Total area for option 2 is 232 hectares (Table A3.6-1).

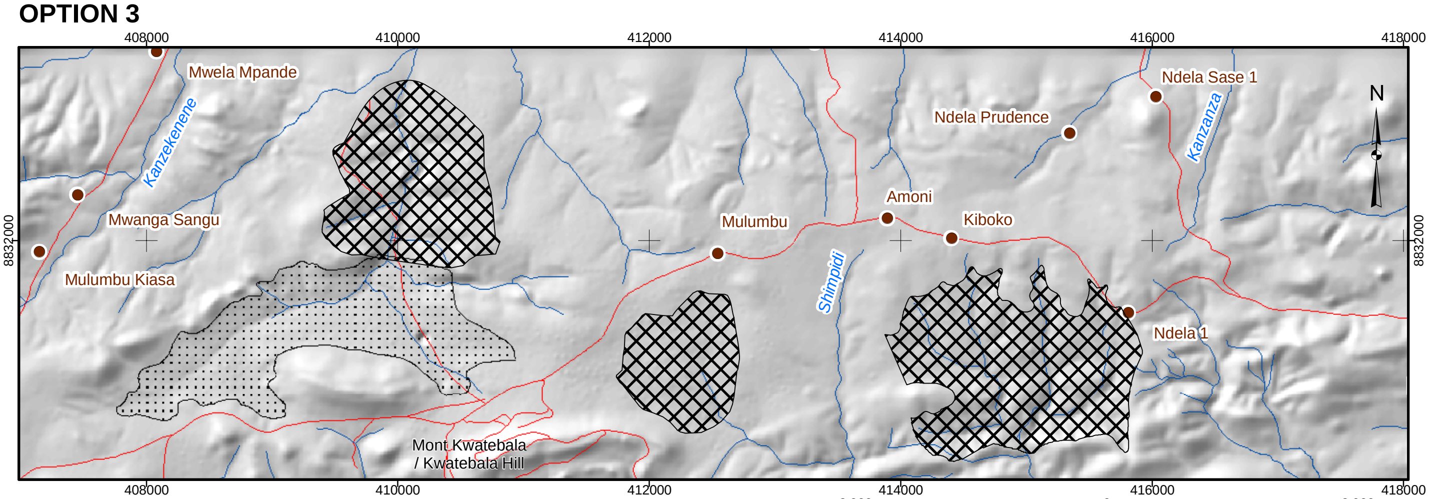
OPTION 1



OPTION 2



OPTION 3



2,000 0 2,000

ÉCHELLE 1:60000 MÈTRES
SCALE 1:60000 METERS

LÉGENDE / LEGEND

- ÉTABLISSEMENT HUMAIN / SETTLEMENT
- LIGNE DE TRANSPORT D'ÉNERGIE / POWER LINE
- RIVIÈRE / RIVER
- ROUTE / ROAD
- OPTION DE DÉCHARGE POUR STÉRILE 1 / WASTE ROCK DISPOSAL OPTION 1
- OPTION DE DÉCHARGE POUR STÉRILE 2 / WASTE ROCK DISPOSAL OPTION 2
- OPTION DE DÉCHARGE POUR STÉRILE 3 / WASTE ROCK DISPOSAL OPTION 3
- PARC À RÉSIDUS / TAILINGS SITE

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S / Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE / TITLE

DIFFÉRENTES OPTIONS POUR L'AIRE DE DISPOSITION DES STÉRILES / ALTERNATIVES FOR WASTE ROCK DISPOSAL

Golder Associates
Calgary, Alberta

N° projet / project no. 05-1334-035.9300			Échelle telle qu'indiquée Scale as Shown	REV. 0
DESSIN / DESIGN	LB	20 Mar. 2006		
SIG / GIS	CW	02 Jan. 2007		
VÉRIFIÉ / CHECK	MR	31 Jul. 2006	**FIGURE: A3.6-1**	
APPROUVÉ REVIEW	MR	31 Jul. 2006		

Option 3 – Kasana - Shimpidi

This site includes the same footprint as option 2 and also includes a third footprint area south of Kiboko. The latter includes about five headwater drainages to the Dipeta River. Option 3 is also dominated by agricultural land, but has a greater proportion of miombo woodland compared to options 1 or 2. Total area for option 3 is 445 hectares (Table A3.6-1).

A3.6.4 Evaluation of Alternatives

Option 2 was ranked first using the weighted score analysis. It also ranked first in both sensitivity analyses (Table A3.6-2). Option 1 ranked second and option 3 ranked third using the weighted score analysis. The same rankings held for both sensitivity analyses for options 2 and 3 (Table A3.6-2). Option 3 scored significantly lower than options 1 and 2 for all scoring methods.

Table A3.6-2 Summary of Scoring for the Alternative Waste Rock Facility Sites

Alternative	Weighted Score (Rank)	Normalized for Equal Weight by Environmental, Social and Technical (Rank)	Normalized for Environmental (.3), Social (.3), Technical (.2) and Sustainability (.2) (Rank)
1. Kasana (large footprint)	777 (2)	626 (2)	751 (2)
2. Kasana (small, high footprint)	880 (1)	851 (1)	871 (1)
3. Kasana-Shimpidi	428 (3)	247 (3)	428 (3)

Option 2 scored highest for environmental criteria as it requires the least footprint, affects fewer drainages and requires less use of haul roads. This would reduce air quality and noise effects, compared to options 1 or 3. Option 2 also scored highest for social criteria. It would affect the least amount of agricultural land and would have the least effect on public safety and cultural resources. Although the waste rock north of the tailings storage facility would be stacked higher in this option, it would be farther from nearby communities than either of the other options.

Option 1 scored much higher than options 2 or 3 for technical criteria. In the case of option 2, the requirement to stack the waste rock higher (about 50 percent of all waste will have to be lifted vertically) would result in more slope areas. More slope areas increases the potential for effects from dust and erosion, increases the amount of slopes which might have to be reduced as part of reclamation, and increases the costs associated with greater vertical hauling requirements.

A substantial portion of option 3 is underlain by mineable ore. Options 1 and 3 scored highest for sustainability criteria.

A3.6.5 Evaluation of Adverse Consequences

Waste Rock Facility Option 1 – Kasana (Large Footprint)

This option scored second highest in all three analyses. Adverse consequences for option 1 include the presence of mineable ore under the site. The probability of this consequence is thought to be low and the severity would be moderate (Table A3.6-3).

Table A3.6-3 Potential for Adverse Consequences at the Waste Rock Facility Sites

Alternative	Consequence	Probability	Severity
1. Kasana (large footprint)	- mineable ore under site	low	moderate
2. Kasana (small, high footprint)	- mineable ore under site - substantial costs associated with greater vertical stack height and more slopes	low high	moderate moderate
3. Kasana-Shimpidi	- mineable ore under site	moderate	high

Waste Rock Facility Option 2 – Kasana (Small, High Footprint)

Option 2 scored highest in all three analyses. Adverse consequences for this option include the presence of mineable ore under the site. The probability of this consequence is thought to be low, and the severity would be moderate. Another adverse consequence is related to the increased cost associated with this option. Approximately 50 percent of all waste will have to be lifted vertically, resulting in more truck hours and greater fuel use. The significantly increased outer slopes will result in more erosion, more dust and higher reclamation costs if slopes need to be reduced, capped or covered with soil.

Waste Rock Facility Option 3 – Kasana-Shimpidi

Option 3 scored lowest in all three analyses. Adverse consequences for this option include the presence of mineable ore under the site. The probability of mineable ore under the site is moderate, as part of the eastern portion lies within the mineralized area of the project. The severity would be high.

A3.6.6 Preferred Alternative

Option 2 scores highest in the analysis, due mainly to its much higher scores on environmental and social criteria. Option 1 scores highest for technical and sustainability factors. Option 3 scores much lower than the other two options, and the adverse consequence related to mineable ore at this site results in the elimination of option 3 as an alternative. In this case, given that the difference in scoring between options 1 and 2 is not large, the high probability of adverse consequences associated with increasing the height of the waste rock in option 2 overrides the scoring. This results in option 1 being selected as the preferred site for the waste rock facilities.

A3.7 PROCESSING PLANT LOCATION

A3.7.1 Introduction and Problem Statement

The prior analyses of alternatives determined that:

- The Kwatebala and Goma ore bodies would be mined first (it was later decided to mine the Fwaulu orebody as well).
- A processing plant would be situated near that orebody (the Kwatebala-Kwatebala configuration).
- The preferred tailings storage facility site is site 2/3.

The Goma orebody is to be mined in addition to Kwatebala, beginning around 2017 and the Fwaulu orebody would be mined beginning around 2020. The problem statement for the processing plant site is:

> What is the preferred alternative for the processing plant site given that the Kwatebala and Goma ore bodies are to be mined first and the preferred tailings storage facility location is site 2/3?

The processing plant site for the TFM project will contain an ore crusher, sulfuric acid plant, acid leach plant, both copper and cobalt processing circuits, water treatment plant, administrative offices, clinic and emergency station, canteen, workshops, warehouse, laboratory and associated facilities. It will be designed to produce approximately 115,000 tonnes per year of cathode copper, 8,000 tonnes per year of cobalt metal and 2,000 tonnes of cobalt as cobalt hydroxide intermediate. Production may increase to up to 200,000 tonnes per year of copper at a future date (note that the cumulative assessment case assumes two processing plants for a total production of 400,000 tonnes per year). Musts for the processing plant site include:

- A site with limited gradient (slope), with good drainage and firm substrate.
- Minimum surface area of 80 to 85 hectares.
- Room for possible future expansion.
- Close proximity to mine pits to minimize distance for ore transport.
- Close proximity to tailings storage facility to minimize pumping of tailings.
- The processing plant site should not be underlain by mineable ore. This is scored as a want for now, to compare sites known to be within the area underlain by high-grade copper ore with sites outside of this area. Ongoing condemnation drilling will determine whether some or all of the alternatives analyzed will have to be rejected.

A3.7.2 Issues (Wants)

The following wants were identified for the processing plant location and ranked as indicated below (see Table 3, Appendix A-IV). Groundwater quantity (effects of groundwater pumping) was not included as a criterion because all three options would draw from the same general wellfield area.

Environmental

- Air emissions from the processing plant (and possible future expansion) should affect as few local inhabitants as possible (10).
- Noise and vibrations from the processing plant (and possible future expansion) should affect as few local inhabitants as possible (10).
- Accidental spills that may contaminate local groundwater should have the potential to affect as few local inhabitants as possible. This want was given a lower weighting as mitigation to prevent and minimize the effects of spills will be used (4).
- Effects on surface water quantity (flows) should be minimized. This want was given a weighting of five as the ore bodies are on hills and in the upper portions of drainages. As a result, relatively few streams will need to be diverted to build the processing plant. Those streams that are diverted will be relatively small (5).
- Effects on surface water quality due to effluent (wastewater) release should be minimized. This want was also weighted relatively low as the

project will recycle as much process water as technically feasible. Also, a treatment plant will be built to treat any discharge (5).

- Loss or alteration of natural habitats should be minimized. The study area has been degraded by land clearing for agriculture. Some miombo woodland remains but it is not pristine (2).
- Loss or changes to biodiversity should be minimized. The main focus of biodiversity conservation should be the copper-cobalt flora and, to a lesser extent, the remaining miombo woodland. Impacts to copper-cobalt flora from the processing plant should be minimal as no suitable processing plant location alternatives exist on copper-cobalt areas (2).

Social

- Loss of agricultural lands should be minimized (10).
- Relocation of local inhabitants should only be considered as a last resort. Relocation may be necessary due to air quality and/or noise effects and due to loss of agricultural land (10).
- The processing plant and its associated roads and rail lines should be located away from local inhabitants so that human injury or death from traffic is minimized (10).
- Loss of cultural resources should be minimized. This want was given a low score as the mining area is not near the main river valleys where archaeological artifacts are concentrated. Effects can be successfully mitigated if proper attention is given to archaeology (2).

Technical

- Mineable ore should not lie underneath the processing plant site. This want is actually a must, and is included in the analysis to compare the sites known to be outside the area underlain by high-grade copper ore with sites in other areas (10).
- Distance to pipe the processing plant effluent should be short and elevation should be minimized. Increased costs are associated with increased distance and elevation (8).
- Haulage of ore and waste rock should be over the shortest distance and the lowest increase in elevation. While haulage costs can be substantial, they are not an overriding factor in determining the best processing plant location (5).
- Rock that flies through the air from blasting (fly rock) can impact processing plant facilities and worker safety. This want was given a relatively low weight since a processing plant will not be built within 150 meters of a mine pit edge. However, the requirement of a 150-meter

buffer zone around the mine pit edges can affect the placement and design of the processing plant (4).

- Additional land for future processing plant expansion should be available (4).
- Transport of raw materials to the site should be over the shortest distance and the have lowest increase in elevation (4).
- Requirements to level the site should not be large.
- Water diversions should be minimized. Diversions cost money and take up space. This concern is not large as relatively few streams will need to be diverted to build the processing plant. Those streams that are diverted will be relatively small (2).
- Drainage of the site should be good. Drainage can be improved on a site but this can be costly (2).

Sustainability

- Energy costs related to transport of raw materials, tailings, water and product should be minimized (3).
- The processing plant is proposed to operate for at least 40 years, after which it would very likely be used to process ore from neighboring hills. At its eventual closure, the processing plant site could be decommissioned or used for alternate purposes. Alternate use of the processing plant site by local business would represent a desired end land use (2).

A3.7.3 Alternatives Considered

Four processing plant locations were initially considered: three locations (options 1, 2 and 3) near the Kwatebala orebody and one at the plant site selected by the previous developer (option 4) (Figure A3.5-1). Option 4 was discarded following selection of the Kwatebala-Kwatebala configuration analysis (Section A3.3).

The three alternative plant sites considered (options 1, 2 and 3) were mainly restricted by the need for level ground. Options 1 to 3 were each assumed to occupy the same area (83 hectares). Each of the three alternatives is described below.

Option 1 – Northwest

This site is situated almost three kilometers from the proposed Kwatebala mine pit and across a small drainage line. The area is 97 percent agricultural land (actively farmed and fallow) and three percent miombo woodland (Table A3.7-1). Site visits showed that the land is used less intensively than the sites for options 3 and 4. The option 1 site is used mainly by seasonal farmers who normally reside in Tenke and set up temporary quarters on the site during the growing (wet) season. It is downslope from the preferred tailings storage facility site 2/3 (see Section A3.5). The site is close (about 100 meters) to the village of Salabwe (population 243). While no air quality or noise modeling was conducted for option 1, it is expected that both the air quality and noise impacts would not meet Democratic Republic of the Congo (DRC) or international guidelines in the town. Therefore, selection of this site would require the relocation of Salabwe. Salabwe has fewer residents than Mulumbu (population 1,200). The site for option 1 is outside the central zone (area encompassing the Dipeta syncline that is potentially underlain by high-grade copper ore) (Figure A3.4-1).

Table A3.7-1 Land Use at Alternative Processing Plant Sites

Alternative	Area (ha)	Agricultural Land	Miombo Woodland
1. northwest	83.2	97.0%	3.0%
2. southwest	83.2	5.2%	94.8%
3. northeast	83.2	91.5%	8.5%

ha = hectares.

Option 2 – Southwest

The site for option 2 is situated between the Goma and Kwatebala ore bodies, both of which will be mined (Figure A3.5-1). It is about 1.5 kilometers from the western edge of the proposed Kwatebala mine pit. It is predominantly covered by miombo woodland (95 percent) (Table A3.7-1). Field visits indicated that this miombo woodland had been degraded by preliminary clearing for agriculture. Several small creeks would have to be diverted around the site for option 2. The site is close to the rail line but in a different drainage from the preferred tailings storage facility site 2/3. No villages are near this location (Tenke is almost five kilometers to the southwest). This site is located within the central zone, although the ore is believed to be at depth (Figure A3.4-1). This site has been included in the analysis of alternatives despite its location, as it may not be economical to mine the ore at this particular site due to the depth.

Option 3 – Northeast

The site for option 3 is situated on the northern side of Kwatebala Hill and is quite close to where the mine pit (150 meters) and preferred tailings storage facility (about 150 meters to eventual top embankment) will be. It is upslope of the proposed tailings storage facility. It is primarily used for agriculture (91.5 percent), with the remainder being composed of miombo woodland (8.5 percent) (Table A3.7-1). Agricultural activities at this location are done mainly by residents of Mulumbu (population 1,200). Mulumbu is located about 400 meters from the northeastern edge of the proposed processing plant site. Agriculture in this area is more permanent, contrasting to the seasonal nature of agriculture at the site of option 1. A small (one hectare) wetland occurs on the eastern portion of the site, although it is not of regional significance. Option 3 is outside of the central zone (Figure A3.4-1).

A3.7.4 Evaluation of Alternatives

The three processing plant sites considered in the analysis are compared in Table 3, Appendix A-IV.

A summary of the results (Table A3.7-2) indicates that option 2 is the preferred and option 3 is second best. This holds true for the simple weighted means and the two sensitivity analyses, indicating that the results are relatively robust.

Table A3.7-2 Summary of Scoring for the Alternative Processing Plant Sites

Alternative	Weighted Score (Rank)	Normalized for Equal Weight by Environmental, Social and Technical (Rank)	Normalized for Environmental (.3), Social (.3), Technical (.2) and Sustainability (.2) (Rank)
1. northwest	590 (3)	565 (3)	513 (3)
2. southwest	760 (1)	749 (1)	847 (1)
3. northeast	698 (2)	635 (2)	711 (2)

The issues most affecting the alternative analysis rankings are air quality, noise levels, land use, and the potential for relocation of nearby residents. Option 2 scored high (10) for all of these categories due to the absence of any nearby villages and the low amount of agricultural lands. Air modeling for option 3 indicated that levels of sulfur dioxide at Mulumbu (900 micrograms per cubic meter) would exceed the guideline (see Section A2.7) of 350 micrograms per cubic meter. Noise modeling indicated that nighttime noise levels at Mulumbu would reach 50 A–weighted decibels, some 10 A–weighted decibels over the DRC nighttime guideline of 40 A-weighted decibels. Option 3 was scored 1 for both air and noise quality.

While no air quality or noise modeling was conducted for option 1, it is expected that both the air quality and noise impacts would not meet DRC or international guidelines in the town of Salabwe. As a result, selection of the site for option 1 would require the relocation of Salabwe. Salabwe has fewer residents than Mulumbu. Salabwe was scored slightly higher than Mulumbu because relocation would affect fewer people.

There is no strong preference between the options for natural habitat or biodiversity. Only option 2 has any substantial remaining natural vegetation. This miombo woodland has been partially cleared for agriculture and it is likely that increasing pressures on the land will affect miombo woodland further. Sites for all three options were found to have equivalent levels of soil fertility.

Option 2 is best from the social perspective, as it is not near any villages and has the least amount of agricultural land within it. Sites at options 1 and 3 are close to the villages of Salabwe and Mulumbu, respectively.

Options 2 and 3 score about the same for technical criteria, and much higher than option 1. Options 2 and 3 have the lowest costs due to their proximity to the ore bodies. Option 3 has an advantage over option 2 as it is located above the preferred tailings storage facility. Also, option 3 is very close to the proposed Kwatebala mine pit. The site for option 2 is closer to the Goma orebody.

Differences between options 2 and 3 were not large from a sustainability perspective. Option 2 is preferred due to its location near the existing rail line and its central location between the Goma and Kwatebala ore bodies.

The processing plant will likely be decommissioned at closure, which could be in the far (40+ years) future. The location of the processing plant site will not greatly influence whether or not it is used for alternate uses post-closure.

A3.7.5 Evaluation of Adverse Consequences

Option 1 – Northwest

The site for option 1 scored lowest of the three alternatives (Table A3.7-2). An adverse consequence for option 1 is the potential for mineable ore to underlie the site. However, the site is not within the known central ore zone and this consequence was considered to have a low probability, with a moderate consequence (Table A3.7-3). The potential need to relocate the residents of Salabwe (population 243) may have two adverse consequences:

- Suitable land for relocation may not be available locally.
- Residents may decide not to move.

Table A3.7-3 Potential for Adverse Consequences at the Alternative Plant Sites

Alternative	Consequence	Probability	Severity
1. northwest	mineable ore under site	low	moderate
	unavailability of suitable lands for relocation	low	high
	refusal of Salabwe residents to relocate	low	high
2. southwest	mineable ore under site	high	moderate
	topography may not be ideal	high	moderate
3. northeast	mineable ore under site	low	moderate
	unavailability of suitable lands for relocation	low	high
	refusal of Mulumbu residents to relocate	low	high

The probability of both of these consequences was rated low. Preliminary work indicates that suitable lands for relocation are available and that residents are not adverse to moving if a suitable compensation package is offered.

Option 2 – Southwest

The site for option 2 received the most favorable scores in the analysis for all three scoring methods. However, it also received the highest probabilities for adverse consequences. An adverse consequence for this site is the high probability that mineable ore underlies the site (Table A3.7-3). The site for option 2 is located within the central zone (Figure A3.4-1).

Further site investigations have indicated that the topography for option 2 is not ideal. The probability of having to undertake extensive leveling is high and the consequence is moderate in terms of increased construction costs.

Option 3 – Northeast

The site for option 3 scored behind option 2 and ahead of option 1 in the analyses. An adverse consequence for this site is the potential for mineable ore to underlie the site. This consequence was considered to have a low probability and moderate consequence (Table A3.7-3). The need to relocate the residents of Mulumbu may have two adverse consequences:

- Suitable land for relocation may not be available locally.
- Residents may decide not to move.

The probability of both of these consequences was rated low. Preliminary work indicates that suitable lands for relocation are available and that residents are not adverse to moving if a suitable compensation package is offered.

A3.7.6 Preferred Alternative

While the preliminary analysis indicated that the preferred alternative for the location of the processing plant is option 2, this is not a preferred option for the following reasons:

- The evaluation of adverse consequences indicated that this site is likely underlain by mineable ore and requires extensive leveling (Table A3.7-3). Option 2 therefore would have significantly higher construction costs due to the need for extensive site leveling.
- The capital and operating costs for pumping the tailings to the tailings storage facility would be very significant. In order to place a tailings storage facility below the options 2 plant site, it would have to be located in or adjacent to the Dipeta River. It was determined early in the analysis of alternatives that the environmental impacts of placing a tailings dam in the river would also be significant, making this a poor alternative. It would therefore be unlikely that any environmental agency would approve placing a tailings dam in the river drainage so pumping to the existing planned TSF would be the next best option, but would add significant capital and operating costs. The site is a feasible alternative if cost were not a consideration.
- Ore haulage to the plant in the initial eight years of the project would be farther than option 3 which would therefore have a negative impact on project economics.
- Residents of Mulumbu, Amoni and Kiboko would likely have to be moved regardless of the plant site location.

In summary, option 2 is technically possible to implement, but is associated with direct impacts on project economics, undesirably high environmental impacts, and potentially significant future impacts to ore recovery. From the perspective of maximizing stakeholder benefits, this is therefore an undesirable option.

Since it is likely that any ore in the site for option 3 would not be economical to mine, option 3 was selected as the preferred alternative. Air quality and noise modeling indicated that nearby residents (in Mulumbu, Amoni and Kiboko) would have to be relocated to avoid unacceptable impacts, particularly for an expanded project. Suitable lands for relocation of nearby residents has been found, and residents are agreeable to being relocated as long as the process is fair (Section D4.3). Further rationale for the relocation of these villages is summarized below and provided in Section D4.3.

- Even if option 2 were selected and compliance achieved in the early years of plant operation, the ability for continued compliance at the closest residential areas would become increasingly difficult if mine production were significantly increased beyond levels evaluated in the FS. Pursuit of such increases is required under the terms of the TFM mining convention.
- Under all three plant site options the primary access road for import and export of materials to the Kwatebala mining operation will pass through the present-day sites of the three village sites Mulumbu, Amoni and Kiboko; presenting public health and safety risks, even with mitigation measures.
- Under all three plant site options the estimated losses of farmland ranged from 30 to 50 percent of that available to Mulumbu villagers (due primarily to tailing and waste rock facilities), and replacing this loss with nearby land of equivalent value and accessibility (such that residents could stay in their current village location) is not considered feasible.
- Based on experiences elsewhere in sub-Saharan Africa, there would be a large influx of new settlement to the villages of Mulumbu, Amoni and Kiboko should they remain where they are, at the gates of an industrial mine development; and could expand by 5 to 10 times their current populations, rendering future resettlement nearly impossible if needed for mine expansion.

In consideration of the factors summarized above, the analysis of alternatives concluded that resettlement of the three most proximate villages to the mine site, Mulumbu, Kiboko and Amoni, with an estimated combined population of 1,600 individuals, represents the lowest overall risk to both the residents of these communities as well as to the future viability of the TFM mining operation. A ‘best practice’ management principle holds that the life-of-project social risk for a given investment is reduced if key issues are addressed during project design rather than once operations have begun. Though it is nominally more challenging to compensate and move villagers during the capital investment and construction phase, the resettlement decision relative to Mulumbu, Amoni and Kiboko is consistent with the broad principle identified above. The quality of life for residents in these three villages will be arguably better if resettled appropriately (i.e., consistent with IFC performance standards and DRC law) than it would be if they were left in their current location, to be eventually surrounded by industrial development and overwhelmed by population influx.

A3.8 PROCESS TYPE

The purpose of this section is to provide a concise summary of the process alternatives and selected process route.

The processes selected to produce copper and cobalt products were primarily determined based on the type of ore available at Kwatebala. Ore types can be separated into two general categories, based on their solubility in acid at ambient temperatures and pressures. Acid-soluble ores (sometimes called “oxide” ores) are generally processed through leaching, to extract the metals into an aqueous solution, from which the valuable metals can be selectively extracted using hydrometallurgical processes. This process can generally produce a market-grade copper product, without the need for further refining processes.

Non-acid soluble ores (such as “sulfide” ores) are generally processed and beneficiated through mechanical separation, such as grinding, followed by flotation, and then further beneficiated using pyrometallurgical processes (smelting). Even this product is usually not pure enough to market, and must undergo a final refining step before use.

There are exceptions to this generality, but for the most part, these are the well-established, most economic processes for the two types of ore. The Kwatebala orebody contains a high proportion of acid-soluble copper. This characteristic means that the most efficient way to extract the copper and cobalt is to acid leach the ore and extract the metals into an aqueous solution. The extraction of copper and cobalt from oxide type minerals is well established in Africa and throughout the world. It is important to note that for TFM both copper and cobalt are extracted as part of the process (i.e., it is a co-product mine).

The main components of the flowsheet include:

- Size reduction, leaching (or an alternative concentration route) and solid liquid separation.
- Solution extraction and electrowinning of copper.
- Cobalt processing from a bleed stream taken from the copper circuit.

The size reduction portion incorporates a single-stage SAG mill that offers a simple, efficient and low capital cost option to achieve a final product size of 80 percent passing 200 micrometers. This size reduction is necessary to achieve high leaching efficiency.

The leaching (or concentration) portion of the process considered three options:

- Heap leaching.
- Concentration by flotation.
- Agitated leaching.

While heap leaching offers a lower capital cost it also will result in very low cobalt recoveries and potential permeability issues due to the clayish nature of the ore. For this reason the heap leach was discarded.

Flotation of copper and cobalt was evaluated but discarded due to lower recoveries being achieved.

Agitated leaching at atmospheric conditions gave very good recoveries and is achieved by a series of agitated tanks. This configuration offers both a simple and robust design. It is also a very well-proven technology.

Solid liquid separation is achieved by counter-current decantation thickeners. This offers a much more robust circuit than the alternative of belt filtration.

Solution extraction and electrowinning of copper is very well understood and used extensively on the copper belt in neighboring Zambia. The solution extraction basis is well proven even with the higher copper tenors in the leach solutions in the Tenke project.

Similarly, electrowinning is also well known in this region of the world. Permanent cathode technology will be used in the electrowinning plant. Copper will be shipped out of the site in cathode form.

The cobalt process treats a bleed stream from the copper circuit. Cobalt processing involves removing impurities before further cobalt processing (either by a precipitation step or to cobalt metal by electrowinning).

A3.9 FINAL COPPER AND COBALT PRODUCTS

A discussion of the alternatives analysis process undertaken for determining the final copper and cobalt products is provided below:

A3.9.1 Copper

The TFM project will produce an annual output of about 115,000 tonnes of copper metal. The choice of producing copper metal was very straightforward, as described above. Once a high purity copper aqueous solution is produced, as described above for the solution extraction process, it is possible to use electrowinning to produce a high-purity, market-grade copper product. Electrowinning is a relatively simple process in which the aqueous copper is electroplated onto "starter sheets" or "cathodes". This process is relatively inexpensive, has a low impact on the environment, and bypasses the need for further smelting or refining. Therefore, the TFM project will produce high-purity copper metal on-site. There are no significant downsides to this choice.

A3.9.2 Cobalt

The TFM project will produce about 8,000 tonnes of cobalt metal and 2,000 tonnes of cobalt as intermediate product per year.

Three product types for cobalt are feasible:

- Cathode.
- Cobalt carbonate.
- Cobalt oxide (or hydroxide).

The selection of the preferred type of product was based on an analysis of the product markets, as well as the market for sodium sulfate (a byproduct of cathode cobalt production). Due primarily to the difficulties of managing/marketing the sodium sulfate byproduct, the cobalt carbonate option was eliminated. Presently, the project is being designed to produce both cobalt cathode and cobalt hydroxide. The proportions produced will depend on the prevailing market conditions.

Cobalt hydroxide (38 percent cobalt) was selected over other cobalt products to minimize environmental impacts (for example if cobalt carbonate is considered then the process also generates sodium sulfate that will cause environmental issues).

Downstream cobalt hydroxide is re-dissolved and the cobalt solution is further purified to remove other metal species. Finally, the purified cobalt solution is sent to cobalt electrowinning.

As the cobalt circuit has a breakpoint, cobalt can be shipped out of the site in a crude cobalt hydroxide form or as cobalt metal (known as 'cobalt rounds').

Solution extraction technology of cobalt was not considered due to the potential risk of co-mingling of solution extraction reagents.

A3.10 CONSTRUCTION VILLAGE LOCATION

A3.10.1 Introduction and Problem Statement

The prior analyses of alternatives determined that:

- The Kwatebala and Goma ore bodies would be mined first (it was later decided to mine the Fwaulu orebody as well).
- A processing plant would be situated near that orebody (the Kwatebala-Kwatebala configuration).
- The preferred tailings storage facility site is 2/3.
- The preferred processing plant site is option 3 (northeast).

The Goma orebody is to be mined starting in 2017. The problem statement for the construction village is:

> What is the preferred alternative for the construction village given that the Kwatebala and Goma ore bodies are to be mined first, the preferred tailings storage facility location is site 2/3, and the preferred processing plant site is option 3 (northeast)?

The construction village for the project will contain facilities to house and feed up to about 2,500 people, including construction workers, engineering supervisors and management during the construction period. These facilities will include electricity, water supply, solid waste and wastewater disposal. The camp will provide secure, serviced accommodation, a canteen (800-person capacity), domestic support (e.g., administration, security, laundry, storage, first aid) and recreational facilities (e.g., recreation hall for television and indoor games, gymnasium, soccer pitch, basketball courts). As the construction phase comes to an end, some of the residences will be converted to a permanent village. It is expected that additional camp space will be required for future expansions of TFM operations.

Musts for the construction village site include:

- A site with limited gradient, good drainage and firm substrate.
- Minimum surface area of 15 to 20 hectares.
- Adequate groundwater source to supply water for the camp's needs.
- Close proximity to the work sites (mine pit, processing plant site) to minimize travel distance.
- The construction village site should not be underlain by mineable ore. It should therefore be located outside of the central zone as indicated in Figure A3.4-1.

A3.10.2 Issues (Wants)

The following wants for the construction site were identified and ranked as indicated below (see also Table 4, Appendix A-IV).

Environmental

- The site should be located in an area where an adequate supply of groundwater is available. This want is actually a must, due to the fact that almost all surface water is heavily contaminated with bacteria, and cannot be used for drinking water without extensive water treatment. This factor is included in the analysis as a placeholder until the results of groundwater analysis are known for all sites (10).
- The site should be located in an area where effects on groundwater quality due to urban pollution and use are minimized. The quality of groundwater will be influenced by surrounding land uses. Costs associated with water treatment may vary (9).
- Air emissions from other TFM project facilities and urban centers should impact the site as little as possible (7).
- Noise and vibrations from other project facilities and urban centers should affect the site as little as possible (7).
- Effects on surface water quality due to wastewater release should be minimized. This want was scored relatively low as the effects can be mitigated through wastewater treatment (3).
- Loss or alteration of sensitive habitats, (e.g., miombo woodland should be minimized) (2).

- Loss or changes to biodiversity should be minimized. The main focus of biodiversity conservation should be the copper-cobalt flora and, to a lesser extent, the remaining miombo woodland. Impacts to copper-cobalt flora from the construction village site should be minimal as no suitable site alternatives exist on copper-cobalt areas (2).

Social

- Loss of agricultural lands should be minimized (10).
- Economic benefits to local communities should be spread among as many communities as possible (10).
- Impacts of induced development, such as the influx of workers and their families into the area, should not strain local services and the cost of providing those services should be minimized (10).
- Relocation of local inhabitants should only be considered as a last resort. Relocation may be necessary due to loss of agricultural land (9).
- Health of workers may be impacted by proximity to urban areas. Illness and/or disease may spread more easily if the construction village site is located close to urban areas (6).
- The site should be located away from existing settlements so that workers are not subjected to social pressures or negative influences (5).
- The visual impact of the construction village site on the landscape should be minimized (4).
- Loss of cultural resources should be minimized. This want was given a low score as the alternative site locations are away from the main river valleys where archaeological artifacts are concentrated. Effects can be successfully mitigated if proper attention is given to archaeology (2).

Technical

- Mineable ore should not lie underneath the construction village site. This want is actually a must, and is included in the analysis as a placeholder until the results of condemnation drilling are known (10).
- Travel distances between the construction village and work sites (e.g., mine pits, processing plant site) should be as short as possible (7).
- Requirements for new roads to access the site should be minimized (5).
- Requirements to level the site should not be large. Cut and fill requirements should be minimal. Fill is more costly than cuts (3).
- Drainage of the site should be good. Drainage can be improved on a site but this can be costly (2).

- Water diversions should be minimized. Diversions cost money and take up space. However, this concern is minimal as there do not appear to be any mapped streams in the alternative construction village sites identified (1).

Sustainability

- Energy costs related to transport of materials and supplies to the site should be minimized (3).
- The site is proposed to operate for two to three years as a construction camp, after which it could be used for operational requirements as a permanent village. At its eventual closure, the village site could be decommissioned or used for alternate purposes. Alternate use of the construction village site by local business or as housing would represent a desired end land use. During consultation, local residents stated that adequate housing was in short supply. Conversion to other uses after construction is more likely if the location is near existing urban areas (10).

A3.10.3 Alternatives Considered

Five construction village sites were considered in the analysis (Figure A3.5-1). It is assumed that an adequate groundwater supply will be available at the construction village, and that the camp site is not underlain by mineable ore. None of the alternatives are located within the central zone (Figure A3.4-1). Each alternative is described below.

Option 1 – Kiboko

The site for option 1 is located less than one kilometer northeast of the settlement of Kiboko (population 126), and south of Ndela Prudence (population 68). Option 1 is situated in an area comprising a relatively equal proportion of agricultural land and closed miombo woodland (Table A3.10-1). There is an east-west access road through Kiboko to the south. There is a mapped drainage located to the north.

Option 2 – In or Near Fungurume

The site for option 2 is located about 4.5 kilometers east of Fungurume (population 36,000) in a predominantly agricultural area (Table A3.10-1). There is an access road immediately to the west. There are no mapped drainages in the immediate vicinity.

Table A3.10-1 Land Use at Alternative Construction Camp Sites

Alternative	Area (ha)	Agricultural Land (percent)	Miombo Woodland[a] (percent)	Disturbed (percent)
1. Kiboko	20	48	52	n/a
2. in or near Fungurume	20	98	2	n/a
3. in or near Tenke	20	53	47	n/a
4. north of Fungurume	20	0	92	8
5. co-located with processing plant site (option 3)	20	n/a	n/a	100

[a] The Kiboko site (option 1) is closed woodland. The Fungurume site (option 2) is open woodland (former closed miombo woodland that has been partially cleared for wood or cultivation). The Tenke site (option 3) is 30 percent open woodland and 17 percent closed woodland. The north of Fungurume site (option 4) is 22 percent closed woodland and 70 percent open woodland.

n/a = not applicable.

ha = hectares.

Option 3 – In or Near Tenke

The site for option 3 is less than one kilometer northeast of Tenke (population 11,000) in a mostly open miombo woodland area (Table A3.10-1). There is a mapped drainage located to the north. The existing railway and access road are located to the east and south.

Option 4 – North of Fungurume

The site for option 4 is located six to seven kilometers north of Fungurume. Option 4 is relatively flat, and consists largely of open miombo woodland. It has a small component of closed miombo woodland as well as a small area of disturbed land (village, road, previous mine sites) (Table A3.10-1).

Option 5 – Co-Located with Processing Plant Site

The site for option 5 considers a construction village located on the same site as the processing plant, and assumes there is no requirement for additional clearing. The analysis assumes that the preferred processing plant site option 3 would be used (Table A3.10-1).

A3.10.4 Evaluation of Alternatives

The five construction village sites considered in the analysis are compared in Table A3.10-2.

Table A3.10-2 Summary of Scoring for the Alternative Construction Village Sites

Alternative	Weighted Score (Rank)	Normalized for Equal Weight by Environmental, Social and Technical (Rank)	Normalized for Environmental (.3), Social (.3), Technical (.2) and Sustainability (.2) (Rank)
1. Kiboko	820 (5)	804 (4)	812 (5)
2. in or near Fungurume	1,022 (2)	880 (2)	1,065 (1)
3. in or near Tenke	828 (4)	704 (5)	865 (4)
4. north of Fungurume	1,040 (1)	968 (1)	1,025 (2)
5. co-located with processing plant site 3 (option 3)	937 (3)	861 (3)	920 (3)

A summary of the results indicates that, for the simple weighted means analysis, the site for option 4 (north of Fungurume) is preferred, followed by sites for option 2 (in or near Fungurume), 5 (co-located with the processing plant), 3 (Tenke) and 1 (Kiboko). Scores are quite close for the first sensitivity analysis, which does not explicitly consider sustainability. In the sustainability analysis option 4 also scores best, followed by options 2, 5, 1 and 3. For the second sensitivity analysis, where more weight is given to environmental and social issues than technical and sustainability issues, different results are achieved. Here, option 2 is preferred, followed by options 4, 5, 3 and 1 (Table A3.10-2). Options 2 and 4 consistently place in the top two, options 1 and 3 consistently place in the bottom two, and option 5 consistently places in the middle. For each scoring method, there is little difference in the scoring between the first- and second-place alternatives.

In terms of environmental criteria, the site for option 4 scored highest, due mainly to its distance from urban centers which resulted in fewer air quality and noise issues, as well as fewer groundwater issues. There was less variability among the scores for social criteria, with options 2, 4 and 5 scoring similarly. Scoring was mainly influenced by induced development impacts economic impacts, and social pressures from proximity to urban areas. Although an important issue, relocation was not a main factor in the social evaluation, because all sites have either low or no present use for housing.

Technical analysis was mainly influenced by distance from work sites. Sites at options 1 and 5 are closest to the mine pits and the preferred processing plant site. This would result in less costs associated with travel to and from daily work sites. These sites also have the fewest requirements in terms of new roads or upgrades. However, the site for option 5 is assumed to have more challenges related to requirements for leveling of the work site, drainage and stream diversions. No site-specific technical information is available for three of the options. Overall, the site for option 1 scores highest for technical criteria.

There were differences between the five alternatives related to sustainability. Options 2 and 3 scored much higher than the other three alternatives because they are located near existing urban centers and are assumed to be more likely to present opportunities for use post-closure.

A3.10.5 Evaluation of Adverse Consequences

Options 1 – Kiboko

The site for option 1 scored last or second last in the analyses. Adverse consequences for this site include the potential for mineable ore to underlie the site and insufficient amounts of groundwater. The first consequence has a moderate probability and moderate severity. The site for option 1 is located in the buffer zone, where the possibility of copper ore is moderate to high. The second consequence is considered to have a low probability and moderate severity (Table A3.10-3). Another issue is the potential for people seeking work to go to the site and set up squatter camps. This has a high probability and a high severity.

Table A3.10-3 Potential for Adverse Consequences at the Alternative Construction Village Sites

Alternative	Consequence	Probability	Severity
1. Kiboko	mineable ore under site	moderate	moderate
	insufficient groundwater	low	moderate
	establishment of squatter camp	high	high
2. in or near Fungurume	mineable ore under site	low	moderate
	insufficient groundwater	low	moderate
	Tenke people upset	high	moderate
3. in or near Tenke	mineable ore under site	moderate	moderate
	insufficient groundwater	low	moderate
	Fungurume people upset	high	moderate
4. north of Fungurume	mineable ore under site	low	moderate
	insufficient groundwater	low	moderate
	establishment of squatter camp	low	high
5. co-located with processing plant site (option 3)	mineable ore under site	moderate	moderate
	insufficient groundwater	low	moderate
	topography may not be ideal	moderate	moderate
	establishment of squatter camp	high	high

Option 2 – In or Near Fungurume

The site for option 2 received the highest score for the sensitivity analysis included environmental, social, technical and sustainability criteria. Option 2 had the second-highest score for the other two analyses.

Adverse consequences for option 2 include the potential for mineable ore to underlie the site and insufficient amounts of groundwater. Both consequences are considered to have a low probability and moderate severity (Table A3.10-3). The site for option 2 is located in the outer zone, an area which has a low to moderate possibility of copper ore. An existing groundwater well will be used, which has been tested and has an adequate water supply. The influx of squatters is likely to be better controlled in Fungurume where there is a large population base as well as room for expansion. Tenke residents stated during consultation that they expected some benefits from the TFM project. They also stated they would be angry if camps and other infrastructure were only built at Fungurume. This issue was considered highly probable and of a moderate severity.

Option 3 – In or Near Tenke

The site for option 3 scored last or second last for all three analyses. Adverse consequences for this site include the potential for mineable ore to underlie the site and insufficient amounts of groundwater. The first consequence is considered to have a moderate probability and moderate severity. The second consequence is considered to have a low probability and moderate severity (Table A3.10-3). Residents of Fungurume would not want to see most benefits flow to Tenke.

Option 4 – North of Fungurume

The site for option 4 and for option 2 scored highest on the first two analyses, and second on the third analysis. Adverse consequences for this site include the potential for mineable ore to underlie the site and insufficient amounts of groundwater. The first consequence is thought to have a low probability (located in the outer zone) and moderate severity (Figure A3.4-1). The second consequence has a low probability because an existing groundwater well will be used. The well has an adequate water supply. Another adverse consequence is the potential for people to seek work and set up squatter camps near the site for option 4. This has a low probability, because the site is some distance from the work areas as well as populated areas. The severity of this would be high because of the cost involved.

Option 5 – Co-Located with Processing Plant Site

The site for option 5 scored on an intermediate level for all three analyses. Adverse consequences for this site include the potential for mineable ore to underlie the site and insufficient amounts of groundwater. The first consequence is considered to have a moderate probability and moderate severity. Ore is likely to be under the site (assumes option 3 is selected for the processing plant), but at what depth is not currently known. If ore is under the site, the construction camp could be moved following depletion of the Kwatebala, Goma and Fwaulu oxide reserves. The second consequence is considered to have a low probability and moderate severity (Table A3.10-3). Hydrology studies have indicated the likelihood of sufficient groundwater supplies. As with Kiboko, the potential for people seeking work and to set up squatter camps at the site for option 5 has a high probability and a high severity.

Option 5 would likely require some leveling, more so than any of the other alternatives. Probability and severity were both rated as moderate.

A3.10.6 Preferred Alternative

The analysis indicated that the preferred alternative for the construction camp site is the site for option 4 (north of Fungurume), when more weight is given to environmental, social and technical criteria, and sustainability is not considered. This is reasonable as environmental and social issues are of high importance for locating a camp of this size. Option 2 scores higher when sustainability is included in the analysis. There was very little difference in the scoring among the top two alternatives (options 4 and 2) for all three scoring methods.

A3.11 GROWTH CENTER LOCATIONS

A3.11.1 Introduction and Problem Statement

The TFM operations near Tenke and Fungurume will attract additional population into the mining concession. This will result in an increase in the population of existing communities, even with the provision of the construction village for employees of the project. There is currently no infrastructure within existing urban centers. Planning is required to prepare for this influx of migrant workers and their families.

"Growth Centers," with some infrastructure such as roads, water and common areas next to major population centers, may assist with this induced development. "Growth Centers" are not the same as the "construction camp/permanent village", and are intended solely to assist the villages of Tenke and Fungurume in managing the predictable growth of these urban areas in response to development of the TFM project. The exact locations of the Growth Centers should be decided upon in consultation with community government and community leaders. These facilities should be managed as part of the larger community development. The project would provide the land and ongoing urban planning technical assistance.

Basic infrastructure to be established by TFM would include access roads, a market and recreation area and potable (drinking) water. If desired by the communities, a portion of the funds derived from the social development fund could be used to build infrastructure, to manage sewage and solid wastes, to build schools and, possibly, to bring electrical power to the growth centers. Note that the construction camp/permanent village will be located to the north of Fungurume. It will have the required infrastructure to handle all sewage and solid wastes from the camp.

The prior analyses of alternatives determined that:

- The Kwatebala and Goma ore bodies would be mined first (it was later decided to mine the Fwaulu orebody as well).
- A processing plant would be situated near that orebody (the Kwatebala-Kwatebala configuration).
- The preferred tailings storage facility site is site 2/3.
- The preferred processing plant site is option 3 (northeast).
- The preferred construction village site is option 4 (north of Fungurume).

The problem statement for the growth center locations is:

> What is the preferred alternative for growth center locations given that the Kwatebala and Goma ore bodies are to be mined first, the preferred tailings storage facility location is option 2/3, the preferred processing plant site is option 3 (northeast), and the preferred construction village site is option 4 (north of Fungurume)?

Musts for the growth center site include:

- A site with limited gradient, good drainage and firm substrate.
- Minimum surface area of 340 hectares.

- Adequate groundwater source to supply water to meet the needs of the growth center.
- Close proximity to the work sites or facilities (mine pit, processing plant site) to minimize travel distance.
- The growth center site should not be underlain by mineable ore. For now, this is scored as a want. Ongoing condemnation drilling will determine whether some or all of the alternatives analyzed will have to be rejected. All of the alternatives considered are outside of the central zone (area underlain by high-grade copper ore) (Figure A3.4-1), but they have varying degrees of probability of underlying ore and require condemnation drilling.

A3.11.2 Issues (Wants)

The following wants for the growth center site were identified and ranked as indicated below (Table 5, Appendix A-IV).

Environmental

- The site should be located in an area where an adequate supply of groundwater is available. This want is actually a must, as virtually all available surface water is heavily contaminated with bacteria and would require extensive treatment if used for drinking water. This factor is included in the analysis as a placeholder until the results of groundwater analysis are known. For the current exercise, this want was scored the same for all alternatives (10).
- The site should be located in an area where effects on groundwater quality due to urban pollution and use are minimized. The quality of groundwater will be influenced by surrounding land uses. Costs associated with water treatment may vary, depending on location (9).
- Air emissions from other TFM project facilities and urban centers should impact the growth center as little as possible (7).
- Noise and vibrations from other TFM project facilities and urban centers should affect the growth center as little as possible (7).
- Effects on surface water quality due to wastewater release should be minimized. This want was scored relatively low as the effects can be mitigated through wastewater treatment (3).
- Loss or alteration of sensitive habitats, (e.g., miombo woodland) should be minimized (2).
- Loss or changes to biodiversity should be minimized. The main focus of biodiversity conservation should be the copper-cobalt flora and, to a lesser extent, the remaining miombo woodland. Impacts to copper-

cobalt flora from the growth center should be minimal as no suitable alternatives exist on copper-cobalt areas (2).

Social

- Loss of agricultural lands should be minimized (10).
- Economic benefits to local communities should be spread among as many communities as possible (10).
- Impacts of induced development, such as the influx of workers and their families into the area, should not strain local services, and cost of providing those services should be minimized (10).
- The ability to mitigate foreseeable induced development should be maximized. Induced development will occur near the facilities (10).
- Community concerns about social equity should be minimized. In other words, the goal is to please the greatest number of people (10).
- Relocation of local inhabitants should only be considered as a last resort. Relocation may be necessary due to loss of agricultural land (9).
- Health of workers/residents may be impacted by proximity to urban areas. Illness and disease may spread more easily if the growth center is located close to urban areas (6).
- The visual impact of the growth center on the landscape should be minimized (4).
- Loss of cultural resources should be minimized. This want was given a low score. The effects can be successfully mitigated if proper attention is given to archaeology (2).

Technical

- Mineable ore should not lie underneath the growth center. This want is actually a must, and is included in the analysis as a placeholder until the results of condemnation drilling are known. For the current exercise, this want was scored based on the probability that mineable ore underlies the sites (10).
- Requirements for new roads to access the growth center should be minimized (5).
- Travel distances between the growth center and work sites (e.g., mine pits, processing plant site) should be as short as possible. This was given a relatively low weighting because it would only apply to operations employees and not all residents of the growth center (4).

Sustainability

- The growth center should meet long-term housing and commercial needs. Proximity to urban areas and goods and services is advantageous (10).
- Potential for small business development should be maximized, (e.g., establishment of market gardens, small vendors, etc.) (9).
- Energy costs related to transport of materials and supplies to the growth center should be minimized (3).

A3.11.3 Alternatives Considered

Four options for growth center locations were considered in the analysis. These alternatives include most of the same alternatives considered for the construction village (Figure A3.5-1), although a much larger footprint would be required. It is assumed that an adequate groundwater supply will be available at all sites, and that the sites are not underlain by mineable ore. Each alternative is described below.

Option 1 – Kiboko

The site for option 1 (Kiboko) is located less than one kilometer northeast of the settlement of Kiboko (population 126) and south of Ndela Prudence (population 68). It is situated in an area comprising a relatively equal proportion of agricultural land and closed miombo woodland. There is an east-west access road through Kiboko to the south. The growth center at option 1 would be situated between two mapped drainages.

Option 2 – Fungurume

The site for option 2 (Fungurume) is located about four kilometers east of Fungurume (population 36,000). It is in predominantly agricultural area (80 percent agriculture, 20 percent open woodland – much of which has been cleared). There is an access road which runs north/south through the western part of the site. There are no mapped drainages that overlap with the site for option 2.

Option 3 – Tenke

The site for option 3 (Tenke) is north of Tenke (population 11,000) and west of the railway line. Option 3 is in an area comprised of relatively equal proportion of open woodland and grassland. There is a mapped drainage located to the north.

Option 4 – Fungurume and Tenke

The site for option 4 (Fungurume and Tenke) considers two growth center sites, one in Fungurume and one in Tenke. Growth centers could operate from both locations once the construction phase is completed.

A3.11.4 Evaluation of Alternatives

The four growth center location options considered in the analysis are compared in Table A3.11-1.

Table A3.11-1 Summary of Scoring for the Alternative Growth Center Sites

Alternative	Weighted Score (Rank)	Normalized for Equal Weight by Environmental, Social and Technical (Rank)	Normalized for Environmental (.3), Social (.3), Technical (.2) and Sustainability (.2) (Rank)
1. Kiboko	869 (4)	884 (2)	923 (4)
2. Fungurume	1,059 (2)	900 (1)	1,082 (2)
3. Tenke	920 (3)	778 (4)	941 (3)
4. Fungurume and Tenke	1,117 (1)	857 (3)	1,090 (1)

A summary of the results indicates that for the simple weighted score analysis, the site for option 4 (Fungurume and Tenke) is preferred followed by options 2 (Fungurume), 3 (Tenke) and 1 (Kiboko). In the first sensitivity analysis, which does not consider sustainability, option 2 scores highest, followed by options 1, 4 and 3. For the second sensitivity analysis, which includes sustainability but gives more weight to environmental and social issues than technical and sustainability issues, option 4 is again preferred, followed by options 2, 3 and 1. Option 4 was first in two of the three analyses, and option 2 was first in only one of the three analyses, where more weight was given to environmental and technical criteria (Table A3.11-1). Overall, there was not a lot of variation in the scores between the four alternatives for each scoring method, particularly for the second sensitivity analysis.

In terms of environmental issues, the site for option 1 (Kiboko) scored highest largely due to its location further from urban areas. Overall, option 4 (Fungurume and Tenke) scored lowest for environmental factors.

Although an important issue, relocation was not a main factor in the social evaluation, because all sites have relatively low present use for housing. Option 4 scores highest on social criteria, with main factors being:

- The soils in the area are less productive than most of the other options.
- It mitigates foreseeable induced development for both Fungurume and Tenke.
- It avoids the perception of unfairness.
- It spreads the benefits of the project among two communities.

Option 1 does not score highly on social criteria because:

- It would result in the greatest visual impact.
- It would impact the most productive soils.
- The lack of existing infrastructure means the area would be less able to deal with induced impacts.
- It is not a prime target for induced development.
- It does not provide benefits to either of the major centers of Fungurume or Tenke.
- Economic benefits from the project would overwhelm the smaller villages in the area.

Option 1 (Kiboko) scored highest in the technical criteria, largely because of its proximity to the mine pits and processing plant and because less road maintenance would be required. The remaining sites scored similarly, although slightly lower than option 1 for the technical criteria.

There were differences between the four alternatives related to sustainability. Option 4 (Fungurume and Tenke) scored highest in terms of sustainability, because it is close to two urban centers and it spreads out small business opportunities to the greatest number of potential vendors. Option 1 scored much lower than the other three sites on sustainability criteria.

A3.11.5 Evaluation of Adverse Consequences

Option 1 – Kiboko

Option 1 (Kiboko) scored second highest using the first sensitivity analysis (where more weight was given to environmental and technical criteria) and fourth in the other two analyses. Adverse consequences for this site include the potential for mineable ore to underlie the site, and insufficient amounts of groundwater. The first consequence is considered to have a moderate probability (located in the buffer zone) and moderate severity. The second consequence is considered to have a low probability and moderate severity (Table A3.11-2).

Table A3.11-2 Potential for Adverse Consequences at the Alternative Growth Center Sites

Alternative	Consequence	Probability	Severity
1. Kiboko	mineable ore under site	moderate	moderate
	insufficient groundwater	low	moderate
2. Fungurume	mineable ore under site	low	moderate
	insufficient groundwater	low	moderate
3. Tenke	mineable ore under site	moderate	moderate
	insufficient groundwater	low	moderate
4. Fungurume and Tenke	mineable ore under site	low to moderate	moderate
	insufficient groundwater	low	moderate

Option 2 – Fungurume

Option 2 (Fungurume) was rated first in the first sensitivity analysis, and second in the other two analyses. Adverse consequences for this site include the potential for mineable ore to underlie the site, and insufficient amounts of groundwater. Both consequences are considered to have a low probability and moderate severity (Table A3.11-2). This site is located in the outer zone (Figure A3.4-1).

Option 3 – Tenke

Option 3 (Tenke) was ranked third in two of the analyses and fourth in the remaining analysis. Adverse consequences for this site include the potential for mineable ore to underlie the site and insufficient amounts of groundwater. The first consequence is considered to have a moderate probability and moderate severity (located in the buffer zone). The second consequence is considered to have a low probability and moderate severity (Table A3.11-2).

Option 4 – Fungurume and Tenke

Option 4 (Fungurume and Tenke) scored first in the weighted score and second sensitivity analysis and scored third in the first sensitivity analysis. Adverse consequences for this option include the potential for mineable ore to underlie the sites and insufficient amounts of groundwater. The first consequence is considered to have a low to moderate probability and moderate severity. The second consequence is considered to have low probability and moderate severity (Table A3.11-2).

A3.11.6 Preferred Alternative

The analysis indicated that the preferred alternative for the growth center locations is option 4, which includes growth centers at both Fungurume and Tenke. This alternative ranked first in two of the three analyses. This result is largely due to social and sustainability factors. It is reasonable to assume that sustainability and social issues are of high importance as growth centers are intended to support many thousands more people than the construction village. The growth centers are also intended to meet long-term housing needs. Final location and description of the growth center will be decided through community consultation.

A3.12 MAIN ACCESS ROAD LOCATIONS WITHIN THE CONCESSION

A3.12.1 Introduction and Problem Statement

Once the locations for the major facilities for the development are established, the main access road route can be determined. This analysis assumes that plant option 3 (northeast) was selected as the processing plant site location. If processing plant sites for options 1 or 2 were selected, the analysis for the access road would not change much. This analysis also assumes that the villages of Mulumbu, Amoni and Kiboko will be relocated. The existing railway may be used to transport some reagents and product. Most of this cargo will be transferred to trucks at an existing siding at Fungurume. Transport of material to and from the concession is considered in Section A3.15.

The main access road as well as the existing rail line will be used for transport of construction equipment and materials (e.g., large vessels, piping) and raw materials (e.g., lime, sulfur) to the site, and product and waste materials from the site. The road and rail line will also be used to transport workers to and from the construction village to the site. It is possible that the main access road will change once operations ramp up to full production.

The problem statement for the main access road within the concession is therefore:

> What is the preferred route for the main access road in the concession from south of Fungurume to the plant site?

The processing plant site for the TFM project will contain various facilities including a sulfuric acid plant, acid leach plant, both a copper and a cobalt processing circuit, water treatment plant and administrative offices. Musts for the access road include:

- Road surface (10 meters wide) and rights-of-way wide enough to accommodate construction and operations traffic.
- Grade (slope) sufficient for heavy truck traffic.
- Avoidance of major human populations.

For this analysis it was assumed that limestone from the quarry would be trucked on existing roads regardless of which of the three alternatives is selected.

A3.12.2 Issues (Wants)

The following wants for the main access road location were identified and ranked as indicated below (Table 6, Appendix A-IV).

Environmental

- Noise and vibrations from traffic should affect as few local inhabitants as possible (6).
- Air emissions from traffic should affect as few local inhabitants as possible. Dust from the road can be minimized near residences (5).
- Effects on surface water quality at creek crossings should be minimized. Appropriate crossing structures (e.g., bridges) should be built to minimize impact. Mitigation for accidental spills should be included in design and an emergency response plan developed. Dust from the road can be minimized at creek crossings (4).
- Loss or alteration of natural habitats should be minimized. All three of the routes follow existing or abandoned roads, although these will need to be widened. The study area has been degraded by land clearing for agriculture. Some miombo woodland remains but it is not pristine (3).

- Loss or changes to biodiversity should be minimized. The main focus of biodiversity conservation should be the copper-cobalt flora and, to a lesser extent, the remaining miombo woodland. Impacts to copper-cobalt flora from the road should be minimal if the final route selection for the main access road is to avoid these areas (2).

Social

- Loss of agricultural lands should be minimized (9).
- Relocation of local inhabitants should only be considered as a last resort. Relocation may be necessary due to agricultural lands lost during construction and to widening of the existing roads. Landholdings in the area are small and road construction may take up most or all of the land belonging to one family. Bypasses should be built around villages where possible. The analysis assumes that Mulumbu, Amoni and Kiboko will be relocated (10).
- The main access road should be located away from local inhabitants so that human injury or death from traffic is minimized and local roads are not overloaded. The road should be landscaped using a berm (a small hill or sloped area running parallel to the road). Also, a bike path should be constructed parallel to the road on the far side of the berm. These efforts will help focus foot and bicycle traffic off the road (10).
- Loss of cultural resources should be minimized. This want was given a low score as the alternative routes do not follow the main river valleys where archaeological artifacts are concentrated. Effects can be successfully mitigated if proper attention is given to archaeology (1).

Technical

- The main access road should minimize effects of potential flooding. Seasonal flooding can affect use as well as increase maintenance costs (10).
- The length of the road should be minimized. Cost of construction and use is directly proportional to length (8).
- The number of creek crossings should be minimized. The cost of bridges and other crossing structures is generally higher than construction of the road (6).
- Terrain should be flat or the route should follow a ridgeline. Routes that cut across slopes should be avoided due to problems associated with erosion and slumping (6).

Sustainability

- Energy use and emissions are proportional to overall road length. Road length should be as short as possible (2).
- Alternate use of the roads by local people would represent a desired end land use (9).
- Cost of road maintenance post-closure should be minimized. The road will not be used if it is too costly to maintain (9).

A3.12.3 Alternatives Considered

Three access road alternatives were considered. All three routes would come from the south on the Kakanda Mine Road (Figure A3.5-1) to the TFM camp road in order to avoid National Road Number 1 and Fungurume.

Option 1 – Southern Route (Kafwaya Cutoff Road)

Option 1 is a southern route of 21 kilometers (Table A3.12-1). This route would pass the existing TFM camp to the west, follow the National Road Number 1, turn north just east of the Konka River, pass by the town of Kwatebala Gare and bypass the Kwatebala orebody on the east side. The route for option 1 would cross eight watercourses, occupy some 21 hectares (assuming a 10-meter width), and affect mostly agricultural lands (59 percent). Much of this route would be along existing roadway. The government would likely require TFM to upgrade the national road that runs between Fungurume and Tenke. The southern route follows the national road for 11 kilometers. A total of 387 people live in towns and villages on or near the route for option 1 (387 in Kwatebala Gare).

Option 2 - Central Route

Option 2 is a central 19-kilometer route passing by the existing TFM camp to the west and bypassing the town of Fungurume (using the Fungurume bypass road). It would run along an old road right-of-way to the town of Kwatebala Gare and then follow the southern route alignment around the eastern edge of the Kwatebala orebody (Figure A3.3-1). The central route would cross six watercourses and affect about 19 hectares, 68 percent of which would be agricultural (Table A3.12-1). Option 2 would also cross a small area of copper-cobalt steppe-savanna (5.0 percent) and a larger area of miombo woodland (27 percent). A total of 504 people live in villages near this route (117 in Mwela Mpande and 387 in Kwatebala Gare).

Table A3.12-1 Comparison of Alternative Access Routes

Alternative	Length (km)	Stream Crossings	Villages Passed	Total Population	Agricultural Land	Closed Miombo Woodland	Degraded Miombo Woodland	Copper-Cobalt Steppe-Savanna	Settlement
1. southern	20.6	8	Kwatebala Gare	387	59.2%	38.3%	0%	0%	2.4%
2. central	19.2	6	Kwatebala Gare, Mwela Mpande	504	68.2%	26.8%	0%	5.0%	0.04%
3. northern	16.8	3	Mulumbu, Amoni, and Kiboko (all three villages will be relocated)	0 (after relocation) 1,630 (before relocation)	89.3%	4.5%	2.4%	1.8%	2%

km = kilometers.

Note: Land use categories in this table follow those of the flora baseline (Section B3.1). Degraded miombo woodland is equivalent to open miombo woodland.

Option 3 - Northern Route

Option 3 is a northern route that is 17 kilometers in length. The route for option 3 would bypass Fungurume by means of the Fungurume bypass road. It would follow an existing road along the height of land between the Dipeta and Mofia catchments, passing the western edge of the site of three villages that will have been relocated (Kiboko, Amoni, Mulumbu). Only three watercourses would be crossed. Most of the area affected is agricultural land (89 percent). Option 3 would also cross small amounts of miombo woodland (4.5 percent), and copper-cobalt steppe-savanna (1.8 percent). A total of 1,630 people currently live in villages near this route, but all would have been relocated (1,200 in Mulumbu, 266 in Amoni and 126 in Kiboko) (Figure A3.3-1).

Limestone Quarry

The access road to the limestone quarry also needs to be considered in the alternatives analysis. Given that the number of trucks (ten per day) is low, it is recommended that quarry trucks connect up with the existing airstrip road and then travel to the access road route (option 1, 2 or 3) selected. Connecting the quarry access road directly to the northern route for option 3 would affect good agricultural land and this short cut should be avoided.

A3.12.4 Evaluation of Alternatives

A summary of the results (Table A3.12-2) indicates that the northern route (option 3) is preferred. Option 3 ranked first in each of the three analyses. The southern route (option 1) ranked second and the central route (option 2) ranked third. These rankings also held for all three analyses.

Table A3.12-2 Summary of Scoring for Alternative Access Routes

Alternative	Weighted Score (Rank)	Normalized for Equal Weight by Environmental, Social and Technical (Rank)	Normalized for Environmental (.3), Social (.3), Technical (.2) and Sustainability (.2) (Rank)
1. southern	677 (2)	515 (2)	663 (2)
2. central	499 (3)	443 (3)	503 (3)
3. northern	740 (1)	641 (1)	743 (1)

The northern route (option 3) scored highest overall for environmental and technical criteria, but lowest for social criteria and intermediate for sustainability criteria. The northern route scored higher for all five environmental criteria and three out of four technical criteria. The southern route (option 1) scored highest on social and sustainability criteria, although the sustainability score for the southern route was only slightly higher than for the northern route.

A3.12.5 Evaluation of Adverse Consequences

Adverse consequences for all three route options are shown in Table A3.12-3.

Table A3.12-3 Potential for Adverse Consequences Along the Alternative Access Routes

Alternative	Consequence	Probability	Severity
1. southern	mineable ore under route	high	low
2. central	mineable ore under route	high	low
	topography may not be ideal	moderate	low
3. northern	mineable ore under route	moderate to high	low

Option 1 – Southern Route

The southern route (option 1) ranked second for all three analyses. An adverse consequence of this route is that it may be found to be on top of mineable ore at some point in the future. The likelihood of this is considered to be high but the consequence (i.e., moving the road) is considered low.

Option 2 – Central Route

The central route (option 2) was ranked third in the simple weighted scoring as well as both sensitivity analyses. This central route may be on top of mineable ore. The likelihood of this is considered to be high but the consequence (i.e., moving the road) is considered low. The topography of the route from option 2 may not be ideal. In places, this central route cuts across some slopes. While this is moderately likely, proper design could reduce the severity to low.

Option 3 – Northern Route

The northern route (option 3) scored first across all three analysis methods. This route may be underlain by mineable ore. The probability of this occurrence ranges from moderate to high over the length of the route. The severity of this consequence is low as the road can be moved later.

A3.12.6 Preferred Alternative

The northern route (option 3) is clearly the preferred alternative. Its overall higher scoring relative to the other two alternatives is largely related to the decision to relocate the villages of Mulumbu, Amoni and Kiboko. It is the shortest route, crosses fewer watercourses and has the least amount of sensitive vegetation types. Option 3 would also be less prone to flooding. The northern route is the preferred route during the construction phase.

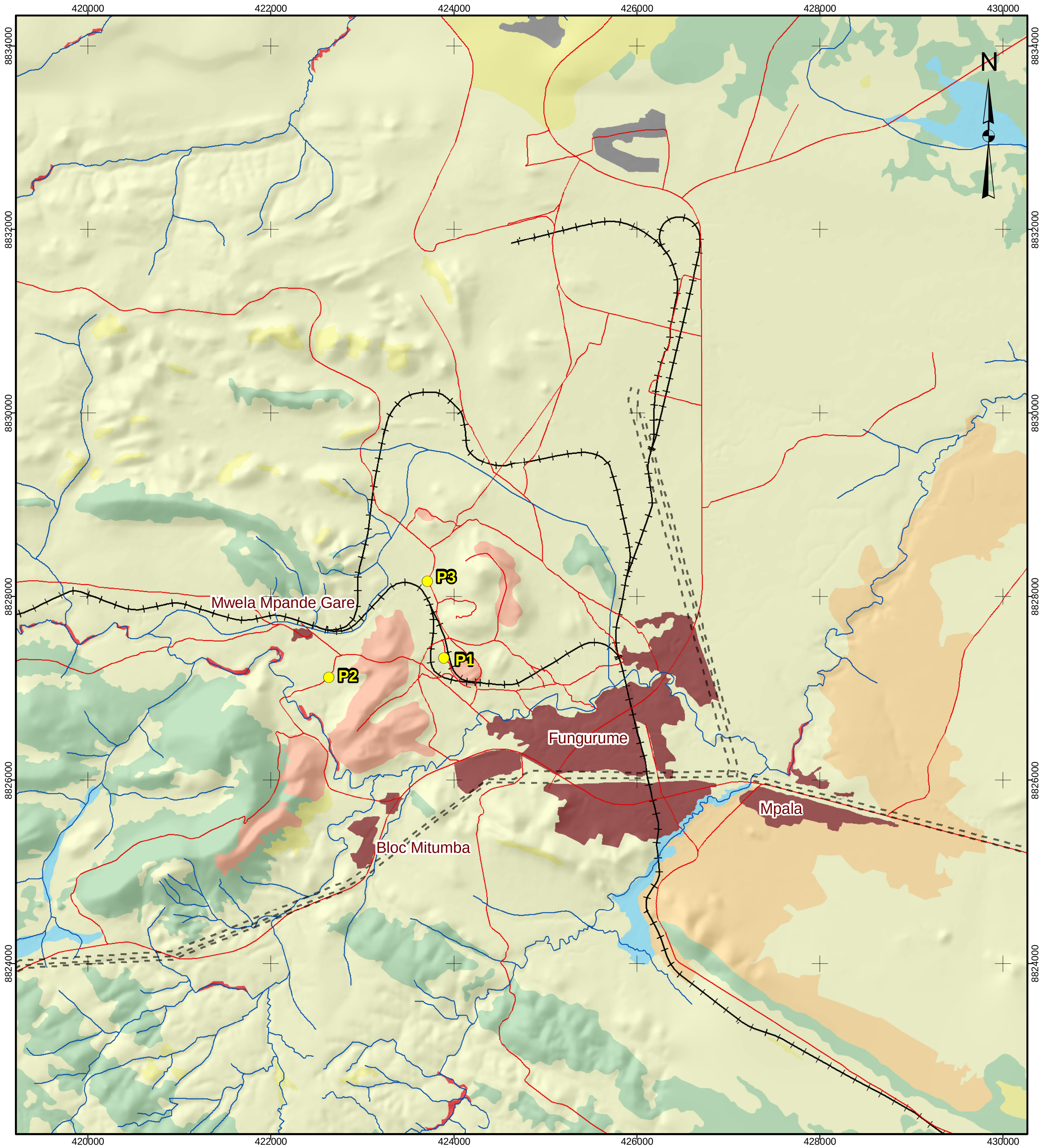
After several years of operation, the wisdom of opening a second route to the site (the southern route) will be studied, to provide a redundant route to the mine and processing plant and to provide a more direct and less traveled route for importation of reagents and export of products. This route may be desired at that stage, if population and traffic increases along the northern route increase the risks associated with using that route. Construction of both options was considered in the ESIA.

A3.13 WATER SOURCE

Raw water supply to the construction village will be from existing production wells (P1, P2 and P3) near Fungurume (Figure A3.13-1). These wells will be inspected and refurbished to provide reliable water sources. A new pipeline will be constructed from the existing 50-meter diameter concrete tank north of Fungurume, about one kilometer from the construction village. Water will flow under gravity from these tanks.

Water to be used for construction of the processing plant, tailings storage facility and for pre-stripping operations at the mine will be extracted from new groundwater wells, to be installed early in the construction campaign. Groundwater investigations in 2006 determined groundwater sources closer to Kwatebala. These wells will supply water for the mine and processing plant during mine operation. It is estimated that two to three wells will be required to produce the volume of water needed (current estimate of maximum demand is 12 megaliters per day).

The use of groundwater rather than surface water will have less impact on agricultural land and streams. An impoundment (reservoir) would be required for surface water due to low dry season flows.



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ÉCHELLE 1:60000 MÈTRES
SCALE 1:60000 METRES

LÉGENDE / LEGEND

- PUITS / BOREHOLES
- LIGNE DE TRANSPORT D'ÉNERGIE / POWER LINE
- RIVIÈRE / RIVER
- RIVIÈRE INTERMITTENTE / SEASONAL RIVER
- ROUTE / ROAD
- VOIE FERRÉE / RAILWAY

COUVERTURE VÉGÉTALE / UTILISATION DU TERRAIN / LANDCOVER

- STEPPE-SAVANE SUR SUBSTRAT CUPRO-COBALTIFÈRE / COPPER-COBALT STEPPE-SAVANNA
- FORÊT DE MIOMBO / MIOMBO WOODLAND
- FORÊT DE MIOMBO DÉGRADÉE / MIOMBO WOODLAND DEGRADED
- FORÊT GALERIE / GALLERY FOREST
- ZONE HUMIDE / WETLAND
- MOSAÏQUE AGRICOLE / AGRICULTURAL MOSAIC
- ANCIENNE JACHÈRE / OLD FALLOW FIELD
- PERTURBATION / DISTURBANCE
- ÉTABLISSEMENT HUMAIN / SETTLEMENT

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S / Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE / TITLE

PUITS P1 À P3 EXISTANTS PRÈS DE FUNGURUME /
EXISTING WATER WELLS P1 TO P3 NEAR FUNGURUME

Golder Associates
Calgary, Alberta

N° projet / project no. 05-1334-035.9000			Échelle telle qu'indiquée Scale as Shown	REV. 0
DESSIN / DESIGN	GJ	22 Jun. 2006	**FIGURE: A3.13-1**	
SIG / GIS	CW	02 Jan. 2007		
VÉRIFIÉ / CHECK	MR	31 Jul. 2006		
APPROUVÉ REVIEW	MR	31 Jul. 2006		

Project: I:\CLIENTS\PHELPS_DODGE\05-1334-035\mapping\mxd\Tenke_ESIA\Volume_A\FigureA3.13-1_ExistingWaterWells.mxd - Plot: I:\CLIENTS\PHELPS_DODGE\05-1334-035\mapping\mxd\Tenke_ESIA\Volume_A\FigureA3.13-1_ExistingWaterWells.pdf

A3.14 POWER SOURCE

Electrical power to the mine will be provided by a new 220-kilovolt overhead power line fed from the existing substation in Fungurume. Voltage will be stepped down to 33 kilovolts for the mine, and processing plant. Voltage will be stepped down to 15 kilovolts for powerlines to the tailings facility and borefields. The power lines will include overhead and/or buried cables. No polychlorinated biphenyl (PCB)-based oils will be used. An emergency diesel generator facility will be established at the processing plant site. Bulk fuel storage at the processing plant site will be refurbished and will hold sufficient fuel. The construction village, airstrip and limestone quarry will also be fed by 33-kilovolt power lines. This system will provide a sustainable form of energy for the TFM project.

The power described in the preceeding paragraph will be delivered in the form of an overhead 15 kilovolt power line to the tailings facility and borefields and an underground 33 kilovolt buried cable to the mine and plant. In total, the line will be approximately 13 kilometers in length and the right-of-way will be 150 meters wide. The entire line will be within the Local Study Areas for the applicable disciplines. No stand alone assessment was conducted or needed for the ESIA as its effects were considered in the overall project footprint and in the mitigation and monitoring programs outlined in the Environmental and Social Management System (ESMS). Thus, for example, the footprint of the power line right of way was included in the assessment of soils, flora, fauna, natural habitats and biodiversity. The ESMS provides Best Management Practices and other site specific mitigation that applies to all project disturbances, including those associated with land clearing, compensation for land users, erosion control, stream crossings and re-vegetation. Thus, no separate ESIA was needed for the power line.

A3.15 TRANSPORT OF RAW MATERIALS AND PRODUCT

A3.15.1 Introduction and Problem Statement

The prior analyses of alternatives considered location and type of facilities within the TFM concession. In this section, transport of raw materials into, and products out of, the concession are considered.

The main reagents that will be imported for the TFM project include:

- Sulfur (for the sulfuric acid manufacturing plant).
- Magnesium oxide (for cobalt purification).

- Lime as limestone (for pH adjustment and impurity precipitation).
- Diesel fuel (Table A3.15-1).

Table A3.15-1 Main Reagents/Imports and Products/Exports for the Project

Reagent or Product	Approx. Tonnes/Year
Main Reagents (Imports)	
sulfur	73,000
magnesium oxide	12,000
quick lime	40,000
diesel fuel	13,000
coagulant/diluent	1,100
Main Products (Exports)	
copper metal (cathode)	115,000
cobalt metal (cathode)	8,000
cobalt hydroxide	4,500

Limestone (about 90,000 tonnes per year) will be obtained from the quarry within the concession. As a result, limestone transport is not considered in this section.

The main products produced from the mine will be copper metal, cobalt metal and cobalt hydroxide. Sodium sulfate is a byproduct that may be disposed of on site or transported for sale.

Import and export of materials will require a coastal port. Transport of supplies and product between the mine and port will be by a combination of rail and road. The number of railcars or road trucks required for sulfur and lime (assuming 115,000 tonnes per year of copper product) is provided in Table A3.15-2. The size of the TFM project requires that rail be used for the transport of major bulk reagents. Road transport may be used for minor reagents.

Air transport is available to the concession airstrip for small to medium-sized aircraft. However, air transport will not be an economically viable option for the transport of raw materials or products for the project.

Table A3.15-2 Estimated Annual Material Transport Requirements During Operations

Material	Annual Average				Daily Average[(a)]						Origin	Mode of Transport	Backload Possible
	t	m^3	Containers	Tankers	t	m^3	34 t Trucks	40 t Rail Cars	Containers	Tankers			
sulfur	73,000	n/a	n/a	n/a	200	n/a	6	5	n/a	n/a	Richards Bay /Dar es Salaam	road / rail	yes
quicklime	40,000	n/a	n/a	n/a	108	n/a	3	n/a	n/a	n/a	Ndola	road only	yes
magnesia containers	12,000	n/a	559	n/a	n/a	n/a	n/a	n/a	2	n/a	Durban	road only	no
coagulant / diluent tankers	1,100	1,229	n/a	41	n/a	3	n/a	n/a	n/a	<1	Durban	road only	no
fuel tankers	13,000	16,451	n/a	548	n/a	45	n/a	n/a	n/a	2	Ndola / Dar es Salaam	road only	no
copper metal	115,000	n/a	n/a	n/a	315	n/a	9	8	n/a	n/a	Tenke	road / rail	yes
cobalt metal	8,000	n/a	n/a	n/a	22	n/a	1	n/a	n/a	n/a	Tenke	road only	yes
cobalt hydroxide	4,500	n/a	n/a	n/a	12	n/a	<1	n/a	n/a	n/a	Tenke	road only	yes

Rail will be the principal means of transport for supplies and products for the major portion of the distance. However, it will be necessary to transport almost all goods to the project site by road for some portion of the journey. The current condition of the DRC rail system is not considered dependable for regular rail service. As a result, road transport will be required for at least the portion of the route from Ndola, Zambia or Lubumbashi, DRC to the mine site. In addition, some materials will probably be transported from the port of origin to the mine site by road.

Roads are surfaced with tarmac (asphalt) on all road routes for the entire distance, except for the last stretch between Likasi and Fungurume, which is of murram or compacted laterite. At present, during the rainy season, this section of road is affected by passage of heavy traffic and prone to washouts as a result of flooding. For all road transport, trucks capable of handling standard containers will be used. Equipment and supplies sourced within the DRC will be transported by road.

Sulfur will be shipped in bulk from a coastal port by rail to a dry port, bagged at the dry port, then shipped by road to the mine site. Magnesium oxide, lime, coagulant/diluent, fuel and other reagents will be shipped by road only. Bulk sulfur and magnesium oxide will be transported in International Organization for Standardization (ISO) standard freight containers, which will be adapted to allow for easy handling, loading and unloading.

Containers for transportation of sulfur will be smooth-sided and lined with non-ferrous material. This will be done to prevent contact between sulfur and steel, which can cause corrosion and ignition of the sulfur. Containers will be equipped with top-loading hatches, which will allow emergency access if required. Containers will be modified to incorporate ventilation measures to effectively disperse evolved concentrations of hydrogen sulfide (H_2S). The formed sulfur planned for use by the TFM project has lower concentration of hydrogen sulfide than other forms. Containers will be equipped with open roof vents to allow free passage of air.

Fuel will be transported in tanker wagons. The diesel fuel used will have a low sulfur content.

Copper sheets will be strapped together in bundles, then placed on pallets and loaded onto flatbed trucks or ISO containers to be transported by road to a rail transfer point. Copper metal will be back-hauled using the same transportation vehicles that were used to bring the sulfur to the mine site. Cobalt metal will be produced in the form of chips and will be placed in sealed drums. Cobalt hydroxide will be transported in bulk bags. Cobalt metal and cobalt hydroxide will be placed on pallets and shipped by road under special security, as rail transport would pose greater security risks for these products. Cobalt hydroxide is considered a hazardous material.

The problem statement for the transportation of raw materials and products is:

> What is the preferred route for the transportation of raw materials and products to and from the concession?

Musts for the off-site (Table 7, Appendix A-IV) transportation route include:

- Rail transport will be organized and managed by a rail company, who will make all arrangements for passage of block trains through several African countries. The railway company will source all rolling stock for TFM, and will provide locomotives for block trains. These block trains will remain together with their locomotives throughout their journey through several national rail systems (i.e., no splitting and shunting of stock or changing of locomotives will take place).
- Use of modified ISO standard containers to allow for both bulk material import and finished product export (i.e., allows for back-hauling).
- Flexibility must be maintained. Flexibility in transportation routing and methods is required due to the extreme transport distances, the number of international borders that must be crossed, and the condition of some of the infrastructure. This makes it likely that environmental or social pressures could make any of them unusable at any time.
- Ports must have modern handling and storage facilities, experience of bulk sulfur importation and good rail links. Ports must not require construction of further infrastructure.
- All road transport will be handled by carriage and forwarding agents, who will employ national and regional carriers in the countries being traversed.

This analysis presents a high-level comparison of main routes. It has been conducted without knowledge of final product destinations; therefore it is assumed that all products have a common, but unknown destination.

A3.15.2 Issues (Wants)

The following wants for the off-site transportation route were identified and ranked as indicated below.

Environmental

- Effects on air quality from emissions should be minimized. The amount of emissions is related to route length. Air quality effects can be mitigated (4).
- Transport routes should avoid environmentally sensitive areas as much as possible (e.g., national parks, protected areas, major rivers, major wetlands, etc.) (6).

Social

- Impacts to public safety should be minimized. Many people use railways and roads as footpaths. Longer routes may provide more potential for impacts to public safety. The route should minimize the number of cities or villages that it passes through or near (10).

Technical

- Required route upgrades or improvements to existing routes should be minimized (10).
- The number of border crossings should be minimized (5).
- Security of cargo (i.e., from theft) should be maximized (5).

Sustainability

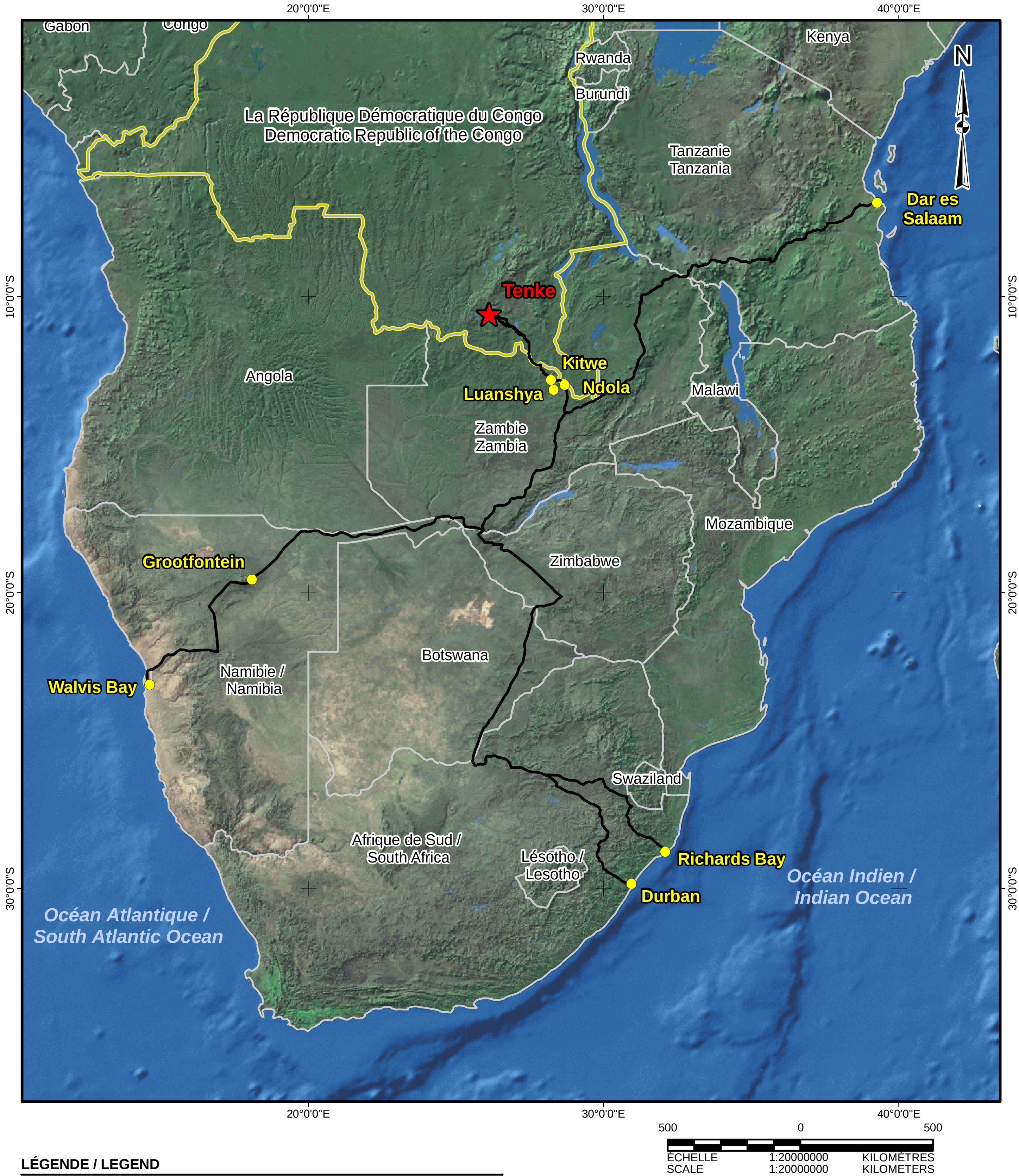
- Transport routes that result in lower energy use are preferred. Relative energy use is related to route length (3).

A3.15.3 Alternatives Considered

A survey of the available ports indicated that the following are usable and meet the requirements outlined for musts:

- Dar es Salaam, Tanzania.
- Richards Bay, South Africa.
- Durban, South Africa.
- Walvis Bay, Namibia.

The route options are indicated in Figure A3.15-1. These routes do not require additional construction, expansion or other development specifically for the project outside of the immediate project area. Specifically, it is important to note that no construction will occur along transport routes through any internationally recognized protected areas.



LÉGENDE / LEGEND

- VILLE PRINCIPALE / MAJOR CITY
- TENKE
- ROUTES DE TRANSPORT / TRANSPORTATION ROUTE
- PAYS / COUNTRY
- LA RÉPUBLIQUE DÉMOCRATIQUE DU CONGO / DEMOCRATIC REPUBLIC OF THE CONGO

RÉFÉRENCE / REFERENCE

Les images, l'emplacement des villes et les frontières nationales ont été obtenus sous licence de ESRI.
Image data, city locations and country boundaries obtained from ESRI used under license. Projection: Mercator transverse. Système géodésique: WGS 84 Système de coordonnées: UTM Zone 35S
Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE
TITLE

OPTION POUR LES CHEMINS DU TRANSPORT DES RÉACTIFS ET DES PRODUITS / ROUTE OPTIONS FOR TRANSPORTATION OF REAGENTS AND PRODUCTS

Golder Associates
Calgary, Alberta

N° projet / project no. 05-1334-035.9300			Échelle telle qu'indiquée Scale as Shown	REV. 0
DESSIN / DESIGN	LB	16 Mar. 2005	**FIGURE: A3.15-1**	
SIG / GIS	CW	02 Jan. 2007		
VÉRIFIÉ / CHECK	MR	13 Jul. 2006		
APPROUVÉ REVIEW	MR	13 Jul. 2006		

Project I:\CLIENTS\PHELPS_DODGE\05-1334-035\mapping\mxd\Tenke_ESIA\Volume_A\FigureA3.15-1_OffsiteTransportationRoutes.mxd - Plot I:\CLIENTS\PHELPS_DODGE\05-1334-035\mapping\pdf\Tenke_ESIA\Volume_A\FigureA3.15-1_OffsiteTransportationRoutes.pdf

Option 1 – Fungurume/Dar es Salaam

Route option 1 (Fungurume to Dar es Salaam, Tanzania) includes the southwest DRC, northeast Zambia and southern part of Tanzania. This route is about 2,100 kilometers in length and includes two border crossings (Table A3.15-3). Three major protected areas occur adjacent to this route. Rail lines in Tanzania are already under full capacity.

Table A3.15-3 Characteristics of the Alternative Transport Routes

Alternative	Distance (km)	Border Crossings	Major Protected Areas [a]	Options Available
1. Dar es Salaam	2,100	2	3	rail, road
2. Richards Bay	3,200	4	5	rail, road
3. Durban	3,400	4	4	rail, road
4. Walvis Bay	2,400	2	4	rail or road from Walvis Bay to Grootfontein; road only from Grootfontein to Tenke

[a] Includes National Parks/Reserves, World Heritage Sites and Biosphere Reserves.

Option 2 – Fungurume/Richards Bay or Durban

The Richards Bay and Durban routes (option 2) are analyzed as one route because they follow the same route between Tenke and Johannesburg, then diverge for about 600 kilometers. The route includes DRC, Zambia, Zimbabwe, Botswana and South Africa. Route option 2 is about 3,200 (Richards Bay) to 3,400 (Durban) kilometers in length, with four border crossings. The Richards Bay route crosses a total of five major protected areas, while the Durban route crosses four. The rail infrastructure in South Africa currently has a larger availability of locomotives and railcars than does Tanzania.

Option 3 – Fungurume/Walvis Bay

Route option 3 (Fungurume to Walvis Bay, Namibia) is about 2,400 kilometers and involves two border crossings. It travels along the northern part of Namibia, from Walvis Bay to Grootfontein via Swakopmund. It then follows the narrow arm of the country north of Botswana (Caprivi Strip) to Sesheke, then on to Livingstone (Zambia). This route crosses four major protected areas.

The Walvis Bay route currently has a rail corridor to Grootfontein only. This route will be more expensive for reagents and product exports as cargo has to be transferred from rail to road at Grootfontein, then road hauled from Grootfontein to Fungurume via Lubumbashi. Should both product exports and reagent imports be routed via Walvis Bay the cost will be reduced as there will be return loads.

Development of a rail corridor to Zambia is being investigated. Walvis Bay is more convenient for deliveries to the West (i.e., the United States and Western Europe) because it is closer than Richards Bay and delivery time would be shorter. However, final product destinations are not known at this point. The route for option 3 is in good condition.

All rail routes have in common the route from Fungurume to Lubumbashi. Rail lines and rolling stock are in a bad state of repair in this section. This is a single rail line with a restriction of 14 railcars per diesel locomotive and 17 railcars per electric locomotive (40 tonnes per railcar). The maximum mass permitted in the DRC is 15 tonnes per train axle. Trains are limited to a speed of about 25 kilometers per hour due to the poor condition of the rail line, level crossings and lack of maintenance of the ballast, sleepers and associated equipment.

Road routes from Lubumbashi to Likasi follow National Road Number 1. From Likasi to Fungurume trucks would travel a gated private road via the Kakanda Mine.

A3.15.4 Evaluation of Alternatives

Results of analysis of the three transportation route options for main reagents and products are summarized in Table A3.15-4.

Table A3.15-4 Summary of Scoring for the Alternative Off-Site Transport Routes

Alternative	Weighted Score (Rank)	Normalized for Equal Weight by Environmental, Social and Technical (Rank)	Normalized for Environmental (.3), Social (.3), Technical (.2) and Sustainability (.2) (Rank)
1. Dar es Salaam	331 (1)	318 (1)	367 (1)
2. Richards Bay/Durban	212 (3)	179 (3)	190 (3)
3. Walvis Bay	260 (2)	254 (2)	304 (2)

Route option 1 (Fungurume to Dar es Salaam) ranked first using the simple weighted score, followed by option 3 (Fungurume to Walvis Bay) and option 2 (Fungurume to Richards Bay or Durban). The same ranking pattern held true for both sensitivity analyses.

The reasons for the higher ranking of option 1 are largely related to route length. With the shortest of the three routes, this option is likely to result in fewer air quality effects from emissions, impact fewer sensitive areas, have less risk to public safety, and incur less cost for route upgrades. It also has few border crossings, which will reduce delays en route. Sustainability scores have little bearing on the overall scores. Sustainability scores are also related to route length, as relatively more energy would be used as route length increased.

A3.15.5 Evaluation of Adverse Consequences

Option 1 – Fungurume/Dar es Salaam (Tanzania)

An adverse consequence for option 1 would be if insufficient rail locomotives and railcars are available to transport the reagents and products (Table A3.15-5). This consequence was given a low probability because contracts will be sought with the relevant railways to allocate specific locomotives to TFM on a long-term basis. If these contracts cannot be secured, and/or existing locomotives cannot be repaired, the severity of this consequence would be moderate to high.

Table A3.15-5 Potential for Adverse Consequences for the Alternative Transport Routes

Alternative	Consequence	Probability	Severity
1. Dar es Salaam	insufficient availability of locomotives and rail cars	low	moderate to high
2. Richards Bay/Durban	insufficient availability of locomotives and rail cars	low	moderate to high
3. Walvis Bay	insufficient availability of locomotives and rail cars	low	moderate to high
	lack of rail line between Grootfontein and DRC makes cost prohibitive	high	high

Option 2 – Fungurume/Richards Bay or Durban

An adverse consequence for option 2 would be if insufficient rail locomotives and railcars are available to transport the reagents and products. This consequence was given a low probability because contracts will be sought with the relevant railways to allocate specific locomotives to TFM on a long-term basis. If these contracts cannot be secured, and/or existing locomotives cannot be repaired, the severity of this consequence would be moderate to high.

Option 3 – Fungurume/Walvis Bay (Namibia)

Similar to options 1 and 2, an adverse consequence for option 3 would be if insufficient rail locomotives and railcars are available to transport the reagents and products. This consequence was given a low probability because contracts will be sought with the relevant railways to allocate specific locomotives to TFM on a long-term basis. If these contracts cannot be secured, and/or existing locomotives cannot be repaired, the severity of this consequence would be moderate to high.

A3.15.6 Preferred Alternative

The analysis of alternatives for the transport of reagents and products indicates that the preferred alternative is option 1, Fungurume to Dar es Salaam. The adverse consequence related to cost makes the Walvis Bay route a poor choice, even though it ranked higher than the Richards Bay/Durban option. However, all three options are acceptable from consideration of environmental, social and technical factors. Once final product destinations are known, preferred options may change, and may also depend on the particular product. In reality, transport routes are likely to remain flexible based on local conditions and availability of locomotives and railcars.

A3.16 NO PROJECT ALTERNATIVE

A3.16.1 Introduction and Problem Statement

The prior analyses of alternatives all assumed that implementation of the TFM project would occur. International standards also require that the need for the project be assessed in what is termed a "no project alternative".

The problem statement for the no project alternative is:

> Will the overall benefits of the project outweigh the overall negatives so that the no project alternative can be rejected?

A3.16.2 Issues (Wants)

The following wants for the no project alternative were identified and ranked as indicated below (Table 8, Appendix A-IV).

Environmental

- Air quality (effects of emissions, dust) should meet DRC and international standards (10).
- Noise levels should meet DRC and international standards (10).
- Groundwater quantity must be adequate to meet needs (7).

- Groundwater quality impacts (e.g., effects due to spills, urban pollution) should be minimized. Groundwater quality is influenced by nearby land uses (7).
- Surface water quantity impacts from nearby land uses (e.g., diversion of streams) should be minimized. This is related to the number and types of existing drainages (7).
- Surface water quality effects from nearby land uses (e.g., spills, dust at creek crossings, release of wastewater) should be minimized. Spills and dust can be mitigated (7).
- Effects on natural habitats (loss or alteration of sensitive habitats such as miombo woodland, riparian, wetlands, copper-cobalt flora) should be minimized. Copper-cobalt flora is a key issue (8).
- Effects on biodiversity due to loss of terrestrial or aquatic biodiversity should be minimized (8).

Social

- Economic impacts at the national level should occur (e.g., royalties, Gécamines involvement) (10).
- Farmland is important to local residents. Loss of agricultural land should be minimized. Much of the existing farmland is of poor soil quality (10).
- Resettlement of people due to air or noise emissions or loss of agricultural land is undesirable (9).
- Where there is an influx of people into an area there will be increased costs associated with providing services (10).
- Economic impacts should go to local people and communities. Opportunities for employment, training, and education are beneficial (10).
- Public safety factors should be minimized. This includes traffic-human interactions and spread of illness and disease (6).
- Visual aesthetics are important to some people. Activities which cause changes in the landscape can have visual effects (4).
- Cultural heritage should not be lost. Cultural heritage sites in the Kwatebala/Goma area are few and can be mitigated (2).

Technical

- Transportation infrastructure such as roads and rail lines are important to the economy of the DRC. Currently, many road and rail routes are in poor condition (10).

- Introduction of better mining methods and mitigation is desirable (10).
- Border crossings have an effect on the economy. Currently there are long waits at some border crossings, which increase the cost of importing and exporting goods (6).

Sustainability

- Opportunities for small business development should be available (10).
- Development of a mine by an international company will have positive impact on development in DRC, e.g., development by other companies will follow (5).

A3.16.3 Alternatives Considered

Option 1 – Project

The TFM project is expected to result in the production of 115,000 tonnes of copper, 8,000 tonnes of cobalt and 2,000 tonnes of cobalt as hydroxide intermediate per year. Currently, the DRC produces about 30,000 tonnes of copper per year, compared to about 480,000 tonnes in 1986. Similarly, cobalt production has fallen from over 14,000 tonnes in 1986 to 6,000 tonnes in 1996. The estimated total project capital investment during the construction phase will be about 643 million USD. Of this, about 75 million USD will be spent in the DRC. The estimated spending during operations will be significant, of which approximately 40 percent will be spent in the DRC. Taxation over the life of the project will also be significant and will be allocated to local, regional and national governments. The TFM project will employ up to about 2,000 people during construction and up to about 1,100 people during operations.

Option 2 – No Project

The TFM project will not be constructed if the no project alternative is implemented. As a result, the beneficial and adverse impacts associated with construction and operation of the project will not occur. The existing environmental and socio-economic conditions within the project area will continue.

A3.16.4 Evaluation of Alternatives

The two alternatives (project versus no project) considered in the analysis are compared in Table A3.16-1.

Table A3.16-1 Summary of Scoring for the Project Versus No Project Alternative

Alternative	Weighted Score (Rank)	Normalized for Equal Weight by Environmental, Social and Technical (Rank)	Normalized for Environmental (.3), Social (.3), Technical (.2) and Sustainability (.2) (Rank)
1. project	919 (1)	918 (1)	1,074 (1)
2. no project	631(2)	525 (2)	536 (2)

Results of the analyses indicate that the implementation of the project is preferred over the no project alternative. The project alternative scored highest in the simple weighted method, as well as in the two sensitivity analyses.

Overall, the project alternative scored lower than the no project alternative for the environmental criteria. Most environmental effects can be minimized, and few are likely to be significant (Section C5). However, air quality effects (e.g., dust and emissions) will not be met for some communities (e.g., Mulumbu, Amoni and Kiboko) and these communities will have to be relocated.

The project alternative scored highest for social, technical and sustainability criteria. The beneficial social and economic impacts of the project are expected to be quite significant, from the local to national levels. These far outweigh the potential negative social impacts, such as relocation of households or communities, and increase public safety and health concerns. The project scored much higher on technical criteria than the no project alternative did. This is due to the expected benefits of improved transportation routes throughout the country and beyond, improved border crossings on transportation routes, and the introduction of better mining and mitigation methods. The project alternative also scored much higher on sustainability criteria. This is due to the increased potential for small business development and the positive impacts resulting from involvement of an international mining company.

Differences in the scores were more evident using the sensitivity analyses. This result would be expected since most of the beneficial effects of the project would be related to socio-economic and sustainability issues and since most of the adverse effects would be related to environmental factors. Environmental factors are not as important in the analysis, as most environmental effects can be minimized. Although some adverse environmental effects may remain after mitigation, few are likely to be significant. Significant social and economic benefits are expected to be realized as a result of the project.

Implementation of the no project alternative would mean that neither adverse nor beneficial effects would occur. Without the project other means to improve social and economic conditions would be needed. The beneficial impacts of increased employment opportunities, job training, education in work practices (e.g., worker safety), infrastructure improvements and increased revenues to local communities as well as to the region and country as a whole will not be realized. Overall, the potential beneficial effects of the project far outweigh the adverse effects. As a result, the no project alternative can be rejected.

A3.16.5 Evaluation of Adverse Consequences

Adverse consequences related to the project and no project alternatives are summarized in Table A3.16-2.

Table A3.16-2 Potential for Adverse Consequences for the Project Versus No Project Alternatives

Alternative	Consequence	Probability	Severity
1. project	refusal of residents to relocate	low	high
2. no project	road and rail lines will remain in poor condition	high	moderate
	social benefits not realized	high	high
	economic benefits not realized	high	high

Adverse consequences related to carrying out the project include the refusal of residents to relocate. This consequence has a low probability, but a high severity. If the project is not carried out, adverse consequences include that both road and rail lines will remain in poor condition and that both social and economic benefits will not be realized. All of these consequences are considered to have a high probability. The severity of the first consequence would be moderate. The severity of not realizing social and economic benefits would be high.

A3.16.6 Preferred Alternative

The project alternative is preferred over the no project alternative.

A4 PROJECT DESCRIPTION

A4.1 INTRODUCTION

The Feasibility Study (FS) envisages that the primary exploitation of the project will be by open pit methods, extracting oxide ores containing copper and cobalt (Minproc 2007). The project under consideration will produce an annual output of around 115,000 metric tonnes (tonnes) of copper metal and around 10,000 tonnes of cobalt; of which up to 8,000 tonnes per year of the cobalt may be produced as metal with the balance being dried cobalt hydroxide. Conversely, up to 8,000 tonnes per year of the cobalt may be produced as dried hydroxide with the balance being metal. Processing of the ore will be by grinding, milling, and acid leaching followed by solution extraction and electrowinning (SX/EW) of copper and cobalt. This first phase of operations will have a mine life in excess of 20 years. However, there is the potential to mine mixed oxide and sulfide ores for many additional years.

The project is currently envisaged to be developed in a series of stages:

- Kwatebala pit, beginning in 2008. This is assessed fully in this ESIA.
- Goma and Fwaulu pits, beginning in 2017. These are assessed in this ESIA for disciplines where data was available, but are primarily assessed in the cumulative effects section.

The scope for the current ESIA is to fully assess development of the ore body at Kwatebala, and to postpone a detailed assessment of development of the Goma and Fwaulu ore bodies until prior to their development 10 years or more hence. This overall approach exceeds the requirements of an ESIA for a long-lived mining project. Notably, the current ESIA assesses all of the needed infrastructure to develop all three pits (i.e., the tailings storage facility, processing plant, haul roads, and Kwatebala waste rock and low grade ore stockpiles all assume full development of all pits and are assessed in the current ESIA). The only aspects not currently covered are the Goma and Fwaulu pits, and the Goma waste rock stockpile.

This strategy has been employed due to:

- Prioritization on the development of mine plans for the Kwatebala ore body over the Goma and Fwaulu mine plans.
- A lack of groundwater, geochemistry and surface water hydrological data for the Goma and Fwaulu ore bodies.

- The knowledge that Goma and Fwaulu mine plans may change over the next 10 years.

The ESIA, however, does assess the Goma and Fwaulu pits for those disciplines where information was available (e.g., flora, fauna, socio-economics, etc.). It also assesses the cumulative effects for all disciplines of all three pits. This was done so that the future potential effects of mining the Goma and Fwualu (and other) pits could be screened for their likely effects and any potentially significant issues for the project.

If the economics of this first phase of exploitation are favorable, plans for expansion of the mining and processing facilities will be developed. Production may eventually reach or exceed 400,000 tonnes of copper metal per year through mining of the Fungurume hills and others. These future expansions will be the subject of future feasibility and environmental studies, but preliminary assessments of the potentially significant impacts of these future expansions within the concession are addressed as a component of the cumulative impact sections (Volume C) of this ESIA.

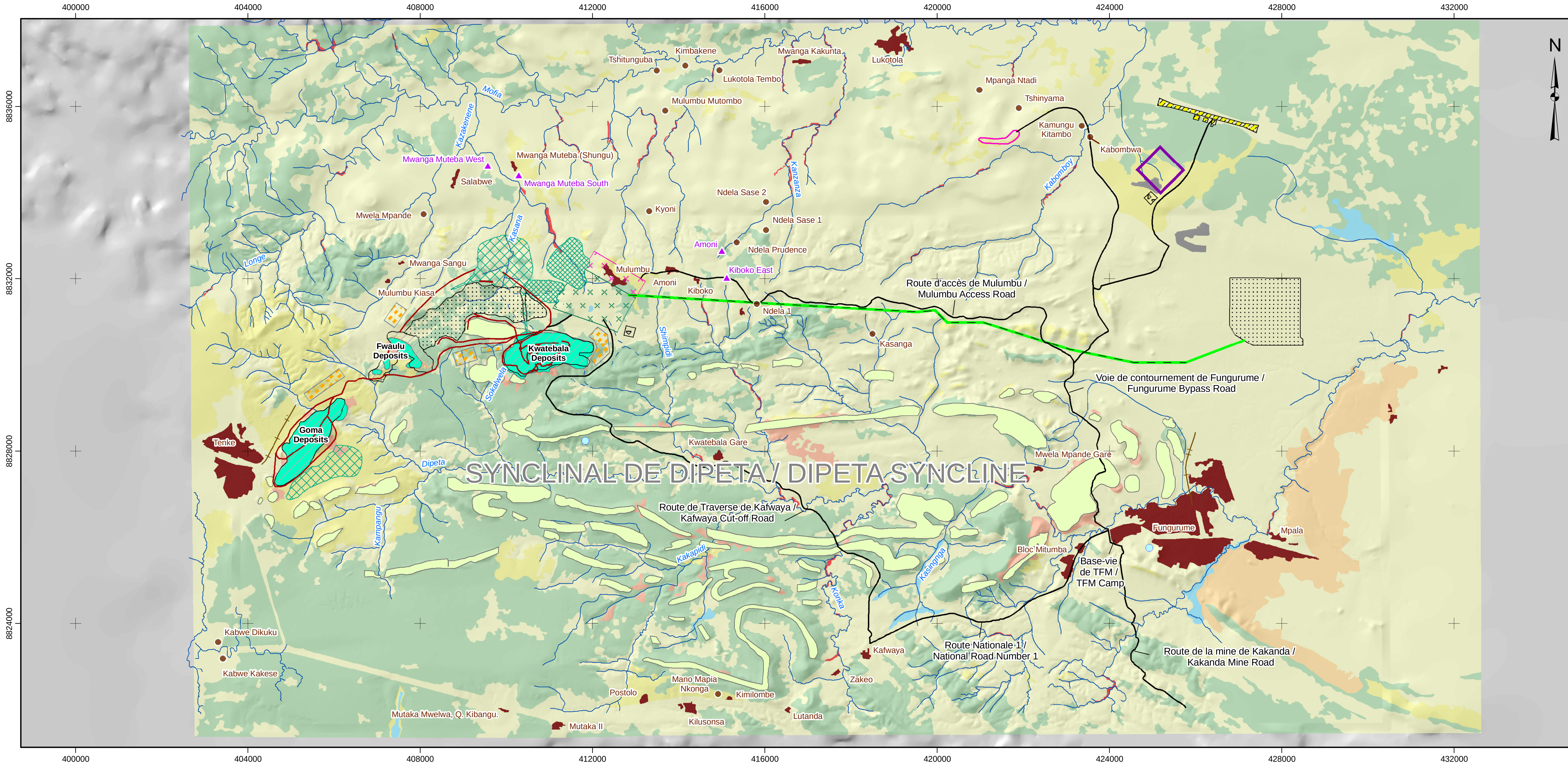
In the sections that follow, TFM's plans for developing and operating the project are described. The descriptions and detail which follow represent the design of the project as presented in the FS (Minproc 2007). While these components constitute a feasible combination of development and operating strategies, variations to the plans and details presented will inevitably occur as the project progresses. Minor variations to project plans would not be expected to change the outcome and conclusions of this ESIA.

A4.1.1 Project Setting

The TFM concession area is described in Section A1 and the Tenke Fungurume deposits are shown in Figure A1.1-1.

A4.1.1.1 Location

The ore bodies, proposed project footprint and mine infrastructure are shown in Figure A4.1-1. Topography of the project area is described in Section B2.1. During the first phase of mining, TFM proposes mining of the Kwatebala ore body in the concession area with the start of mining of the Goma ore body planned for 2017 and the start of mining of the Kavifwafwaulu (Fwaulu) ore body planned for 2020. A mineral processing plant will be constructed near these ore bodies. The nearest villages to the Kwatebala ore body are Mulumbu, Amoni and Kiboko. Following detailed noise and air quality studies, it was determined that these three villages would have to be relocated to avoid unacceptable noise and air quality impacts. The Goma ore body is situated just outside the Tenke Gare side of Tenke.



LÉGENDE / LEGEND

- VILLAGE
- RELOCATION SITE
- RIVIÈRE / RIVER
- RIVIÈRE INTERMITTENTE / SEASONAL RIVER
- FUTURE ZONE D'EXPLOITATION MINIÈRE / ZONE TO BE MINED
- ZONE MINÉRALISÉE / MINERALIZED ZONE

COMPOSANTES DU PROJET / PROJECT COMPONENTS

- BANC D'EMPRUNT / BORROW PIT
- CHEMINS DE ROULAGE/ HAUL ROAD
- LIGNE DE TRANSPORT D'ÉNERGIE / POWER LINE
- PIPELINE / PIPELINE
- ROUTE / ROAD
- VOIE D'ÉVITEMENT / RAILWAY SIDING
- AÉROPORT / AIRFIELD
- CARRIÈRE / QUARRY
- CLÔTURE / FENCE
- FOSSE DE LA MINE / MINE PIT
- LIMITES DE L'IMPLANTATION FUTURE / FUTURE EXPANSION BOUNDARY
- LIMITES DE L'USINE (ÉTAPE DE CONCEPTION) / PLANT DESIGN BOUNDARY
- PARC À RÉSIDUS / TAILINGS STORAGE FACILITY
- PILE DE STOCKAGE - SOL / STOCK PILE - SOIL
- SITE D'ENFOUISSEMENT / LANDFILL
- STÉRILES / WASTE ROCK
- MINERAI À FAIBLE TENEUR SUR STÉRILES / LOW GRADE ORE ON WASTE ROCK
- VILLAGE PERMANENT / PERMANENT VILLAGE

COUVERTURE VÉGÉTALE / UTILISATION DU TERRAIN / LANDCOVER

- AFFLEUREMENT ROCHEUX DE MINERAI CUIVRE-COBALT - COMPLEXE EXPLOITÉ PAR L'ACTIVITÉ MINIÈRE ARTISANALE / COPPER-COBALT ROCK OUTCROP - ARTISANAL MINING COMPLEX
- STEPPE-SAVANE SUR SUBSTRAT CUPRO-COBALTIFÈRE / COPPER-COBALT STEPPE-SAVANNA
- FORÊT DE MIOMBO / MIOMBO WOODLAND
- FORÊT DE MIOMBO DÉGRADÉE / MIOMBO WOODLAND DEGRADED
- FORÊT GALERIE / GALLERY FOREST
- ZONE HUMIDE / WETLAND
- MOSAÏQUE AGRICOLE / AGRICULTURAL MOSAIC
- ANCIENNE JACHÈRE / OLD FALLOW FIELD
- AÉROPORT / AIRFIELD
- PERTURBATION / DISTURBANCE
- ÉTABLISSEMENT HUMAIN / SETTLEMENT

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S / Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

3 0 3

ÉCHELLE 1:90000 KILOMÈTRES

SCALE 1:90000 KILOMETERS

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE / TITLE

GISEMENTS, EMPREINTE DU PROJET PROPOSÉ ET INFRASTRUCTURE DE LA MINE / ORE BODIES, PROPOSED PROJECT FOOTPRINT AND MINE INFRASTRUCTURE

Golder Associates
Calgary, Alberta

N° PROJET / PROJECT NO. 05-1334-035		ÉCHELLE TELLE QU'INDIQUÉE SCALE AS SHOWN	REV. 0
DESSIN / DESIGN	RT	10 Jul. 2006	
GIS / SIG	CW	02 Jan. 2007	
VÉRIFIÉ / CHECK	MR	19 Oct. 2006	
APPROUVÉ REVIEW	MR	19 Oct. 2006	

FIGURE: A4.1-1

A4.1.1.2 Access and Infrastructure

The concession lies astride the corridors of the principal railway in Katanga province, the main Lubumbashi to Kolwezi road (National Road Number 1), and a major powerline, all of which run east-west between Fungurume and Tenke. These are shown in Figure A4.1-2, which displays the current geography and infrastructure of the mine area.

The electrified railway, run by the Societé Nationale des Chemins de fer du Congo (SNCC), runs from Lubumbashi through Likasi and Fungurume to a major junction at Tenke, which lies on a principal catchment in the Congo River catchment. SNCC also runs diesel locomotives on this rail line. At Tenke, the single track divides with one line heading north to Kamina and the other west to Kolwezi and eventually to Benguela in Angola. Tenke consequently has the typical characteristics of a former colonial railway town, including a station building and a sizable marshaling yard, and both Tenke and Fungurume are the sites of railway workers camps. A minor halt and siding are located at Kwatebala Gare. Trains pass through Fungurume at the rate of around three per week in each direction.

The principal road from Lubumbashi to Kolwezi follows the general route of the powerline for much of its length, passing through Likasi and Fungurume. The road runs east-west through the southern portion of the concession, passing to the south of Tenke and then westwards to Kolwezi. The majority of this road is in severe disrepair, with essentially no asphalt surface existing between Likasi and Kolwezi. Nearer Likasi the condition of the road improves somewhat, and between Likasi and Lubumbashi it consists of two lanes of asphalt in potholed but reasonable condition.

Other roads in the area are generally surfaced with lateritic rock, extracted from local sources, and infrequently maintained and often overgrown. The majority of these roads are passable only with difficulty during the rainy season. An asphalt road in reasonable condition runs north from Fungurume to the mine's airstrip.

The major 220 and 120 kilovolt powerlines carrying electrical power from hydroelectric power plants on the Congo River to Zambia share the road corridor throughout its passage through the concession. A 150 meter-wide swath has been cleared of trees and other obstructions for these powerlines.

An airstrip, which was resurfaced for use by the mine in the late 1990s, is located about nine kilometers north of Fungurume.

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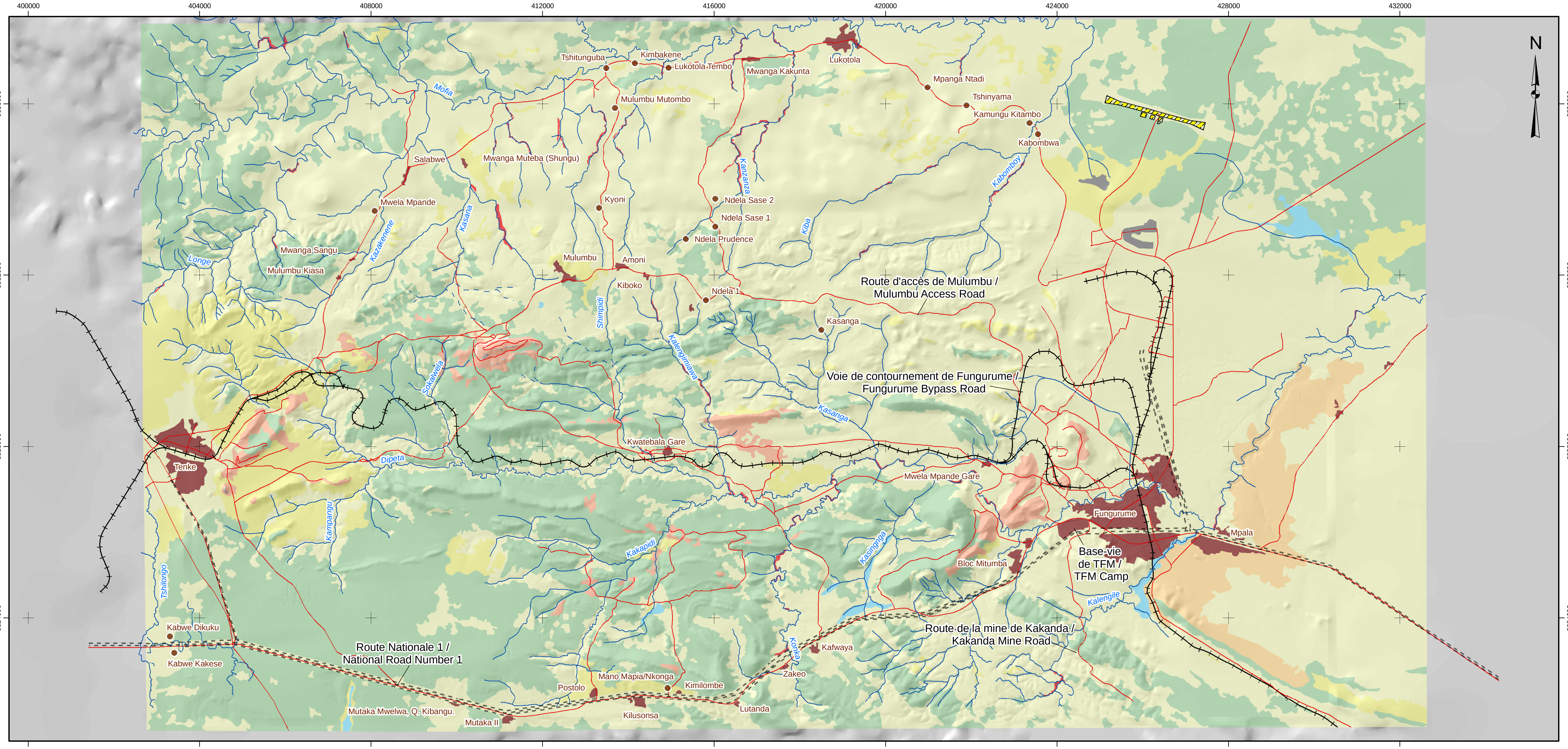

LÉGENDE / LEGEND

- VILLAGE
- LIGNE DE TRANSPORT D'ÉNERGIE / POWER LINE
- RIVIÈRE / RIVER
- RIVIÈRE INTERMITTENTE / SEASONAL RIVER
- ROUTE / ROAD
- VOIE FERRÉE / RAILWAY
- AÉROPORT / AIRFIELD

COUVERTURE VÉGÉTALE / UTILISATION DU TERRAIN / LANDCOVER

- AFFLEUREMENT ROCHEUX DE MINERAI CUIVRE-COBALT - COMPLEXE EXPLOITÉ PAR L'ACTIVITÉ MINIÈRE ARTISANALE / COPPER-COBALT ROCK OUTCROP - ARTISANAL MINING COMPLEX
- STEPPE-SAVANE SUR SUBSTRAT CUPRO-COBALTIFÈRE / COPPER-COBALT STEPPE-SAVANNA
- FORÊT DE MIOMBO / MIOMBO WOODLAND
- FORÊT DE MIOMBO DÉGRADÉE / MIOMBO WOODLAND DEGRADED
- FORÊT GALERIE / GALLERY FOREST
- ZONE HUMIDE / WETLAND
- MOSAÏQUE AGRICOLE / AGRICULTURAL MOSAIC
- ANCIENNE JACHÈRE / OLD FALLOW FIELD
- AÉROPORT / AIRFIELD
- PERTURBATION / DISTURBANCE
- ÉTABLISSEMENT HUMAIN / SETTLEMENT

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S / Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

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ÉCHELLE 1:90000 KILOMÈTRES

SCALE 1:90000 KILOMETERS

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE / TITLE

OCCUPATION ACTUELLE DU SOL, GÉOGRAPHIE ET INFRASTRUCTURE RÉGIONALE / CURRENT LAND USE, GEOGRAPHY AND REGIONAL INFRASTRUCTURE

Golder Associates
Calgary, Alberta

N° PROJET / PROJECT NO. 05-1334-035		ÉCHELLE TELLE QU'INDIQUÉE SCALE AS SHOWN	REV. 0
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GIS / SIG	CW	02 Jan. 2007	
VÉRIFIÉ / CHECK	MR	31 Jul. 2006	
APPROUVÉ REVIEW	MR	31 Jul. 2006	

FIGURE: A4.1-2

A4.1.1.3 Historical Perspective

The Tenke Fungurume prospect was first explored in 1917 and drilled in 1918. But until SX/EW technology was developed in the 1970s the mineralogy of the deposits did not permit economic extraction of copper and cobalt. Full-scale exploration of the Tenke Fungurume deposits was undertaken by Société Minière de Tenke Fungurume (SMTF) and Gécamines in the early 1970s, and a total of 98,000 meters of drilling and 17,000 meters of trenching were undertaken. The concession was abandoned by SMTF in 1978, by which time construction of a large part of the mine infrastructure had begun.

Gécamines, the state-owned mining company that owned Tenke Fungurume and all the other copper mines and deposits in Katanga, encountered severe operational difficulties from the late 1980s onwards. Production has dropped dramatically since then.

TFM was formed in November 1996 as a joint venture between Tenke Mining Corporation (TMC) of Canada and Gécamines, to mine the Tenke Fungurume concession. TMC is a publicly held company traded on Canada's Toronto Stock Exchange. The introduction of Phelps Dodge Corporation as the managing partner is described in Section A1.

A4.1.1.4 Previous Site Development

The current development is taking place against a background of considerable previous development, including many facilities that were built in the immediate area by SMTF for the exploitation of the deposits, but which were later abandoned. Much of the surface of the mineralized hills has been heavily disturbed by extensive artisanal mining operations. These disturbances include trenches, pits and adit development. Kwatebala Hill and the Fungurume deposits particularly have been targeted. Many sites such as those for a plant site, a primary crusher and a conveyor near Fungurume were leveled and construction initiated, but most were abandoned before construction was completed. Rail spurs and sidings, many partially dismantled, are present at the abandoned plant site and pilot plant areas near Fungurume.

Three camps for mine employees were constructed in the Fungurume area. The principal camp close to the plant site is now derelict, but the workers' camp two kilometers west of Fungurume now is used effectively as a local village. Following abandonment of the mine by SMTF, Trabeco (Traverses Béton de Congo - Concrete Sleeper Company), a local company, took control of much of the infrastructure and facilities left behind, including the geologists' camp. This camp (the TFM camp), on the eastern edge of the town of Fungurume, is presently under the control of TFM and is serving as TFM's main camp and administration facility.

Several arterial roads were constructed through the concession in the early 1970s, with most in use today, as well as many drilling access roads and pads. The network has been expanded to facilitate TFM's current exploration and drilling program. Several bridges have been built or refurbished by TFM to cross rivers and streams.

A4.1.2 Proposed Project

This section provides a general summary of the proposed project configuration.

A4.1.2.1 Mineral Resource

Figure A4.1-3 shows the location of the Tenke Fungurume copper-cobalt deposits. The axes of the Dipeta syncline and other fold structures are evident, with the Shadirandzoro, Shimpidi, Mwadinkomba and Goma deposits marking the exposure of the north limb, and the Mambilima, Kansalawile, Kamalondo and Katuto deposits marking the southern limb. Much distortion, thrusting and folding has resulted in a large number of smaller fragments toward the south of the concession.

The deposits to be mined in staged phases between 2008 and 2027 are the Kwatebala, Goma and Fwaulu deposits within the larger Tenke deposit group.

All exposed outcrops contain heavily weathered oxide ore. In the context of this project, oxide ore is defined as material with an acid-soluble copper to total copper ratio of 85 percent or greater.

Several mineralized zones have been drilled extensively in the past by Union Minière, SMTF and Gécamines, and a proportion of the deposits identified within the concession have been evaluated by drilling, trenching and geophysical methods. In addition, TFM has conducted recent drilling to more accurately delineate the mineral resource at Kwatebala.

As a result of this exploration, a mineral resource estimated at over 500 million tonnes at a grade of 2.1 percent copper and 0.3 percent cobalt has been identified.

The staged approach exploitation considers mining and processing of only the oxide portion of the Kwatebala, Goma and Fwaulu ore bodies, with a total measured and indicated ore reserve of over 100 million tonnes.

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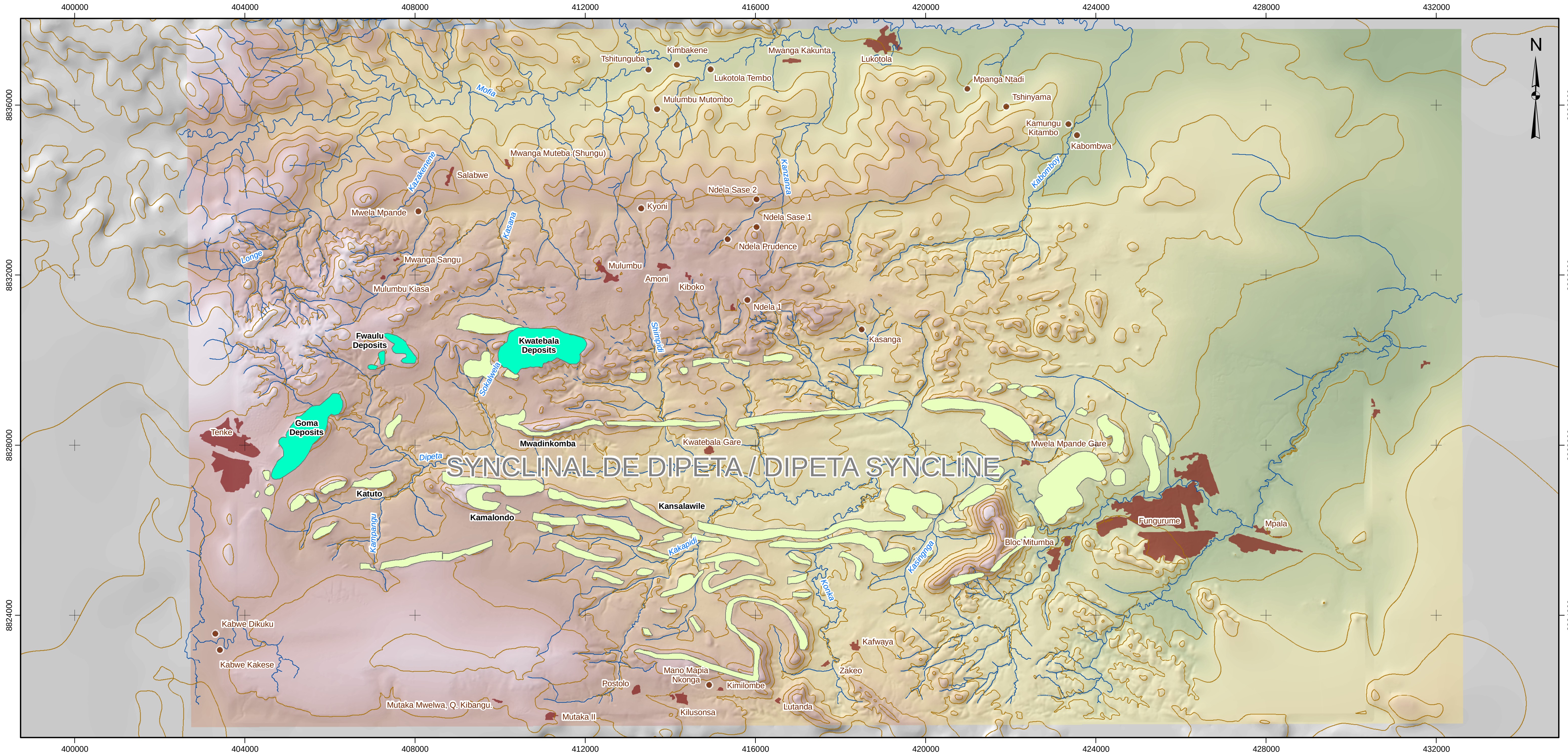


LÉGENDE / LEGEND

- VILLAGE
- COURBE DE NIVEAU (INTERVALLE DE 40 METRES) / CONTOUR (40 METER INTERVAL)
- RIVIÈRE / RIVER
- RIVIÈRE INTERMITTENTE / SEASONAL RIVER
- ÉTABLISSEMENT HUMAIN / SETTLEMENT
- FUTURE ZONE D'EXPLOITATION MINIÈRE / ZONE TO BE MINED
- ZONE MINÉRALISÉE / MINERALIZED ZONE

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S / Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

3 0 3

ÉCHELLE 1:90000 KILOMÈTRES

SCALE 1:90000 KILOMETERS

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME

TENKE FUNGURUME PROJECT

TENKE FUNGURUME MINING SARL

TITRE

TITLE

DÉPÔTS DE CUIVRE-COBALT DE TENKE-FUNGURUME / TENKE-FUNGURUME COPPER-COBALT DEPOSITS

Golder Associates

Calgary, Alberta

N° PROJET / PROJECT NO. 05-1334-035		ÉCHELLE TELLE QU'INDIQUÉE SCALE AS SHOWN	REV. 0
DESSIN / DESIGN	RT	10 Jul. 2006	
GIS / SIG	CW	02 Jan. 2007	
VÉRIFIÉ / CHECK	MR	24 Oct. 2006	
APPROUVÉ REVIEW	MR	24 Oct. 2006	

FIGURE: A4.1-3

Plans for exploitation of the additional resources, including the ore bodies at Fungurume, Pumpi, and probable ore bodies at other sites on the concession, fall outside the scope of this ESIA, except for a discussion of potential cumulative impacts found in Volume C.

A4.1.2.2 Project Phases and Schedule

While the entire project is projected to last more than 40 years, the ESIA only assesses the first 20 years during which construction and active mining takes place. The following project phases are envisioned:

Construction Phase: Some early construction activities are proposed to occur as early as the third quarter of 2006 and all construction activities are projected to be complete near the end of 2008.

Operation Phase: The operation phase covered under this ESIA and associated FS cover the first 20 years (approximate) of the mine's operating life. During its operation phase, the yearly production is designed to be 115,000 tonnes per year copper metal, 8,000 tonnes per year cobalt metal with flexibility to produce another 2,000 tonnes per year of cobalt from about 4,500 tonnes per year of cobalt hydroxide. During this phase, low-grade ore will be stockpiled for subsequent processing. This low-grade ore-processing will last for approximately 22 years. A detailed assessment of the mining of the Goma and Fwaulu pits is not included in the ESIA. An addendum to the ESIA will be prepared for these pits prior to their development.

Closure Phase: Closure activities are expected to be complete within two years of cessation of mining and mineral processing.

Post-Closure Phase: This phase is expected to continue at least 10 years after closure is complete, and involves monitoring the closed facility to assure that it is meeting its environmental and post-mining land use objectives.

Higher Production Phases: This phase will be determined by subsequent feasibility studies, beginning during the construction phase. The goal is to raise production to at least 130,000 tonnes per year copper metal by Year 4 or so, and eventually to 400,000 tonnes per year (Section A4.17). However, increases in production will be covered under future ESIA work.

The schedule and order of development that has been proposed for the mining of Kwatebala, Goma and Fwaulu oxide materials during the initial operation phase are shown in Table A4.1-1.

Table A4.1-1 Proposed Schedule of Ore Body Development

Ore Body[(a)]	Mining Area	When Mined
Kwatebala	Kwatebala pit	2008 to 2016, 2020, and 2023 to 2026
Goma	Goma pit	2017 to 2020, and 2025
Fwaulu	Fwaulu pit	2020 to 2022, and 2027

(a) Others to be determined by feasibility studies beginning during the construction phase.

Table A4.1-2 provides information on the average mining rates for the operation phase of the project.

Table A4.1-2 Life of Mine Production

Mill Ore (Mt)[(a)]	Low Grade Stockpile (Mt)[(a)]	Waste Rock (Mt)[(a)]	Moisture of Ore	Moisture of Waste	Explosives Types Used
49	54	225	8%	8%	ANFO[(b)] and emulsion[(c)]

(a) Mt = million tonnes.
(b) ANFO = ammonium nitrate / fuel oil.
(c) Probably an emulsion / prill blend.

Total life of mine (LOM) ore to be processed will be 103 million tonnes and total LOM waste rock will be 225 million tonnes (Table A4.1-3). Total product is projected to be 2 million tonnes of copper and 262,000 tonnes of cobalt.

Table A4.1-3 Mining Sequence

Pit	Years	Ore (Mt)	Ultimate Pit Extent (ha)
Kwatebala	2008 to 2016, 2020, and 2023 to 2026	80	143
Goma	2017 to 2020, and 2025	17	125
Fwaulu	2020 to 2022, and 2027	6	74

A4.1.2.3 Project Economics

The project will have a large economic impact on the local, regional and national economies of Katanga and the DRC. These economic impacts will be different during the construction phase than in the operational phase. The estimated total project capital investment during the construction phase will be about 643 million United States dollars (USD). Of this investment, about USD 75 million will be spent in the DRC, with the remainder spent in the United States, South Africa, Australia and Europe (Minproc 2007).

A macro-economic assessment of the project can be found in Appendix C4.1-I.

A4.1.2.4 Analysis of Alternatives (Summary)

An analysis of alternatives was conducted for the TFM project for the major project components where viable alternatives were available (Section A3). These analyses considered technical, environmental and social factors, as well as sustainability issues.

A4.2 TRANSPORTATION CORRIDORS AND INFRASTRUCTURE

A4.2.1 On Site

A4.2.1.1 Materials and Equipment to be Transported

The primary materials to be transported on site include the ore and waste rock. In addition, supplies for both construction and operations will use the main access roads and, in some cases, the railway sidings at Tenke and Fungurume.

A4.2.1.2 Roads

This summary lists the basic design concepts for roads on the Tenke Fungurume concession. Underlying this concept is the assumption that roads are traditionally used by vehicles, bicyclists, animals and pedestrians alike (see Section B2.13) and often, simultaneously with ensuing safety hazards. The objective of engineering roads for the TFM project is to provide controlled space that separates pedestrians, bicyclists and animals from vehicle traffic, provides an order to the traffic flow and establishes regulated common use areas (where roads pass through villages or are crossed by established pedestrian and farm animal trails).

Road Classification: On the TFM concession, there will be essentially four classes of roads, with differing safety engineering integrated into the designs:

Class 1: Low-use secondary roads used primarily around buildings and residential areas. These roads are designed for common use between vehicles and pedestrians, with low-speed, under 30 kilometers per hour. Motor vehicles would be limited to resident's vehicles, small delivery or service vans/pick up trucks and occasionally larger trucks required for facility maintenance. An example of this type of road exists in the current TFM administration camp. These roads would be installed in the construction camp/permanent village. Public access to these roads is controlled by security and the entire area is surrounded by a fenced boundary. Speed limits would be posted along with normal yield, stop and other cautionary traffic signs.

Class 2: Industrial use, secondary roads. These roads primarily are used by industrial vehicles in and around the plant sites or other industry centers on the TFM concession. Workers would use these roads for pedestrian access ways between buildings and plant operations. These areas frequently would be used by smaller pickup trucks or service vans and also by semi-type trucks delivering supplies or transporting product. Speed limits would be controlled to less than 50 kilometers per hour. Public access to these roads would be prohibited and controlled by security and the entire area would be surrounded by a fenced boundary. Speed limits would be posted as well as normal yield, stop and other cautionary traffic signs.

Class 3: Combined industrial and residential traffic and main plant access roads. These roads are designed to accommodate the regular truck and other industrial traffic servicing the plant and other areas of the concession, as well as the local population using the road for local access to their traditional agricultural areas and residences. Where possible, these roads will be planned to avoid high pedestrian congestion by routing around villages or moving residences away from the road. Residence set-backs of 20 meters will be established to avoid congestion along the road rights-of-way. These roads would not be used for regular mine trucks hauling ore and waste.

Due to the special nature of Class 3 roads, separation of pedestrian and bicycle traffic from vehicle traffic will be achieved by placing a physical or visual barrier between the two traffic paths. The objective is to keep foot traffic and bicycles confined to their own pathway and avoid vehicle traffic. Specific controls will be used at areas of high traffic and use, such as near villages and at path crossings. Specific traffic safety controls will include posted cautionary signs for both pedestrians and vehicle operators, stop signs, speed bumps, cross-walks, reduced speed limits in congested areas, and posted road crossing guards as required for schools and other high-use pedestrian crossings.

Class 4: Mine haul traffic and mine access roads. These roads are designed for specific use by large mine haul trucks to transport ore and waste from the pits to the plant. The principal routes used by mine vehicles will be haul roads linking the Kwatebala pit and the Goma pit to the primary crusher at the Kwatebala plant site. The sub-grade of the haul road will be constructed of material excavated during cut and fill operations, and any additional material will be sourced from pits located along the route of the haul road. This material may be topped by compacted laterite. The haul road will be nominally 30 meters wide and will be wide enough to allow two heavy vehicles to pass.

These roads will be off-limits to pedestrians and commercial (industrial) vehicle access will be tightly controlled. All users will be trained in safe driving skills for mine operations. Vehicles will have radio communication between vehicles as well as to a central dispatch. Where feasible, these roads will be within a fenced and secured area and will not be open to the public. The proposed routes for these roads are shown in Figure A4.1-1.

Figure A4.1-1 shows the location of the two routes that will be established for importing and exporting materials from the Kwatebala processing plant, as well as providing personnel access. The primary route will be the Mulumbu access road to the north of the mine area. It is presently a minimally constructed road dating from the SMTF development in the 1970s. This road will be upgraded as described above. A secondary route (Kafwaya cutoff road) to the processing plant will be constructed between the national highway and the processing plant. A section of the national road between the Kafwaya cutoff road and Fungurume will be incorporated as part of the secondary access road. The Kafwaya cutoff road will be constructed after the upgrades to the Mulumbu access road are built and is planned to be put in operation within about three years after startup of plant operations. Therefore, for the first three years, almost all haulage to the Kwatebala facility will be over the Mulumbu access road.

After the Kafwaya cutoff road is built, project-related traffic on the Mulumbu access road primarily will be limited to haulage of dolomite from the Mofia limestone quarry and transport of workers to and from the Kwatebala facility, unless flooding makes the Kafwaya cutoff road inaccessible. Sections of the road are thought to cross areas that may be difficult to maintain in high rainfall conditions. In addition, a bypass route (Fungurume bypass road) has been constructed to the west of Fungurume village so that large vehicles serving the plant site will not pass through the village. These routes also are shown in Figure A4.1-1.

All construction traffic will be via the Fungurume bypass/Mulumbu access road (other than workers who will use the Mulumbu access road). Construction traffic will use the following three access roads:

- Likasi to Fungurume using the Kambove to Kakanda mine road and cutoff to the TFM camp through the concession. This road is being rerouted along the last 1.5 kilometers to bypass south of the TFM camp and will intersect the national road and cross over west of the camp.
- Access will continue on the Fungurume bypass road around the west side of Fungurume and continue until the intersection of the last road, Mulumbu access road.
- The Mulumbu access road will run principally from east to west to access the Kwatebala plant site.

There will be some access required along the existing roads from the Mofia limestone quarry to the Mulumbu access road to haul aggregate to the plant site and to haul aggregate to the construction camp.

In all cases, the roads that bisect Fungurume will be avoided as much as possible and only used if no other access is available (such as during a bridge washout, or if road construction blocks a passage).

The Kafwaya cutoff road will be developed during the initial three years of operation. The southern route along the national highway to the Kafwaya cut-off route is available for light vehicle traffic, but is not planned as the main access for construction for the first two years of operations. The roadways requiring construction and upgrade are summarized in Table A4.2-1.

Table A4.2-1 Roadways Requiring Construction/Upgrade

Summary of Roadways Requiring Construction/Upgrades				
Item	**Road**	**Description**	**Approx Length**	**Details**
1	Kakanda cutoff road	from Fungurume to Kakanda mine	24 km	• upgrade existing secondary road • allow for 2 bridges and 20 culverts • bypass the national highway • widen and straighten, manage water crossings
2	Kwatebala plant site road	from Fungurume to plant site	15 km	• widening and resurfacing of existing road • some realignment required • develop pedestrian access and crossings
3	permanent village and quarry access road	from Fungurume to Mofia quarry and to permanent village	9 km	• maintenance grading clearing and re-sheeting as required

A4.2.1.3 Railways

If required, existing railway sidings at Tenke and Fungurume will be refurbished and used by the project for transfer of materials between rail and road trucks. No new facilities are proposed to be built at these siding locations. The location of these rail sidings are shown in Figure A4.1-1.

A4.2.2 Off Site

A4.2.2.1 Materials and Equipment to be Transported

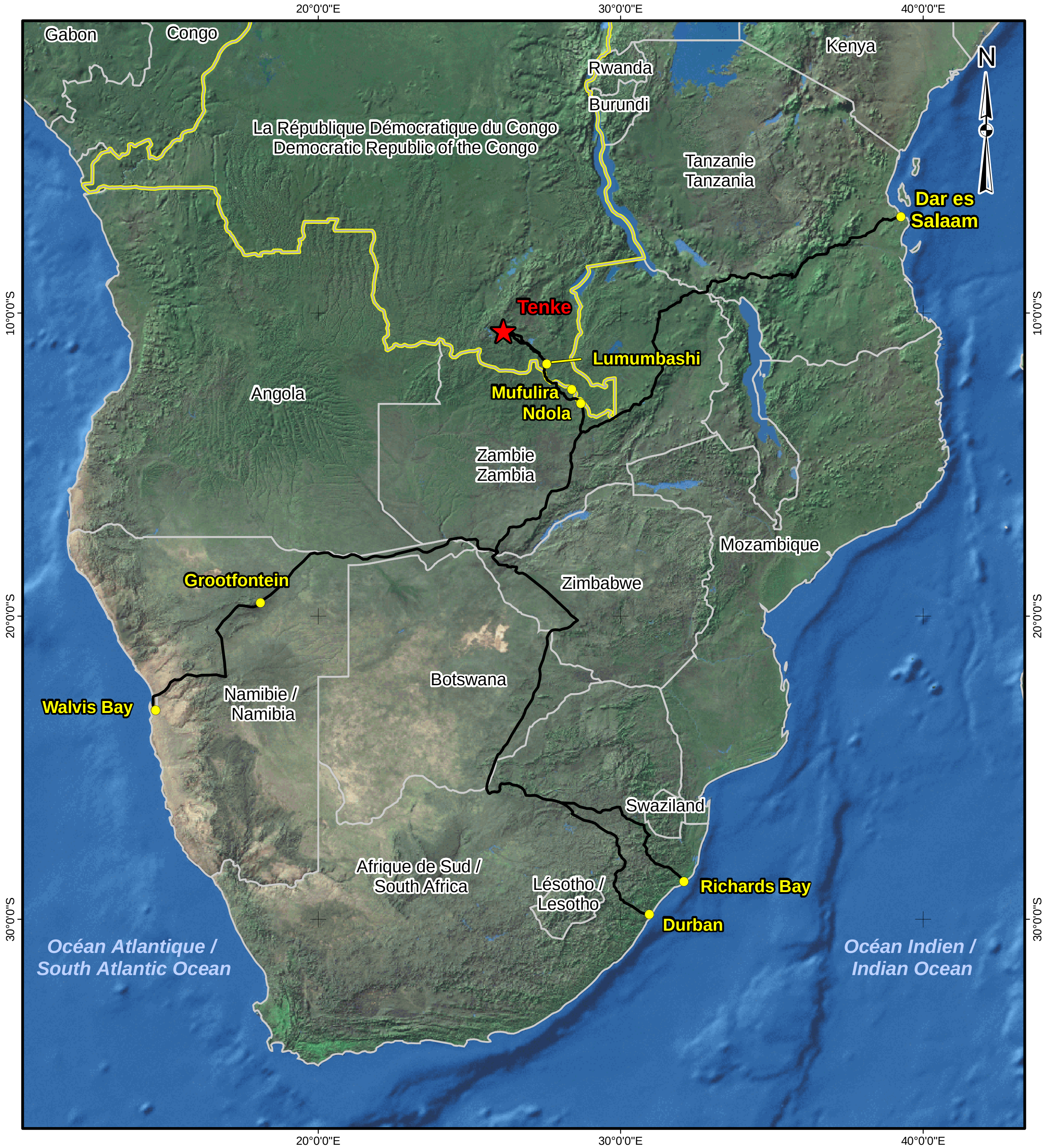
It is proposed that the bulk of both raw material and equipment imports and finished product exports will be handled though the ports of Richards Bay or Durban, (South Africa), Dar es Salaam (Tanzania) and/or Walvis Bay (Namibia). Transport of supplies and products between mine and port will be by a combination of rail and road (Figure A4.2-1).

A detailed ESIA for off site transportation is not required, however TFM commits to:

- Hiring reputable transportation firms.
- Conducting reviews of their safety procedures.
- Conducting audits and having changes implemented, if needed.
- Putting in place a mechanism to investigate spills, if any (see Section D3.1.11).

Each reagent commodity will be transported as per the requirements of each supplier and the applicable MSDS (material safety data sheet). The majority of cargo will be transported in shipping line containers and shipped in packaging as supplied by each reagent supplier. Some reagents, such as Shellsol, diesel, magnesia and coagulant will be shipped in tankers or tank containers as per each supplier requirements. Detailed transport investigations will be taken up with each reagent supplier and TFM site to determine how to handle and off-load each reagent in accordance with the MSDS safety requirements, including hazardous handling requirements of each reagent.

Bulk materials will, where possible, be transported by rail to a suitable transfer point, Ndola (Zambia), Mufulira or Lubumbashi (DRC) and then transferred to road vehicle for the final leg to the mine site. The use of modified International Organization for Standardization (ISO) standard containers will enable both bulk material import and finished product export, and will also permit switching between different modes of transport when necessary.



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ÉCHELLE 1:20000000 KILOMÈTRES
SCALE 1:20000000 KILOMETERS

LÉGENDE / LEGEND

- VILLE PRINCIPALE / MAJOR CITY
- TENKE
- ROUTE DE TRANSPORT / TRANSPORTATION ROUTE
- PAYS / COUNTRY
- LA RÉPUBLIQUE DÉMOCRATIQUE DU CONGO / DEMOCRATIC REPUBLIC OF THE CONGO

RÉFÉRENCE / REFERENCE

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Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE
TITLE

ROUTES DE TRANSPORT ENTRE LE SITE DE LA MINE ET LES PORTS D'EXPORTATION / TRANSPORT ROUTES BETWEEN MINE SITE AND EXPORT PORTS

Golder Associates
Calgary, Alberta

N° projet / project no. 05-1334-035.9300			Échelle telle qu'indiquée Scale as Shown	REV. 0
DESSIN / DESIGN	RT	10 Jul. 2006	**FIGURE: A4.2-1**	
SIG / GIS	CW	02 Jan. 2007		
VÉRIFIÉ / CHECK	MR	31 Jul. 2006		
APPROUVÉ REVIEW	MR	31 Jul. 2006		

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Outside of the immediate project region, no construction of new road or rail lines, or expansion of existing routes, is proposed for the transport of these materials.

Flexibility is required for both transportation routing and methods. The extreme transport distances, the number of international borders that must be crossed, and the condition of some of the infrastructure makes it likely that environmental or social pressures (such as extreme natural events or social conflicts) could render any of them unusable at any time. Transport flexibility must be maintained.

The largest bulk imports will be sulfur for the sulfuric acid manufacturing plant, magnesium oxide for cobalt purification, lime for pH adjustment and impurity precipitation, diesel fuel, diluent (kerosene), mill balls, lead anodes and other miscellaneous items. Imports of machinery, spares and other items will be on an ad-hoc basis.

Fuel and diluent will be transported in tanker wagons. Machinery and spares will be transported in containers where possible to maximize security, but larger items may be transported on rail flatcars.

Magnesium oxide will be transported in ISO standard freight containers, which will be adapted to allow easy handling, loading and unloading. These containers will be transported on flatbed trucks.

Sulfur will be transported in bulk bags by rail to a suitable transfer point in Zambia and then by truck to site.

Elemental sulfur from virtually all sources contains quantities of hydrogen sulfide gas (H_2S), which is entrained in the material as a result of the manufacturing process. Hydrogen sulfide is toxic, and can explode under certain circumstances. Evolution or “out-gassing” of hydrogen sulfide takes place during transport, although storage or transportation by sea normally would allow sufficient time for a large proportion of the gas to be evolved.

Out-gassing of hydrogen sulfide may lead to accumulation of hydrogen sulfide inside bags. Concentrations approaching the lower explosive limit are also possible.

Experience shows that sulfur is prone to ignition from external sources, and also from contact with bare steel. Appropriate safety procedures to deal with elemental sulfur will be incorporated into an emergency response plan as indicated in Section D7.

Copper cathode in finished form will be strapped together in bundles. Cobalt cathode will be produced in the form of chips and will be placed in drums. Cobalt cathode drums will be placed on pallets. Pallets of cobalt cathode and bundles of copper cathode will be loaded onto flatbed trucks or into ISO containers for transport.

A listing of the reagents and associated volumes to be imported and exported is provided in Tables A4.2-2 to A4.2-4. Table A4.2-2 provides an estimate of the "first fill" quantities to be transported to the site in advance of operations. Table A4.2-3 provides an estimate of the operational phase material transport requirements.

Table A4.2-2 Estimated First Fill Quantities of Reagents to be Imported to the Site

Reagent	First Fill and Initial Stock (tonnes)	Average Number of Trucks Required
grinding media	215	6
flocculant	70	2
coagulant	137	7
extractant	634	19
diluent – cubic meters	1,701	57
quicklime	5,158	152
hydrated lime	4	<1
tri sodium phosphate	1	<1
hydrazine	1	<1
sodium hypochlorite	243	7
magnesium oxide	1,500	71
sulfur	9,403	277
sulfuric acid[(a)]	1,000	33
glucosol CH_4	9	<1
bentonite clay	21	1
antiscalant	16	<1
polyolefin prills (19 mm)	99	3
sodium hydroxide	801	24
garnet	161	5
anthracite	157	5
boric acid	24	1
soduim lauryl sulphate	0	<1
strontium carbonate	1	<1
strapping	10	<1
sodium hydrosulfide	10	<1
zinc ion exchange resin	47	2
nickel ion exchange resin	36	1
carbon	13	<1
cobalt packaging	68	2
diesel	2,742	91
Total	**24,282**	**765**

mm = millimeters.

(a) Imported only for first fills, for the commissioning of the acid plant. After this, sulfuric acid will be produced on-site.

Table A4.2-3 Estimated Annual Material Transport Requirements during Operations

Material	Annual Average				Daily Average[a]						Origin	Mode of Transport	Backload Possible
	t	m^3	Containers	Tankers	t	m^3	34 t Trucks	40 t Rail Cars	Containers	Tankers			
sulfur	72,947	n/a	n/a	n/a	200	n/a	6	5	n/a	n/a	Richards Bay /Dar es Salaam	road / rail	yes
quicklime	39,528	n/a	n/a	n/a	108	n/a	3	n/a	n/a	n/a	Ndola	road only	yes
limestone	108,540	n/a	n/a	n/a	297	n/a	10[b]	n/a	n/a	n/a	quarry[c]	road only	no
magnesia containers	11,745	n/a	559	n/a	n/a	n/a	n/a	n/a	2	n/a	Durban	road only	no
coagulant / diluent tankers	1,106	1,229	n/a	41	n/a	3	n/a	n/a	n/a	<1	Durban	road only	no
fuel tankers	13,161	16,451	n/a	548	n/a	45	n/a	n/a	n/a	2	Ndola / Dar es Salaam	road only	no
consumables	5,000	n/a	n/a	n/a	14	n/a	<1	n/a	n/a	n/a	various	road only	yes
other reagents	6,525	n/a	n/a	n/a	18	n/a	1	n/a	n/a	n/a	Durban / Walvis Bay / Dar	road only	yes
copper cathode	115,000	n/a	n/a	n/a	315	n/a	9	8	n/a	n/a	Tenke	road / rail	yes
cobalt rounds	8,000	n/a	n/a	n/a	22	n/a	1	n/a	n/a	n/a	Tenke	road only	yes
cobalt hydroxide	4,545	n/a	n/a	n/a	12	n/a	<1	n/a	n/a	n/a	Tenke	road only	yes

[a] Daily figures represent the number of units that would be required if only that method of transport were used.
[b] Limestone transport is based on 30 tonne dumptrucks.
[c] Sourced from the Mofia pit on the concession.
Note: Included are: gas cylinders, lubricants, spare parts and tires.

Table A4.2-4 Product to be Shipped from Site and Alternative Transport Routes

Port	Length of Route (km)	No. of Major Water Crossings	Mode of Transportation	Product (tonnes per year)	Daily Average		
					Tonnes	Trucks	40 t Rail Cars
Dar es Salaam	2,100	17	road/rail	copper 115,000	315	9 (mine to Zambia)	8 (Zambia to port)
Durban	3,400	17	road/rail				
Dar es Salaam	2,100	17	road	cobalt metal 8,000	22	1	n/a
Walvis Bay	2,400	9	road				
Durban	3,400	17	road				
Dar es Salaam	2,100	17	road	cobalt hydroxide 4,545	12	<1	n/a
Walvis Bay	2,400	9	road				
Durban	3,400	17	road				

n/a = Not applicable.

The planned transport routes and estimated volumes of products to be shipped out are provided in Table A4.2-4. As referenced in Table A4.2-4, major water crossings refer to permanent rivers of sufficient width to be marked on maps at a 1:4,000,000 scale. These rivers range from very major (Zambezi, with an average discharge at mouth of 7,000 cubic meters per second, although the volume at crossing is much lower) to much smaller rivers. River lengths from headwaters to crossing locations begin at approximately 50 kilometers and range into hundreds of kilometers.

Table 4.2-5 shows the amount of diesel fuel planned to be consumed during construction and operation phases.

Table A4.2-5 Estimated Fuel Consumed

Details	Estimated Diesel Fuel Consumption				
	kL per annum	kL per month	kL per week	kL per day	kL per hour
construction 2007 to 2008					
construction of process plant	8,943	745	172	24.5	1.02
mining – peak 2007 to 2008	5,337	445	103	14.7	0.61
total construction	**14,279**	**1,190**	**274**	**39.2**	**1.63**
operation					
mining - average 2009 to 2018	14,062	1,172	270	38.5	1.61
processing - mobile equipment	877	73	17	2.4	0.10
acid plant	619	52	12	1.7	0.07
emergency generators / fire pump	894	74	17	2.4	0.10
total operation	**16,451**	**1,371**	**316**	**45**	**1.88**

kL = kiloliter.

To supply first fill materials a total of approximately 765 full truck trips (not including back haul) are required to supply these quantities. In addition to this, around 670 full truck trips are required to transport equipment, steel and cement for the construction of the process plant. Three hundred vehicles for the mining fleet, cranes and other mobile equipment will also be transported to site.

There will also be a requirement for 70,000 tonnes of aggregate and sand for construction, which will be sourced close to the process plant site.

As shown in these tables, an estimated total average daily volume of 10 bulk trucks, two magnesia container trucks and two fuel tanker trucks will travel the off-site roads from the origins shown to supply the mine with needed materials during operations. It is estimated that an average of 10 trucks per day of limestone (assuming 30 tonne trucks) will only travel on-site between the quarry and the plant. Also, an average of 10 trucks per day will export product from the mine site. These 10 trucks may be used in a back-haul mode with trucks supplying the mine. Railcar volume between the dry port and the import and export ports average five sulfur rail cars per day inbound and eight copper rail cars per day outbound.

A4.2.2.2 Rail

Rail transport will be organized and managed by a rail company that will make all arrangements for passage of block trains through the necessary countries.

The choice of ports allows some variations in the rail route between Fungurume and South Africa. A likely transport route into South African ports is Fungurume - Ndola - Victoria Falls - Bulawayo – Messina - Nelspruit - Richards Bay/Durban. However, the Fungurume to Ndola portion likely will be by road due to the poor condition of the DRC rail system. This route has a total length of 3,200 kilometers (3,400 kilometers to Durban) and one-way journey times will be of about 15 days. A route to Dar es Salaam would be about 2,100 kilometers and transport to Walvis Bay would cover about 2,400 kilometers (Table A4.2-3).

The railway company will source all rolling stock for TFM, and will provide locomotives for block trains. These block trains will journey through several national rail systems, with necessary changing of locomotives taking place in each country.

Rolling stock requirements have been based on one 30-car train every four days, and will call for a total fleet of 132 container flatcars, each of which can accommodate two standard 20-foot containers.

A4.2.2.3 Roads

Although rail will be the principal means of transport for supplies and products for the major portion of the distance, it will be necessary to transport almost all goods to site by road for some portion of the journey. The current condition of the DRC rail system is not considered dependable for regular rail service. Therefore, road transport will be required for at least the portion of the route from Ndola/Lubumbashi to the mine site. In addition, a portion of the materials probably will be transported from the port of origin to site by road.

The preferred road route to Richards Bay is Fungurume - Kasumbalesa - Kitwe - Lusaka - Chirundu - Harare - Beitbridge - Messina - Pretoria - Johannesburg - Richards Bay/Durban, a total distance of 2,946 kilometers (Figure A4.2-1). Transport by road also may occur from Walvis Bay and/or Dar es Salaam.

An alternative route for heavier loads, avoiding low axle weight limits and bridge clearances, either uses the Zambezi ferry crossing at Kazungula or crosses the Zambezi at Livingstone to gain entry to Botswana. The route is then Gaborone - Lobatse - Pretoria. This route has a total distance of 3,201 kilometers.

Roads are surfaced with tarmac (asphalt) on all road routes for the entire distance, except for the last stretch between Likasi and Fungurume which is of murram or compacted laterite. At present, during the rainy season this section of road is affected by heavy traffic and prone to washouts from flooding. Therefore, it is contemplated that a bypass route from Likasi to Fungurume via the Kambove and Kakanda mines will be used until the national road is improved and maintained by the regional and national government to provide year-round passage (Figure A4.1-1 and Figure C2.6-5).

For all road transport, trucks capable of handling standard containers will be employed. Equipment and supplies sourced within the DRC will be transported by road. All road transport will be handled by carriage and forwarding agents, who will employ national and regional carriers in the countries being traversed.

A4.3 OPEN PITS

Although the deposits appear to extend continuously along the profile of the syncline and on strike, extraction will be confined in a staged approach to three of the outcrops for the period covered by this study. Ore will be attained by open pit mining methods. Discrete open pits will mine predominantly oxide ore from the Kwatebala, Goma and Fwaulu deposits.

A layout of the site is displayed in Figure A4.1-1, showing the locations of the three open pits, processing plant, haul roads and other infrastructure.

Vegetation will be removed from the mining area and the available topsoil will be salvaged and placed in stockpiles for later use in reclamation and mine closure activities. Special focus will be placed on preservation of endemic plant species occurring on portions of the exposed copper/cobalt mineralized zones. A salvage and preservation plan for these species has been developed and is discussed in Section D3.1.12. Pre-stripped overburden and waste rock will be used to construct the mine haul road and tailings storage facility.

The mine haul road will run north from the Kwatebala pit, to the south side of the proposed plant site, around the east side of the proposed tailings facility and north to the proposed waste rock repository. The tailings storage facility will be directly southwest of the processing plant site, and waste rock facilities will be established immediately north of the tailings facility and west and north of the processing plant. Workshop areas will be established just north of the Kwatebala pit and east of the tailings storage facility. See Figure A4.1-1 for a view of the facility layout and Figure A4.4-2 for the processing plant layout.

A4.3.1 Mining Description

Production and development will be by two “Tesmec” surface miners which will extract the ore on site (Table A4.3-1). Drill and blast methods will be used for waste rock.

Table A4.3-1 Major Mine Equipment

Equipment		Equipment	
trucks, 45 tonne	33	drills	2
track dozers	4	rubber tired dozers	1
loaders, 6.3 m^3	8 to 9	motor graders	2
surface miner	2	water trucks	2

The surface miners will be track mounted with a large rotating drum and hardened steel picks that break the rock in situ. They will be used for Kwatebala, Goma and Fwaulu. The ore, which is in relatively thin seams, will be mined in very thin cuts (0.6 meters) to minimize ore dilution and loss. Surface miners are being used successfully throughout the world and in this application will provide significant capital and operating cost savings by eliminating the need to drill, blast and primary crush the ore. The ore will be broken to 150 millimeters in diameter and will be loaded into 45 tonne haul trucks with front end loaders.

High grade ore will be delivered to stockpiles near the mill feed chute where a loader will be used to produce an ore blend from these stockpiles that maximizes plant production. The lower grade ore, totaling 54 million tonnes by Year 19, will be dumped on stockpiles near or on top of the waste stockpiles to the north and northwest of the plant site and southeast of the Goma pit. The low-grade ore that is stockpiled during mining operations provides an additional 22 years of processing that extends the project life to more than 40 years.

The bulk of the waste material will be mined in five-meter benches using conventional open-pit methods with drilling and blasting. Front-end loaders will be used to load 45-tonne capacity haul trucks.

Fourty-nine million tonnes of ore will be sent to the mine overall with 54 million tonnes of low-grade ore stockpiles for later reclaiming. The Kwatebala pit will start operations in 2008, the Goma pit in 2017 or afterwards and the Fwaulu pit in 2020.

As the waste to ore ratio increases later in the mine life, hydraulic excavators or large front-end loaders will be used to load the waste.

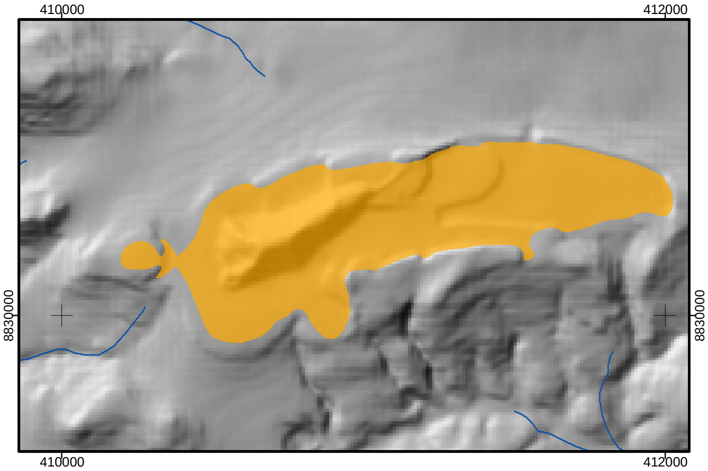
Locations of ore, low-grade ore and waste transport infrastructure are illustrated in Figure A4.1-1.

A4.3.2 Site Plans and Cross Sections

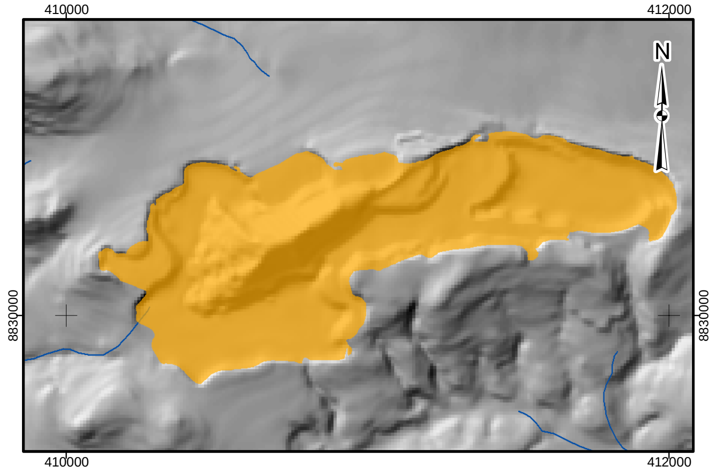
Figure A4.1-1 provides an overall view of the project footprint, with all of the significant facilities indicated. The footprints of Kwatebala and Goma are shown as they will appear near the end of the mining of oxide ores. Plan views and cross sections of the Kwatebala ore body, showing the approximate extent for the first 10 years of mining are in Figure A4.3-1. The maximum difference between the uppermost and lowermost mining levels at Kwatebala, Goma and Fwaulu will be about 250[10], 155 and 110 meters, respectively. Mining at Goma and Fwaulu is shown in Figures A4.3-2 and A4.3-3.

10 Oxide ores are generally found within the top 100 meters of the earth's surface in the region. However, in the case of Fungurume and Goma, folding and rising of the ore bodies into hills means that oxides can be mined to as deep as 150 to 250 meters below the top of the hills.

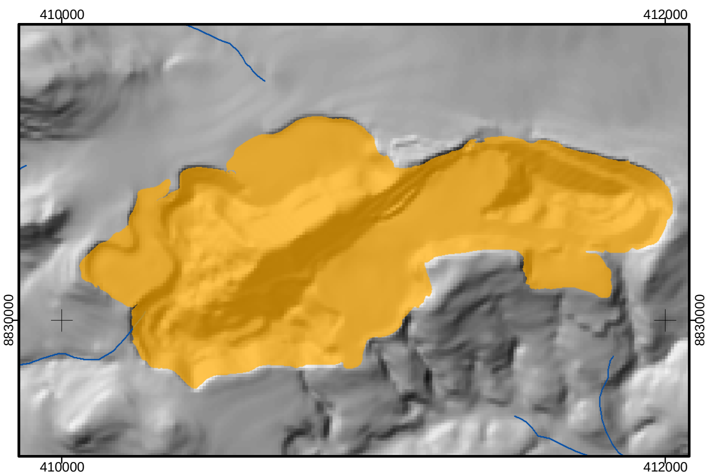
ANNÉE 0-2 / YEAR 0 - 2



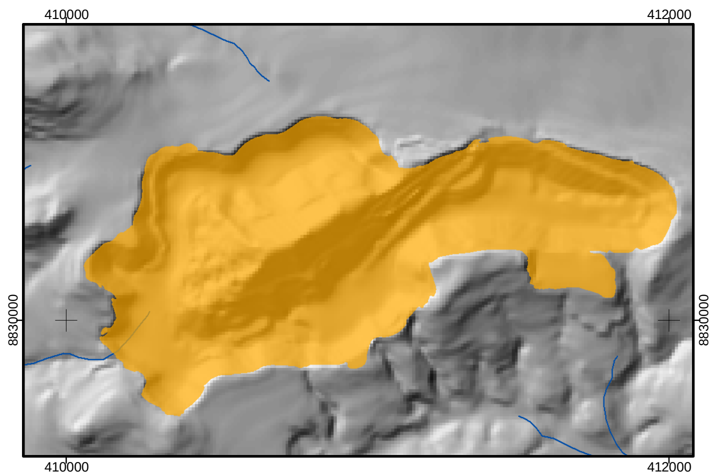
ANNÉE 2 - 4 / YEAR 2 - 4



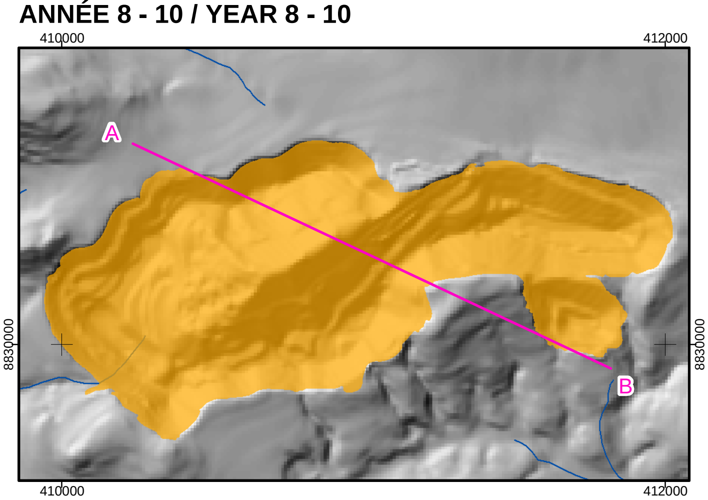
ANNÉE 4 - 6 / YEAR 4 - 6

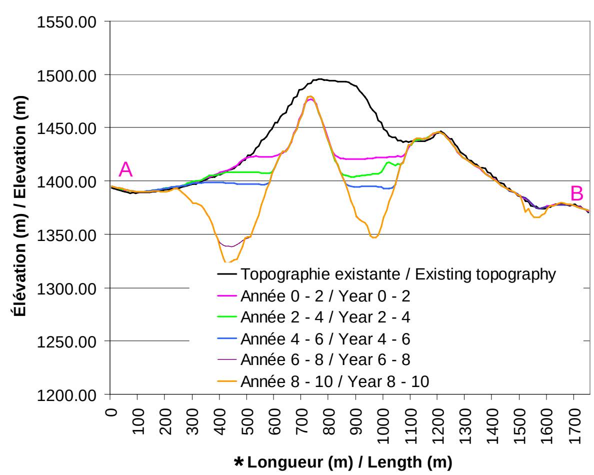


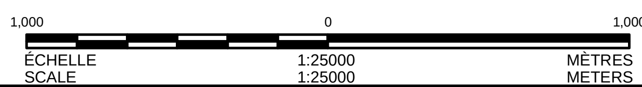
ANNÉE 6 - 8 / YEAR 6 - 8



ANNÉE 8 - 10 / YEAR 8 - 10







LÉGENDE / LEGEND

- RIVIÈRE / RIVER
- ÉTAPE DE LA FOSSE KWATEBALA / KWATEBALA PIT STAGE
- FOSSE DE LA MINE / MINE PIT

*L'exagération de l'échelle verticale de ce graphique est de 5 fois. / The vertical exageration for this chart is 5 times.

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S / Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE / TITLE

VUE EN PLAN DE LA FOSSE DE KWATEBALA POUR LES ANNÉES 0 À 10 / PLAN VIEWS OF KWATEBALA PIT YEARS 0 - 10

Golder Associates
Calgary, Alberta

N° projet / project no. 05-1334-035.9300		Échelle telle qu'indiquée Scale as Shown	REV. 0
DESSIN / DESIGN	MR	07 Jul. 2006	FIGURE: A4.3-1
SIG / GIS	CW	02 Jan. 2007	
VÉRIFIÉ / CHECK	MR	01 Aug. 2006	
APPROUVÉ REVIEW	MR	01 Aug. 2006	

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Figure A4.3-2 Pit Designs for Goma

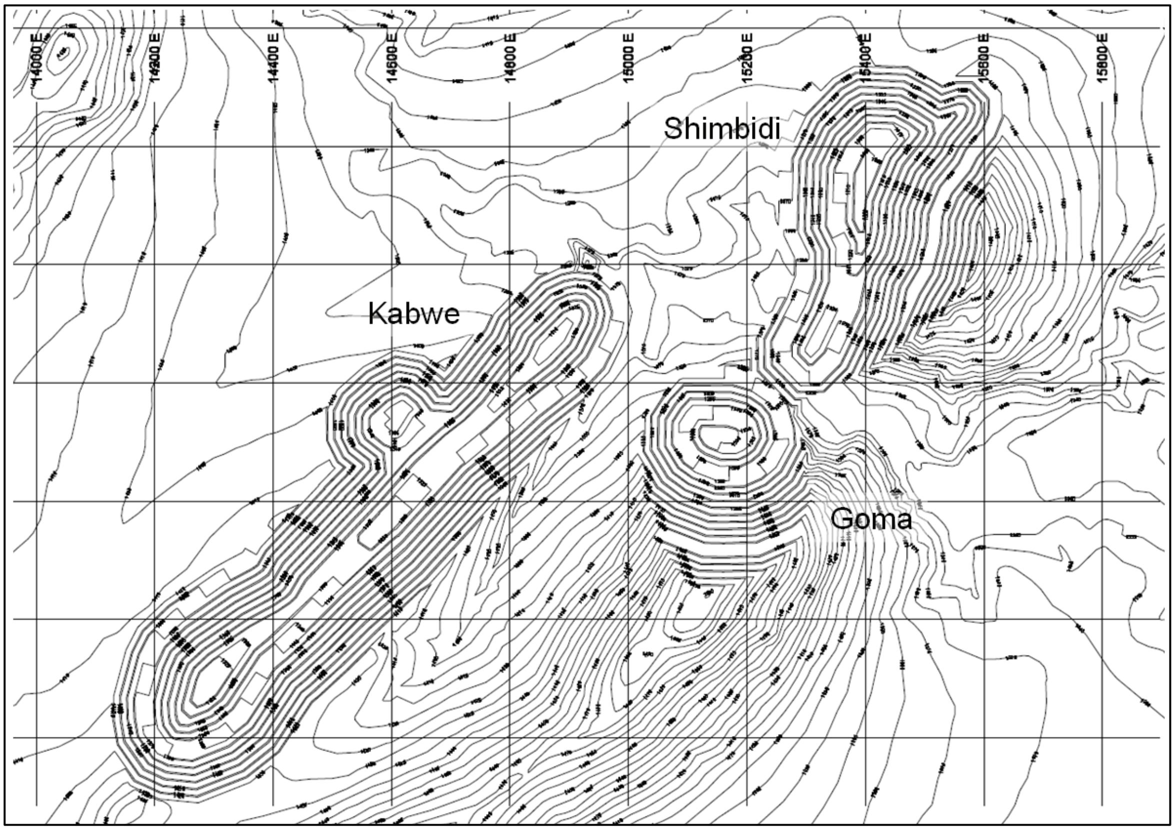
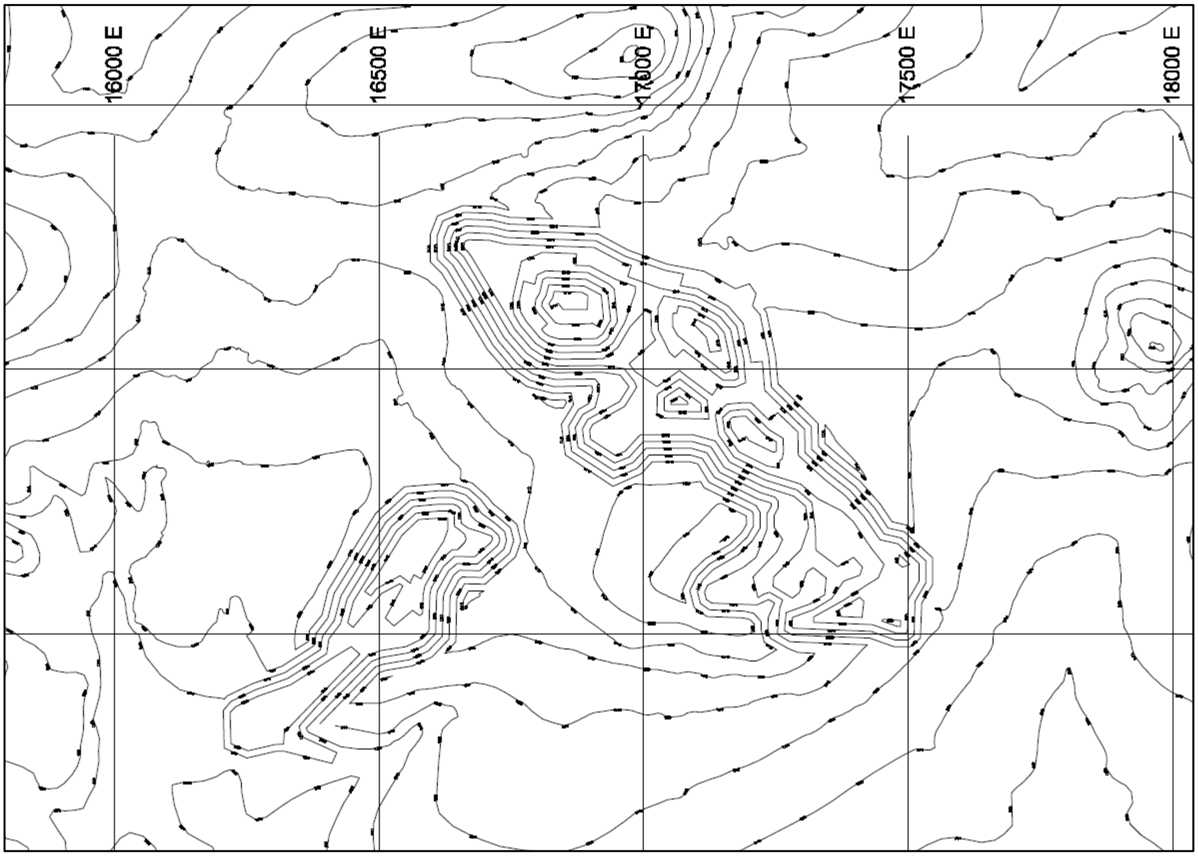


Figure A4.3-3 Pit Design for Fwaulu



A4.3.3 Mining Details

Various types of equipment will be used within the open pit during the life of the mine. These include the surface miner, graders and dozers for general road and working area maintenance, water trucks for dust control, conventional dozers for initial mining bench establishment and maintenance of the working bench, and numerous drills both for drilling and blasting service for the waste rock as well as ore verification and exploratory drilling (Table A4.3-1).

A fleet of mobile service equipment also will serve within the pit perimeter. These include equipment maintenance vehicles, fuel vehicles and cranes/lift equipment. Night operations will require large mobile light sources, including diesel-powered light plants.

Explosives

The storage and handling of explosives will be managed by a contractor specializing in these activities. The contractor will be a blasting services company fully licensed in the DRC. Once the type of explosives to be used is determined the type of storage appropriate to that type of explosives will be identified. The specific type of explosive to be employed is not yet confirmed. TFM may opt to use multiple types of explosives depending on the desired effect or specific ground conditions. For example, in particularly wet areas, TMF may use Heavy ANFO, slurry or opt to pump drill holes while dry areas may be loaded with ANFO. TFM will work with the DRC licensed blasting services contractor to determine specific storage requirements for each type of explosive considered. TFM and its blasting services contractor will respect DRC guidelines for minimum distances from habitations, dwellings, etc. and will clearly mark explosives magazines with international signs and symbols denoting the presence of explosives. The explosives magazine will also be in a controlled access area away from areas of blasting agent bulk storage.

The storage, transport and handling of explosives will be handled by a DRC licensed blasting services contractor specializing in blasting services for mining companies. The blasting service contractor shall have a dedicated safety officer as part of the organization deployed to the mine site. The safety officer will be responsible for complying with applicable DRC laws as well as TFM's Health and Safety Plan.

Blasting safety is of great importance that will be managed without compromise and will include the following measures:

- All explosives must be stored in an explosives store that has been specifically designed and built in accordance with statutory requirements and international best practice (typically a concrete bunker built below ground level that limits blast damage by directing the force of the explosion upwards in case of accidental detonation).
- The explosives store must be located in a high security area, but well removed from other buildings and project infrastructure.
- The explosives store must be locked at all time and access to the keys and the store must be limited to qualified and specifically authorized personnel.
- Audits/inventory of explosives as required by law (at a minimum).
- Storage of explosives located in an area close to mining operations.
- Explosives kept in secure locked location with access by Blasting Manager only.
- Storage facility of explosives will be in area protected by berms and other earthworks.
- Separate storage location for initiation systems, boosters and bulk explosives.
- Requirement for the contractor to follow mine safety policies with respect to vehicle safety.
- Two caps per hole thus reducing probability of a misfire.
- Using the latest detonation technologies – reduces probability of misfire.
- Holes stemmed and charged to prevent/minimize flyrock.
- A plan to only blast waste material where possible – so as to reduce total blasting activities to a minimum.
- Data to be captured for each blast hole – location, depth, charge, explosive (ANFO, slurry, etc.), detonation device, drill date, blast date, water, post blast audit.
- Operations in active blasting area will cease during blast.
    - Area cleared by blasting team.
    - Road blocks established.
    - Radio call to Operations seeking radio silence.
    - Blast Manager initiates blast sequence.

- Blast Manager to walk the pattern post blast to assess safety (no lost holes or misfires).
- Blast Manager reports “safe to operate”.

More details on the management of explosives are provided in Section D1.11.3.

Dust Control

Water will be used to control dust during construction and operation of the mine. Dust control is anticipated to be used on the following areas and operations:

- On haul roads inside or outside the mine pit.
- On the tops of active waste facility areas.
- During blast hole drilling.
- On ore transfer points.
- On stockpiles and waste rock areas, as per active waste areas.

The determination of when watering is necessary will be based primarily on dust management protocols that will be followed during mine operations and the outcome of the air quality management program (Section D3.1.1).

The amount of water used for dust control will depend on several factors. Seasons (wet or dry) will affect the need for more or less water. During blast drilling, water usage for dust control will depend on the production schedule as more tonnage produced will require more water. Water use for dust control may also be affected by the depth of the pit as haul roads will increase in length as the pit deepens.

Dust from the haul road and other roads will be minimized by the use of a 45-tonne capacity water truck that will operate both within the pit and along all waste and ore haul routes. It also will be used to cover other minor facility roads and the plant areas, as required. The water truck is also an essential element of the fire response team.

A4.3.4 Road Activity

The dominant road activity will be transport of ore and waste by haulage equipment. It is presently envisioned that this equipment will include up to 33 45-tonne end-dump trucks, nine loaders, four track dozers, two graders, two 45-tonne water trucks, one rubber-tired dozer, and other equipment (Table A4.3-1). In addition, the intermittent movement of such equipment as drills, ammonium nitrate fuel oil (ANFO) trucks, track hoes, front-end loaders, hydraulic excavators, cranes, fuel trucks, mechanic trucks, lube trucks and equipment transport trucks will add to the road activity.

Road activity is dependent on the production schedule. Construction activity will maximize highway transport equipment moving through the facility, as well as the movement of support equipment such as cranes, dozers, graders and front-end loaders. As overburden stripping operations begin, waste rock will be hauled to the tailings facility and used to construct a portion of the tailings embankments. As mine production begins, there will be a transition to increased traffic on haul roads to the processing plant and waste rock facilities.

A4.3.5 Hours of Operation

Although initial mining operations for road and tailings facility construction activities likely will be conducted only eight hours per day, they will quickly shift to 24 hours per day, seven days per week.

A4.3.6 Schedule for Development

Mining of ore from Kwatebala is scheduled to start in the fourth quarter of 2008. Several months before this, some pre-stripping of overburden will occur at Kwatebala. The removed material will be used in part for construction of the tailings storage facility embankment. Mining of the ore will quickly ramp up to a production of about 7,000 tonnes per day of ore and about 16,000 to 17,000 tonnes per day of low-grade ore. In subsequent years, low-grade will be mined at variable rates.

Mining rates increase over time largely due to a rising waste ratio but may also increase in the future, pending additional feasibility studies, for expansion of the processing plant and mine. Detailed discussions of these expansions are beyond the scope of this study.

If mining rates do not increase due to future possible expansions, the open pits at Kwatebala will develop as shown in Figures A4.3-1 up to Year 10. There would be a similar development at the Goma and Fwaulu pits (Figures A4.3-2 and A4.3-3).

A4.3.7 Waste Rock and Ore Stockpile Facilities

Locations of waste rock and low-grade ore facilities are illustrated in Figure A4.1-1. These facilities are located close to the open pits in order to minimize haul distances, but generally stay a minimum distance of 500 meters from the pit rim to ensure that they will not prevent exploitation of potential future reserves. Waste rock will be hauled from the pits initially using haul trucks with a 45-tonne capacity and later, as the waste ratio increases, larger 100-tonne capacity trucks will be employed.

The maximum height of the main waste rock facility at Kwatebala will be about 100 meters, with a side slope of 1:1.5 (33.7 degrees). The waste rock facility at Goma is projected to be about 55 meters in height.

In addition to the waste rock facilities, there will be a short-term ore stockpile, divided into six sections, to allow blending of ore at the plant site. There also will be two low-grade ore stockpiles (east and west stockpiles), situated on top of waste rock and containing various grades of copper that is below the present cutoff grade for processing at the proposed plant site.

A program for identifying and segregating waste rock types will be evaluated to see if a best management practice can be established to further minimize the impact on storm waters. Although Acid Mine Drainage (AMD) will not be an issue with the oxide waste rock, there are soluble mineral phases containing metals present in the waste rock. For example, malachite, a copper carbonate, is mildly soluble in water at circum-neutral pH. Release of storm water from rock high in malachite is predicted to have possible impacts on the aquatic life in receiving water bodies. Therefore, the storm water management system has been designed not to discharge waste rock runoff to receiving water bodies at a frequency of greater than once every ten years, on average. Some of the leach tests on the waste rock indicated little or no potential to impact storm water quality. Further testing of the waste rock types is proposed, in the hope of being able to establish easily tested criteria for segregating waste rock with the potential to impact water quality from waste rock that do not. This may significantly limit the impact on storm water quality and allow release of much of the water that would otherwise be contained. Being able to release this water would further increase the ability of the proposed facility to handle large storm events and would increase the water flow in downgradient stream sections.

Plant areas covered by the various waste rock facilities, their volumes and maximum elevations, are provided in Table A4.3-2. These dimensions (facility footprint and maximum height) are for the fully identified ore reserves of both oxide and mixed oxide/sulfide ores and therefore represent the greatest dimensions that the stockpiles likely ever are to achieve. This ESIA covers only the mining and processing of oxide ores and assumes at least a 20-year mine life (processing about 49 million tonnes of oxide ore and stockpiling 54 million tonnes of low grade ore). Future mining beyond the scope of this ESIA would entail the mining and processing of mixed oxide and sulfide ores and also would require a higher stripping ratio due to the increased depth of the ore. A discussion of this potential future mining is provided in Section A4.17. Therefore, the actual dimensions required to contain the 20-year mine life covered under this ESIA are somewhat less than shown in Table A4.3-2.

Table A4.3-2 Dimension of Waste Rock Facilities and Ore Stockpiles

Facility	Approximate Area (ha)	Volume (Mt)	Maximum Height (m)
Kwatebala waste rock facility[(a)]	145	171	100
Goma waste rock facility	90	55	55
short-term ore stockpile	6	3	10
low grade ore stockpiles (east and west stockpiles)	38, 77	54	30

(a) Includes waste from Fwaulu

Portions of the access roads may be constructed using compacted mine waste from pre-production stripping operations.

A4.3.8 Construction

There will be heightened activity on site during the two-year construction phase with infrastructure development including the pits, processing area, tailings storage facility and waste rock facilities and pre-stripping ground preparation. An indication of this activity level is the addition of thirteen 45-tonne haul trucks to the mine fleet in Year 1.

Preparation of the waste rock facility and ore stockpile sites will involve brush clearance, salvage of topsoil, salvage/preservation of endemic flora, construction of the access roads, and construction of storm ditches and culverts to direct water away from the waste rock facility and open pit areas.

These diversion ditches will intercept clean surface water before it reaches waste materials, and typically will be dug along the up-gradient side of the waste rock facilities where significant amounts of storm water runoff may drain through the dump. These ditches will incorporate culverts where they pass under access roads and will drain freely into nearby river courses.

The waste rock facilities and ore stockpiles will be constructed by truck dumping and dozing. In the first lift, trucks will dump the waste rock at, or near, the edge of the dump and a dozer will maintain and grade the area. The second lift will be developed using area dumping, although consideration must be given to surface runoff control during the wet season, in order to sustain suitable operating conditions.

The low grade ore stockpiles will be placed on a compacted base of waste rock.

A4.3.9 Operation

Operation of the waste rock facilities and ore stockpiles primarily involves grade and perimeter surveying control, maintenance of the haul roads accessing the dumps, and water control. A surveying staff will have the responsibility of maintaining grade and perimeter controls. Dozers and graders will be used to maintain the haul roads and working edges of the facilities. Runoff water will be diverted away from haul roads and in general not be allowed to pond near working faces. The waste rock from the oxide ore has been determined to be non-acid generating. However, waste rock runoff may contain constituents at concentrations that prevent direct discharge to the environment. Waste rock runoff and toe seepage water will be directed to a storm water pond. This pond will be designed to spill at a frequency of no more than once every ten years, on average. Non-contact runoff (i.e., runoff that does not contact waste rock) will be channeled around the waste rock facilities, where possible and collected in desilting ponds before release. These channels will be inspected and maintained as part of the storm water management system for the waste rock facilities.

Operation of the short-term ore stockpile will involve the use of front-end loaders to selectively feed the mill. The runoff water from the short-term ore stockpile will be directed to a storm water pond designed to spill at a frequency of no more than once every ten years, on average.

It is intended that most waste rock runoff and long-term stockpile runoff will normally be used within the process water circuit. The storm water pond that captures waste rock and long-term ore stockpile runoff has been designed to spill no more than once every ten years, on average. The waste rock has been determined to be non acid generating. However, some minerals in the waste rock are slightly soluble in rain water. Waste rock runoff is predicted to have some elevated dissolved metal concentrations relative to surface waters in the area. Runoff from waste rock facilities and ore stockpiles will normally be captured and tested prior to release, treatment, and/or use within the processing plant. When meeting the applicable water quality guidelines, storm water may be released during the wet season to manage the amount of water retained within the water circuit. If the water inventories exceed the containment capacity of the facility, a discharge of untested and untreated storm water may occur. The facility is designed to limit this kind of discharge to a frequency of less than once every ten years, on average. The water quality impact assessment (Section C2.12) demonstrates that no effects to aquatic life or other uses are expected as a result of waste rock runoff during these uncontrolled releases. During the initial phases of mining, waste rock runoff water will be tested to determine if metals concentrations are lower than the conservative predictions used in the assessment. Facilities design changes will be made, if required, to manage all runoff that has the potential to affect aquatic life or other water uses.

A4.4 PROCESS AND PLANT DESCRIPTION

The plant is capable of processing 7,000 tonnes per day of ore from the Kwatebala area to produce up to 115,000 million tonnes per year copper cathode and 10,000 tonnes per year of cobalt; of which up to 8,000 tonnes per year of the cobalt may be produced as metal with the balance being in the form of dried cobalt hydroxide. Figure A4.4-1 shows a schematic of the copper circuit and copper purification steps.

A4.4.1 Grinding

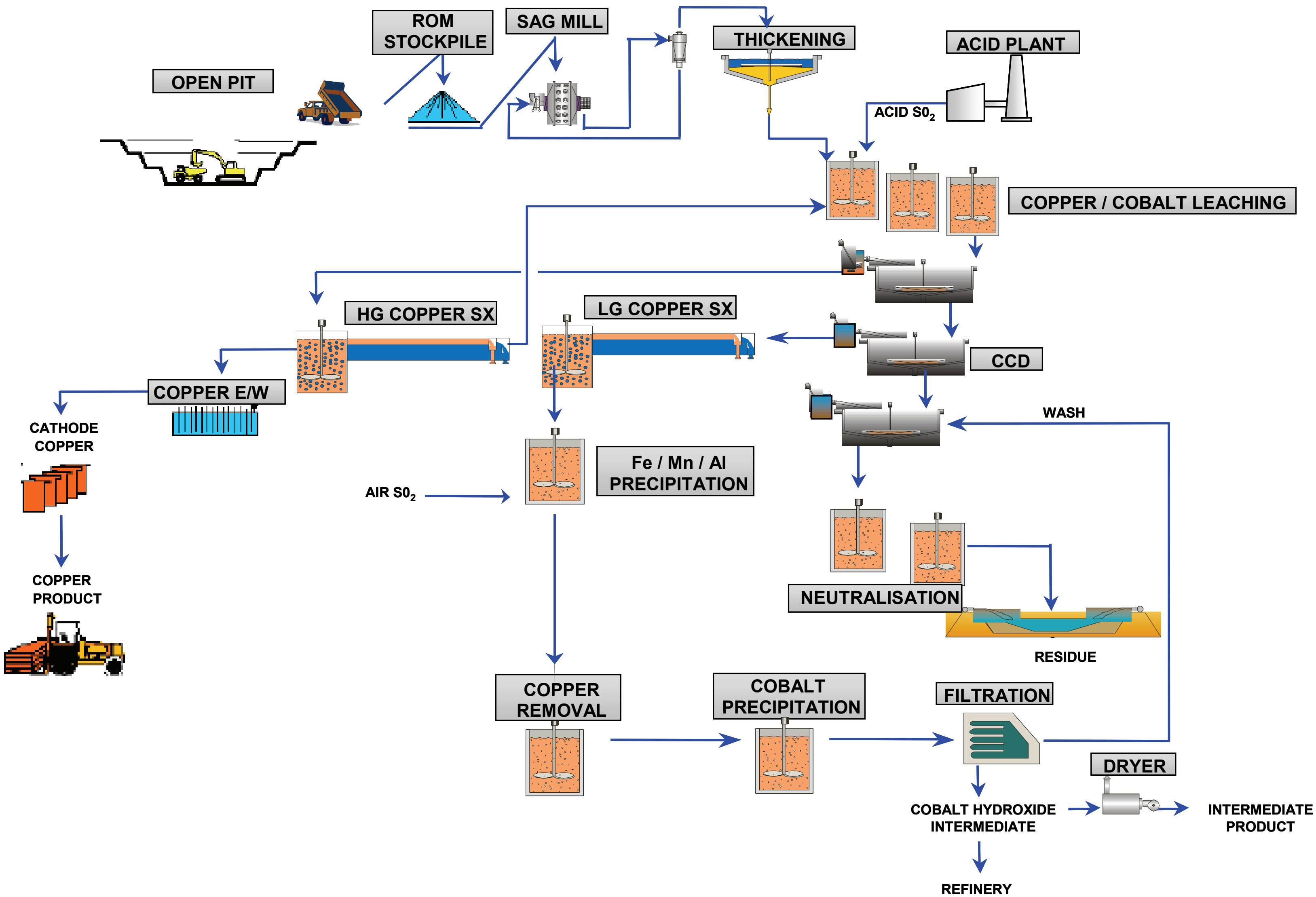
Run-of-mine (ROM) ore is delivered by haul truck to the ROM pad. The ore is blended into the ROM bin using front-end loaders. Oversize rock is removed using a grizzly. The ore is conveyed to the single stage (6.1 meter diameter, 6.1 meter EGL SAG) mill, which operates in closed circuit with a cluster of 660 millimeter hydrocyclones, to grind the ore to 80 percent passing 200 microns.

A4.4.2 Leaching and Counter Current Decantation

The ground slurry is thickened, pumped to the first of five leach tanks and mixed with sulfur dioxide (SO_2), sulfuric acid (H_2SO_4) and raffinate to achieve a leach feed pulp density of 20 percent (weight/weight). Copper and cobalt leach extractions in excess of 98 percent and 90 percent, respectively are achieved in the leach operation. The leached slurry is thickened and the overflow, containing 13 grams per liter of copper, is clarified and pumped to the high-grade (HG) pregnant leach solution (PLS) pond.

Thickener underflow is pumped to the counter current-decantation (CCD) circuit to recover dissolved copper and cobalt values from the leached solids. A wash ratio of 1.4 to 1.6 tonnes of wash solution per tonne of CCD feed solids is used to achieve a wash efficiency of 99.2 percent. CCD 1 overflow, containing six grams per liter of copper, is clarified and pumped to the low-grade (LG) PLS pond. The washed solids from CCD 6 are pumped to the neutralization circuit.

Figure A4.4-1 Copper Circuit and Cobalt Purification



A4.4.3 Neutralization

CCD 6 underflow, excess CCD wash solution, iron residue slurry and cobalt refinery eluate streams are neutralized using hydrated lime. Hydrated lime is added to a pH of 10.2 to precipitate magnesium. The final neutralized slurry is pumped to the lined tailings pond at a pulp density of 46 percent (weight/weight).

A4.4.4 Solution Extraction and Electrowinning

The solution extraction facility consists of a single circuit comprising four extraction and two stripping stages. The HG and LG circuits have two extraction stages each and the common organic stream is stripped in two stages.

Copper is extracted from the PLS solution using organic at an extractant concentration of 30 percent (volume/volume) and an overall advance organic aqueous ratio in the extraction circuit of approximately 1.2:1. The copper is subsequently stripped from the organic phase to produce strong electrolyte at a concentration of 55 grams per liter of copper.

The strong electrolyte is filtered to remove any entrained organic, prior to electrowinning using 280 cells, operating at a nominal current density of 330 amp per square meter. The copper concentration is reduced to 40 grams per liter (i.e., delta copper of 15 grams per liter). Copper cathode is harvested every six days. The LME Grade A cathodes are removed, washed, stripped, weighed and dispatched using three semi-automatic stripping machines. The stainless steel cathode blanks are returned to the cells for re-use.

The HG raffinate, containing approximately 1.6 grams per liter of copper, 7 grams per liter of cobalt and 19 grams per liter of H_2SO_4, electrolyte bleed and electrolyte filter backwash solutions are combined in the HG raffinate pond and are predominantly returned to the leach circuit to reduce fresh H_2SO_4 consumption and to achieve the desired 20 percent (wet weight) pulp density. Excess HG raffinate, is pumped to the LG raffinate pond.

A4.4.5 Cobalt Recovery

The cobalt recovery circuit comprises three discrete unit operations, prior to the cobalt refinery:

a) Fe/Al/Mn Removal

Excess HG raffinate and LG raffinate, containing 0.44 grams per liter of copper, 3.4 grams per liter of cobalt and 12.3 grams per liter H_2SO_4, are neutralized using limestone to a pH of 3.5. Sulfur dioxide and air are sparged into the agitated tanks to precipitate iron, aluminum and manganese (FAM) under oxidizing conditions. Limestone is added to each of the tanks for pH control. The resultant slurry is thickened and filtered to recover the cobalt solution. The filter cake, containing predominantly gypsum, iron and aluminum hydroxides, is repulped and pumped to the neutralization circuit. The FAM is commingled with tailings and disposed of in the tailings storage facilty.

b) Copper Precipitation

Slaked lime is added to the solution from the FAM removal circuit, to increase the pH to 5.8, removing copper from solution. Sulfur dioxide and air maybe sparged into the agitated tanks to promote the precipitation of any remaining manganese. The slurry is thickened and the solids are returned to the leaching circuit for recovery of the precipitated copper.

c) Cobalt Precipitation

Magnesia is added to the solution from the copper precipitation circuit to produce cobalt hydroxide at a purity of approximately 44 percent cobalt. Two stages of precipitation are used to improve the purity of the hydroxide precipitate. The thickened cobalt hydroxide is filtered and either fed to the cobalt refinery, or dried in a flash dryer and bagged for export. The cobalt-free solution is predominantly used as CCD wash solution, with the excess reporting to the neutralization circuit.

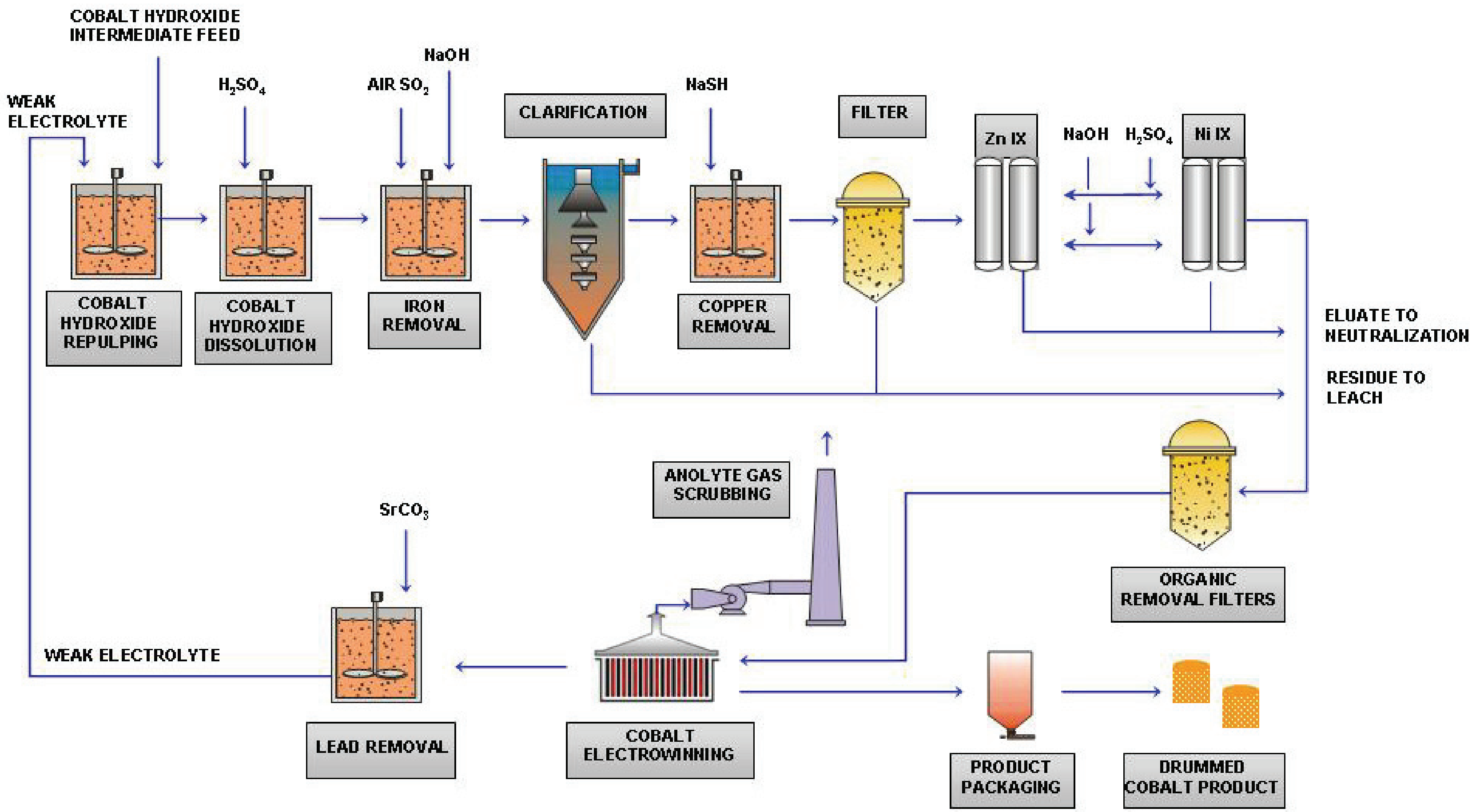
A4.4.6 Cobalt Refinery

The on-site cobalt refinery circuit comprises the following circuits (see also Figure A4.4-2).

a) Cobalt Hydroxide Dissolution

Cobalt hydroxide filter cake from the cobalt precipitation circuit is leached with H_2SO_4 to dissolve the cobalt into solution. An air/SO_2 mixture is added to the resultant slurry to precipitate any dissolved iron. Caustic soda is used to adjust the pH. The solution is filtered to remove impurities.

Figure A4.4-2 Cobalt Refinery



b) Copper Removal

Traces of copper are removed from the solution by the addition of sodium hydrosulphide. The solution is filtered, with the solids being returned to the ore leaching circuit for the recovery of contained cobalt.

c) Ion Exchange Clarification

The Fe/Cu free solution is passed through Zn and Ni ion exchange circuits prior to electrowinning of cobalt.

d) Cobalt Electrowinning

The Zn/Cu/Ni-free strong electrolyte is circulated through 62 electrowinning cells, employing anode bag technology and operating at a current density of 350 amps per square meter. Each of the cells takes approximately three grams per liter of cobalt "bite" from the feed solution, which is subsequently returned to the recirculation tank.

Anolyte is withdrawn from the anode bags prior to removal of lead using strontium carbonate. Excess solution is pumped to the cobalt precipitation circuit for recovery of cobalt values, while the remainder is returned to the cobalt hydroxide dissolution circuit for repulping the cobalt hydroxide precipitate.

Approximately 50 percent of the cathode surface area is masked with a resin to produce cobalt cathode deposits which are discs of approximately 25 millimeter diameter and 6 millimeters thick. The cathodes are removed from the electrowinning cells, washed with hot demineralized water and manually stripped from the cathode mother blanks. The high-purity cobalt metal is then packaged into drums, sampled, weighed and shipped.

A4.4.7 Sulfuric Acid Plant and Steam Generation

Based on an overall acid plant availability of 92.5 percent, the 600 tonnes per day sulfur burning sulfuric acid plant produces 202,500 tonnes per year of sulfuric acid and 50,600 tonnes of sulfur dioxide, predominantly for use in the leach circuit. Total consumption of sulfur is estimated to average 28.6 kilograms per tonne of ore. Waste heat from the acid plant is utilized for steam raising and is supplemented with steam produced from electric boilers, for various heating duties throughout the plant.

A4.4.8 Reagents

An indication of quantities of material used or produced is provided in Tables A4.4-1 and A4.4-2. Limestone is delivered to the site stockpile from the Mofia limestone quarry. The limestone is crushed, milled and pumped through a ring main distribution system to the FAM removal circuit.

Quicklime is delivered to the site in bulk bags and stored in sheds. The lime is mixed with water in a slaking mill and the resulting milk of lime slurry distributed through a ring main system to the tailings neutralization and copper precipitation circuits.

Magnesia is delivered to the site in bulk containers and pneumatically off-loaded into twin storage silos. The magnesia is mixed with water and the resulting milk of magnesia pumped to the primary and secondary cobalt precipitation circuits.

Flocculant make-up and distribution systems are provided on site for the thickening applications in the leach feed, leach discharge, HG clarification, LG clarification, CCD, FAM removal, copper precipitation, cobalt precipitation (both stages) and secondary cobalt hydroxide precipitation solution clarification circuits. Coagulant storage and distribution facilities also are provided to assist with the removal of soluble silica from the PLS.

Sodium hydroxide (NaOH) is delivered to the site as a solid (flake or pearl), dissolved in water to form a 10 percent solution, and distributed to the leach area, sulfuric acid plant and cobalt dissolution off-gas scrubbers, where it is used to scrub sulfur dioxide in the off-gases. Sodium hydroxide also is used in the cobalt refinery for IX resin regeneration and for pH adjustment of the cobalt electrolyte.

Diluent and extractant off-loading, storage and pumping facilities also are provided within a classified area, for distribution to the solvent extraction circuit.

A4.4.9 Utilities

Plant air is generated in two duty/one standby air compressors and reticulated throughout the plant site at approximately 700 kilopascals pressure. Instrument air is produced by taking a slip stream of plant air and passing it though desiccant dryers and filtration units before reticulating the instrument air throughout the plant site.

Four (three duty, one standby) low-pressure air blowers generate low-pressure air for use in the FAM removal circuit.

Table A4.4-1 Estimated Materials and Air Emissions Produced

Reagent	Details	Units	Per Year
Materials			
Products			
copper cathode	transported off site	t	115,000
cobalt cathode	transported off site	t	8,000
cobalt hydroxide	transported off site	t	0 to 4545
cobalt carbonate	transported off site	t	0
Tailings solids			
kaolinite	tailings disposal	kt	127
quartz	tailings disposal	kt	1,431
gypsum	tailings disposal	kt	187
biotite	tailings disposal	kt	51
tourmaline	tailings disposal	kt	128
kokchetavite	tailings disposal	kt	26
muscovite	tailings disposal	kt	192
dibantite	tailings disposal	kt	69
dolomite	tailings disposal	kt	11
periclase	tailings disposal	kt	41
pyrolusite	tailings disposal	kt	2
brucite	tailings disposal	kt	16
unreacted lime	tailings disposal	kt	8
unreacted limestone	tailings disposal	kt	27
FeOOH	tailings disposal	kt	21
$MgCa(SO_4)$	tailings disposal	kt	181
aluminium hydroxide	tailings disposal	kt	6
anthracite	tailings disposal	t	79
garnet	tailings disposal	t	80
converter catalyst from acid plant	hazardous waste disposal	t	20
acid plant waste from filters	tailings disposal	t	750
crud [(b)]	tailings disposal	t	240
Tailings liquids			
$CaSO_4$ from neutralisation	tailings disposal	kt	8
Na_2SO_4	tailings disposal	Kt	20
laboratory waste (liquid)	tailings disposal	t	200
neutralised acid plant waste	tailings disposal	kt	4
Mining waste			
waste ore	waste ore stockpile	kt	11,000
Waste landfill			
paper waste	waste disposal facility	t	10
food scraps (plant & villages)	waste disposal facility	t	7,500
general waste (plant & villages)	waste disposal facility	t	5,000
empty sulphur bulk bags	waste disposal facility	bags	12,158
empty quicklime bulk bags	waste disposal facility	bags	6,588
other empty reagent bags	waste disposal facility	bags	30,000
laboratory waste (solids)	waste disposal facility	t	500
used anode bags	waste disposal facility	bags	2,496
Storage yard			
used parts	used storage yard	t	500
empty 1m^3 extractant IBCs	used storage yard	IBCs	170
used anode frames	used storage yard	frames	499
For recycling			
used pallets	used storage yard	pallets	1,902
empty 200 litre ball drums	used storage yard	drums	1,050
used lubricants	recycling	t	100
used tires	recycling	tires	2,250
used anodes	recycling	anodes	668

Table A4.4-1 Estimated Materials and Air Emissions Produced (continued)

Reagent	Details	Units	Per Year
used cathodes	recycling	cathodes	657
batteries (light vehicles)	recycling	batteries	67
batteries (heavy vehicles)	recycling	batteries	48
toner cartridges	return to manufacturer	cartridges	50
vanadium oxide catalyst	recycling	t	20
resins	recycling	t	15
carbon	recycling	t	11
Sewage plant			
sewage (plant + construction village)	sewage plants	kL	219,000
Clinic waste (village)			
general clinic waste	incinerator	t	1
syringes	incinerator	t	1
blood products	incinerator	t	1
Other			
used personal protective equipment	incinerator	t	0.2
used electronic equipment	incinerator	t	0.3
Air emissions			
Airborne waste			
SO_2 emissions from acid plant	stack	t	438
SO_3 emissions from acid plant	stack	t	16
SO_2 emissions from leaching	scrubber	t	73
SO_2 emissions from Fe removal	vents	t	183
SO_2 emissions from Cu precipitation	vents	t	55
SO_2 emissions from Co feed prep scrubber	scrubber	t	12
SO_2 emissions from vehicles	exhaust	t	13
SO_2 from intermittent sources	emergency generators	t	0.38
H_2S gas from sulphur store	atmosphere	t	1
NO_x emissions from vehicles	exhaust	t	516
NO_x emissions from intermittent sources	emergency generators	t	18.6
CO emissions from vehicles	exhaust	t	221
CO from intermittent sources	emergency generators	t	1.58
CO_2 emissions from leaching	stack	t	70,841
CO_2 emissions from Fe removal	vents	t	30,353
CO_2 emissions from mining activities	mine	t	37,296
CO_2 emissions from vehicles on processing plant	exhaust	t	2,326
CO_2 emissions from intermittent sources	acid plant startup	t	1,642
CO_2 emissions from intermittent sources	emergency generators and fire pump	t	2,371
fine particulate matter from vehicles	exhaust	t	266
fine particulate matter from ROM	crushing	t	11
fine particulate matter from limestone	crushing	t	1
fine particulate matter from mining	drilling, blasting and materials handling	t	15
fine particulate matter from vehicles	road entrainment	t	273
fine particulate matter from stockpiles	wind erosion	t	79
Dust			
total particulate matter from ROM	wind erosion	t	28
total particulate matter from limestone	crushing	t	4
total particulate matter from mining	drilling, blasting, material handling	t	34
total particulate matter from vehicles	road entrainment	t	959
total particulate matter from stockpiles	wind erosion	t	2647
sulphur	bag splitting	t	1
hydrated lime	bag splitting	t	1
flocculant	bag splitting	t	0.1

(a) Greenhouse gas emissions are assessed in Section C2.8. Emissions will represent approximately 0.14 percent of Africa's yearly greenhouse gas emissions.

(b) Crud – an aqueous / organic emulsion formed in mixer settlers typically due to the presence of fine particulates. Crud is removed from the circuit as it impedes the efficient operation of the extraction circuit.

Table A4.4-2 Estimated Materials Used for the Copper Plant

Reagent	Details	Tonnes per Year
Reagents		
anthracite		79
antiscalant	CIBA antiprex 16, 8ppm	93
bentonite clay	crud treatment	125
boric acid	cobalt refinery	144
coagulant	polysil RM 1250 - 50% w/w	462
diluent	shellsol 2325	644
extractant	LIX 984N (30% v/v)	179
flocculant	hychem 302	417
flocculant	CIBA 919	4
garnet		80
glucosol CH4	electrowinning	52
hydrazine	acid plant	4
lime (hydrated)		13
limestone		108,540
magnesium oxide		11,745
mist suppressant	FC1100	0
quicklime		39,528
polyolefin prills		1
sodium chloride	copper EW	1
sodium hydrosulphide	cobalt refinery	51
sodium hydroxide flakes	leach vent scrubber	4,763
sodium hypochlorite	10.5 - 15% solution for potable water	729
sodium lauryl sulphate	cobalt refinery	1
sulphur	for acid / SO_2 plant	72,947
sulphur dioxide	from on site acid / SO_2 plant	41,999
sulphuric acid	from on site acid / SO_2 plant	161,676
strontium carbonate	cobalt refinery	4
tri sodium phospate	acid plant - water	4
Mechanical		
acetylene gas	for welding	150 cylinders pa
air cylinders	for welding	150 cylinders pa
diesel fuel	mining & processing	13,161
jet fuel		800
lubricants	mining & processing	10
spare parts	mining & processing	100
tires	mining & processing	1,150 heavy vehicle
tires	mining and processing	1,100 light vehicle
batteries		115
Other consumables		
copper cathode blanks	copper EW	535
copper anodes	copper EW	543
cobalt cathode blanks	cobalt refinery	122
cobalt anodes	cobalt refinery	125
anode bags	cobalt refinery	2,496
anode frames	cobalt refinery	499
resins	cobalt refinery	15
carbon	cobalt refinery	11
catalyst (vanadium oxide)	acid plant	20
Laboratory		
acetylene gas		120 cylinders pa
argon gas		120 cylinders pa
laboratory chemicals		10

Table A4.4-2 Estimated Materials Used for the Copper Plant (continued)

Reagent	Details	Tonnes per Year
laboratory consumables		5
oxygen gas		60 cylinders pa
General		
cleaning consumables		10
clinic supplies		10
first aid consumables		10
food / drink		300 to 600
safety consumables		1
stationery		30

Raw water is received on site from a series of water supply wells. It is anticipated that the raw water will be of potable quality with low concentrations of total suspended solids (TSS), total dissolved solids (TDS) and chlorides. Water quality tests will be carried out for each well to document that the water is potable. If water must be used from a well that is found to be non-potable, it will be treated. Raw water is fed to a fire water storage pond which continuously overflows into the adjacent raw water storage pond, thereby ensuring that the fire water pond is always full. The fire water pond is equipped with an electric fire water pump and a back-up diesel-driven fire water pump, together with dual jockey pumps. Fire water is piped throughout the plant site.

Gland seal water is distributed throughout the plant to pump mechanical and stuffing box seals on centrifugal pumps. A dedicated high-pressure gland seal water system also is provided for the tailings pumps.

Potable water is distributed to the washroom facilities, buildings and safety shower/eyewash stations throughout the site.

Low-pressure steam is generated in six steam electrode boilers (five operating, one standby) and reticulated at 600 kilopascals in lagged piping to the leach feed, FAM removal, and cobalt electrolyte feed heating systems. Steam condensate recovered from these units is returned to the boiler feed water tank. High conductivity (off-spec) steam condensate, however, is returned to the main process water tank. Steam generated in the acid plant waste heat boiler is also utilized in the process plant.

A4.4.10 Processing Plant Layout

Figure A4.4-3 shows the layout of the TFM processing plant.

NUMBER	DESCRIPTION		AREA
1	CRUSHING & EMERG. RECLAIM	CONSASSAGE ET ALIMENTATION D'URGENCE EN MINERAI	0010
2	GRINDING	BROYAGE	0020
3	LEACH FEED THICKENING	EPAISSISSEMENT DE LA SOLUTION LIXIVIANTE	0030
4	LEACHING	LIXIVIATION	
5	COUNTER CURRENT DECANTATION	DECANTATION A CONTRE COURANT	0040
6	SOLVENT EXTRACTION	EXTRACTION PAR SOLVANT	0060
7	COPPER ELECTROWINNING	ELECTRO-OBTENTION DU CUIVRE	0070
8	COBALT RECOVERY PLANT	USINE DE RECUPERATION DU COBALT	0080
9	NEUTRALIZATION & TAILS	NEUTRALISATION ET RESIDUS MINIERS	0050
10	SULFURIC ACID PLANT	USINE D'ACIDE SULFURIQUE	0090
11	COBALT REFINERY	RAFFINERIE DE COBALT	0080
12	PLS POND - LG	SOLUTION DE LIXIVIATION ENRICHIE - FAIBLE TENEUR	0060
13	PLS POND - HG	SOLUTION DE LIXIVATION ENRICHIE - HAUTE TENEUR	0060
14	RAFFINATE STORAGE POND - LG	BASSIN DE STOCKAGE DU RAFFINAT - FAIBLE TENEUR	0060
15	RAFFINATE STORAGE POND - HG	BASSIN DE STOCKAGE DU RAFFINAT - HAUTE TENEUR	0060
16	SX EMERGENCY POND	BASSIN D'URGENCE SX	0060
17	PROCESS WATER TANK	RESERVOIR D'EAU DE PROCEDE	0110
18	WORKSHOP	ATELIER	0150
19	WAREHOUSE	ENTREPOT	0150
20	MAIN 33kV SUBSTATION	PRINCIPAL POSTE ELECTRIQUE 33kV	0130
21	OFFICE & CONTROL ROOM	BUREAU ET SALLE DE CONTROLE	0140
22	COBALT HYDROXIDE STORE	ENTREPOT D'HYDROXYDE DE COBALT	0140
23	WEIGH BRIDGE	PONT-BASCULE	
24	GATE HOUSE	POSTE DE GARDE	0140
25	REAGENT STORAGE	ENTREPOSAGE DES REACTIFS	0140
26	LABORATORY	LABORATOIRE	0140
27	LIMESTONE & LIME	CALCAIRE ET CHAUX	0103
28	DILUENT & EXTRACTANT	DILUANTS ET AGENTS D'EXTRACTION	0102
29	LEACH CONTAINMENT POND	BASSIN DE CONFINEMENT DU LIXIVIAT	0030
30	CHANGE HOUSE	VESTIARE	0140
31	BREAK ROOM	SALLES DE RECREATION	0140
32	CAR PARK	PARKING	
33	HV SWITCHYARD	CENTRALE ELECTRIQUE	0130
34	HEAVY VEHICLE REFUELING	STATION A ESSENCE POUR VEHICULES LOURDS	
35	STANDBY GENERATORS	GROUPE ELECTROGENE DE SECOURS	0130
36	FUEL STORAGE	ENTREPOSAGE DE CARBURANT	0113
37	HEAVY VEHICLE WORKSHOP	ATELIER DE REPARATION DES VEHICULES LOURDS	0150
38	DRAINAGE POND	BASSIN DE COLLECTE DES EAUX DE RUISSELLEMENT	
39	SULFUR STORAGE	ENTREPOSAGE DU SOUFRE	0140
40	SEWAGE PLANT	USINE DE TRAITEMENT DES EAUX USEES	
41	AIR/COMPRESSOR	AIR/COMPRESSEUR	0111
42	TIRE SERVICE BAY	POSTE DE REPARATION PNEUMATIQUE	
43	SENTRY BOX	GUERITE	0140
44	POTABLE WATER FACILITY	USINE D'EAU POTABLE	0110
45	LIME STORAGE	ENTREPOSAGE DE CHAUX	0140
46	FLOCCULANT PLANT	USINE DE FLOCULANT	0101
47	COBALT ELECTROWINNING	ELECTRO-OBTENTION DU COBALT	0088
48	BOILER HOUSE	BATIMENT DES CHAUDIERES	0112
49	BUS DROP OFF ZONE	ARRET DE BUS	
50	GAS/DIESEL TANKS	RESERVOIRS D'ESSENCE/DIESEL	
51	LEACH DISCHARGE THICKENING	EPAISSISSEMENT DU LIXIVIAT DE DECHARGE	0030
52	RAW WATER POND	BASSIN D'EAU BRUTE	0110
53	FIRE WATER POND	BASSIN D'EAU INCENDIE	0110
54	WATER STANDPIPE	D'EAU TUYAU VERTICAL	
55	LAY DOWN AREA	AIRE DE STOCKAGE	
56	CRUD	RESIDUS SOLIDES D'EXTRACTION	0060
57	MAGNESIA	OXYDE DE MAGNESIUM	0105
58	SODIUM HYDROXIDE	HYDROXYDE DE SODIUM	0106
59	LIME	CHAUX	0104
60	LIGHT VEHICLE REFUELING	STATION A ESSENCE POUR VEHICULES LEGERS	
61	FIRST AID & FIRE BUILDING	POSTE DE POMPIERS ET PREMIERS SECOURS	0140
62	SUBSTATION	POSTE ELECTRIQUE	0130
63	VEHICLE WASH DOWN BAY	STATION DE LAVAGE	

ABN 52 008 992 694

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CLIENT: phelps dodge Corporation

REV	BY	DATE	REVISION
A	RJC	30.03.07	APPROVED FOR EIA

DRAWN: R.CARTER 30.03.07

SCALE 1:2500

PLANT GRID NORTH

PROJECT No. 52018 — DRG SIZE A1

CLIENT: PHELPS DODGE CORPORATION — FIGURE C2.6-2

TITLE: TENKE FUNGURUME MINING PROJECT

PLAN D'AMENAGEMENT DE L'USINE DE TRAITEMENT / PROCESSING PLANT LAYOUT

DRAWING No. 52018-0000-20-124-159 — REV No. A

Date: 30/03/2007 Time: 12:54:35 PM Plotted By: rcarter Pentable: LZR.TBL Plotdriver: PDF A3 - BW.plt Filename: W:\TENKE\52018\Drawings\General\Design Data\Sketches\52018-0000-20-124-159.dgn

A4.4.10.1 Stacks and Vents

There are stacks and vents located in the following areas:

- Leaching.
- FAM removal circuit.
- Cobalt refinery.
- Acid plant.

A4.4.10.2 Buildings

Table A4.4-3 shows the main list of buildings in the processing plant.

Table A4.4-3 Main Processing Plant Facilities

Building	Location (Number)	Building Height (m)	Building Area (m^2)
main security and gatehouse	24	3	244
change room and locker room	30	4	610
ablution (lunch room / 3 offices)	31	3	130
workshop / warehouse	18 / 19	7	1,980
cobalt hydroxide storage	22	7	300
reagent storage	25	7	1,500
fire aid & fire building	61	4	209
sulfur storage	39	10	2,700
lime storage	45	7	1,700
sentry box	43	3	12
heavy vehicle workshop / offices	37	19	2,050
main control room	21	3	440
laboratory	26	3	36

A4.4.10.3 Conveyors

Conveyors are used to transport ore, sulfur and limestone as follows:

- Mill feed conveyor transferring ore from ROM ore stockpile to SAG mill.
- Sulfur reclaim conveyor transferring sulfur from the bagsplitter to the feed hopper.
- Limestone plant crusher discharge conveyor transferring crushed limestone to screen.

- Limestone cone crusher feed conveyor transferring oversized limestone from screen to secondary crusher.
- Limestone mill feed conveyor transferring crushed limestone to limestone mill.

A4.4.10.4 Roads

All roads from the gatehouse within the processing plant will have a treated surface (about four kilometers in total). The access road to the plant site will be graded, compacted, surfaced with lateritic material and stabilized, most likely with a polymer-based additive. This stabilizer will reduce dust generation and improve the durability of the surface during the rainy season. Adequate surface drainage will be designed into the road cross section. A water truck will be used to reduce dust, as needed, during dry periods.

A4.4.10.5 Hours of Operation

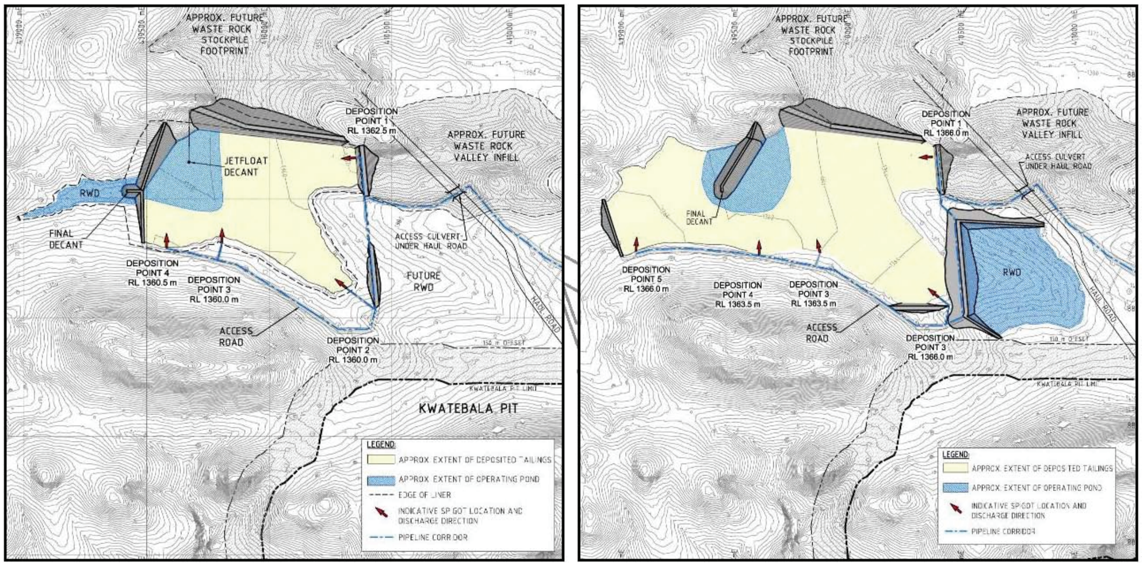
The processing plant will run 24 hours per day, 7 days per week.

A4.5 TAILINGS STORAGE FACILITY

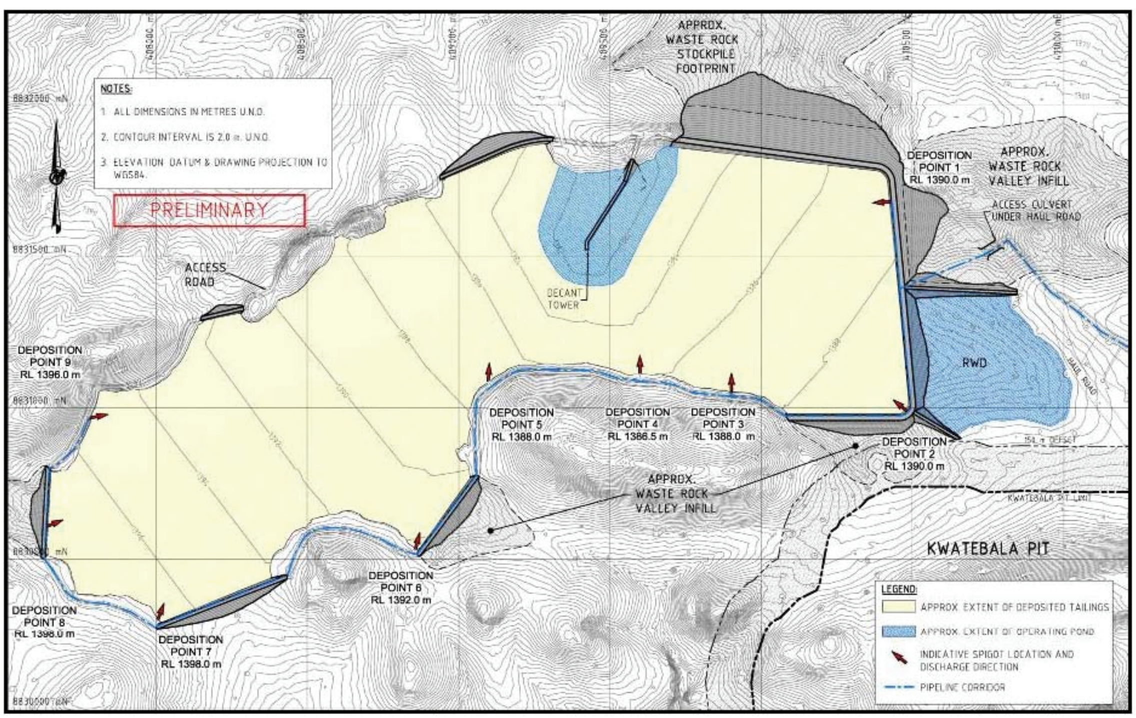
Phelps Dodge is committed to compliance with a “zero discharge” concept. This implies that all processed water in the tailings storage facility and return water dam (RWD) will either be evaporated, remain permanently in storage or recycled to the plant for re-use or be treated to meet acceptable water standards prior to being discharged. As well, little contaminated water discharge should report to groundwater, i.e., seepage through the floor of the tailings storage facility and RWD is to be minimized through all stages of operation and after closure.

The tailings storage facility (TSF), which will be lined, receives the milled, leached and neutralized mineral residue from the processing plant. It can be divided into two general facilities: the main tailings pond and the return water dam (RWD). The location of these proposed facilities is shown in the general tailings storage facility layout provided as Figure A4.5-1. A discussion of the facility is provided in the following sections. A summary of the tailings design study is provided in Section E9. A second TSF may be required towards the end of the mine life. It will be located north of Fungurume as shown on Figure A4.1-1.

Figure A4.5-1 Tailings Storage Facility Layout



Layout of tailings storage facility and return water dams after ~2 Years (left) and ~4 Years (right)



Layout of tailings storage facility and return water dams at End of Operational Life

A4.5.1 Tailings Tonnages

The design delivery tonnage to the tailings storage facility (including neutralization and FAM) will be 6,980 tonnes per day[11], based on a 0.997 tailings: ore ratio.

The ultimate storage capacity of the tailings storage facility is 115 million tonnes, based on a nominal ore reserve, established during an earlier stage of the design. The tailings storage facility will accommodate approximately 41 years of tailings at the proposed production rates.

A4.5.2 Base Metal Residues

This project involves the processing of oxide copper and cobalt ores through sulfuric acid leaching to produce solutions suitable for solution extraction and electrowinning recovery of copper and cobalt. Based on this proposed process design, two primary waste streams have been identified. These include tailings from the grinding/leaching circuit and iron/aluminum/manganese residues (FAM) plus magnesium hydroxide residues from the electrowinning process. These waste streams are neutralized with lime to pH 10.2 prior to disposal in the tailings dam.

A4.5.3 Tailings

The main tailings impoundment is located immediately north of the Kwatebala ore body, as shown in Figure A4.1-1. The TFM design has the required storage capacity of the presently known oxide ore reserve for the Kwatebala, Goma and Fwaulu ore bodies. It will be a lined impoundment, to prevent seepage to the groundwater or surface water. The embankments will be constructed primarily of waste rock, provided from the Kwatebala overburden and nearby areas within the impacted final footprint, if needed. The maximum embankment height will be about 70 meters. Construction of the embankments will be phased, with the first phase of construction planned to serve about four years before a raise in embankment is required. The placement of the liner also will be installed in a phased manner, with the first phase projected to serve for two years before an extension is needed. The tailings will be discharged from thickeners at the plant as slurry, containing about 54 percent water by weight. Water will be reclaimed from the tailings impoundment through the use of barge pumps and the reclaimed water will be pumped to the return water dam (RWD), for eventual recycling to

11 This estimate assumes the processing plant will not operate at 100 percent (24 hours per day) capacity. The tailings water balance is calculated at 7,469 tonnes per day, which assumes that discharge would occur 100 percent of the time (i.e., for 24 hours per day at 311.2 tonnes per hour).

the processing plant. After about Year 3, there is an option to construct a permanent decant tower or to continue use of barge pumps. If a permanent decant tower is used, it will be constructed to use a sump pump and will not drain through or under the TSF embankment. Tailings will be conveyed from the mill to the tailings disposal area by pipeline, where they will be discharged into the lined impoundment through strategically placed spigots.

A4.5.3.1 Tailings Characteristics

The average specific gravity of the tailings to be generated is expected to be about 2.65, and the material is described as a fine-grained sandy silt with a trace of clay, classified as SM under the Unified Soil Classification System. The dry density of the tailings is predicted to be about 1.4 tonnes per cubic meter. The tailings and ore mineralogy is presented in Table A4.5-1.

Table A4.5-1 Tailings and Ore Mineralogy (2006)

Mineral	Ideal Formula	Tailings % (Bench Upper)	Ore % (Bulk Upper)
quartz	SiO_2	56.0	53.7
chrysocolla	$Cu_{1.75}Al_{0.25}H_{1.75}(SiO_5)(OH)_4 0.25H_2O$	0.1	4.1
muscovite	$KAl_3Si_3O_{10}(OH)_2$	7.5	7.5
malachite	$Cu_2(CO_3)(OH)_2$	0.1	5.2
plagioclase	$NaAlSi_3O_8 – CaAl_2Si_2O_8$	0.4	0.4
pseudomalachite	$Cu_5(PO_4)_2(OH)_4$	-	0.4
heterogenite	CoOOH	0.1	0.7
chlorite (dibantite)	$(Mg_2Fe_{1.7}Cu_{0.06}Al_{1.75})Si_{3.25}Al_{0.75}O_{10}(OH)_8$	2.7	2.7
tourmaline	$K_{0.5}Mg_5Fe_{0.3}Cu_{0.2}Al_{9.5}Si_6O_{18}(BO_3)(OH)_4$	5.0	5.0
k-feldspar (kokchetavite)	$KAlSi_3O_8$	1.0	1.0
dolomite	$CaMg(CO_3)_2$	0.4	4.5
biotite	$K_2Fe_3Mg_{2.7}Cu_{0.25}Ti_{0.1}Si_{5.7}Al_{2.3}O_{20}(OH)_4$	2.0	2.0
kaolinite	$Al_2Si_2O_5(OH)_3$	5.0	5.2
goethite	FeOOH	0.8	0.8
periclase	MgO	1.6	1.6
pyrolusite	MnO_2	0.1	0.06
bunsenite	NiO	-	37 ppm
zincite	ZnO	-	31 ppm
hydrated lime	$Ca(OH)_2$	0.0	-
lime	CaO	0.1	-
gypsum	$CaSO_4.2H_2O$	7.3	-
brucite	$Mg(OH)_2$	0.6	-
calcite	$CaCO_3$	1.0	-
	$MgCaSO_4$	7.1	-
aluminium hydroxide	$Al(OH)_3$	0.2	-
water			5

Percentage (%) of each mineral phase shown.

The bulk of the total tailings will represent neutralized spent leach material. Approximately 684 tonnes per hour of slurry (including water content) from the plant will be discharged to the tailings storage facility.

A4.5.3.2 Design Criteria

The design of the TSF was carried out by Golder Associates of Perth, Australia and a design report has been prepared, which is the basis for some of the summaries in the following section. Some previous tailings design work by Knight Piésold and Partners of Ashford, Kent, UK, also was used in the design of the tailings storage facility.

Predicted tailings production will be at a rate of about 2.5 million tonnes per year. Tailings will be produced as slurry, with a water content of around 54 percent by weight (46 percent solids by weight).

A4.5.3.3 Tailings Storage Facility Embankments

The first stage of development will require the construction of two permanent earth embankments, which are to be formed predominantly from compacted waste material sourced from the mine pre-stripping operations and nearby areas within the impacted footprint, if needed. (Approximately 1.5 million cubic meters of waste rock will be required at the outset). The embankments also will be provided with a geomembrane cushion zone of compacted clayey silt material, to be sourced from within the tailings storage facility footprint. A typical cross-section through the permanent tailings storage facility perimeter embankments is shown in Figure (A4.5-2).

The upstream face is to be formed at 1(V):2.5(H) in order to facilitate liner placement and the first stage downstream face is to be formed at 1:2, which provides adequate short term factors of safety against slope instability. To reduce stresses on the liner, it will be necessary to compact the waste rockfill in the zones shown on Fig. A4.5-2. This implies that all of the Stage 1 rockfill will need to be compacted. This is envisaged to be carried out by placing or spreading the waste in approximately one meter layers and compacting it to a performance specification with a heavy impact roller. In later stages of development the waste material need not be compacted to this level.

Hydrological data for use in design of the tailings storage facility has been obtained from both local sources and from the Zambian copper belt, which lies within a similar meteorological zone. Total storm rainfall for 24-hour and 72-hour events have been derived. For reference, relevant events are in Table A4.5-2.

Figure A4.5-2 Tailings Storage Facility Embankment Construction

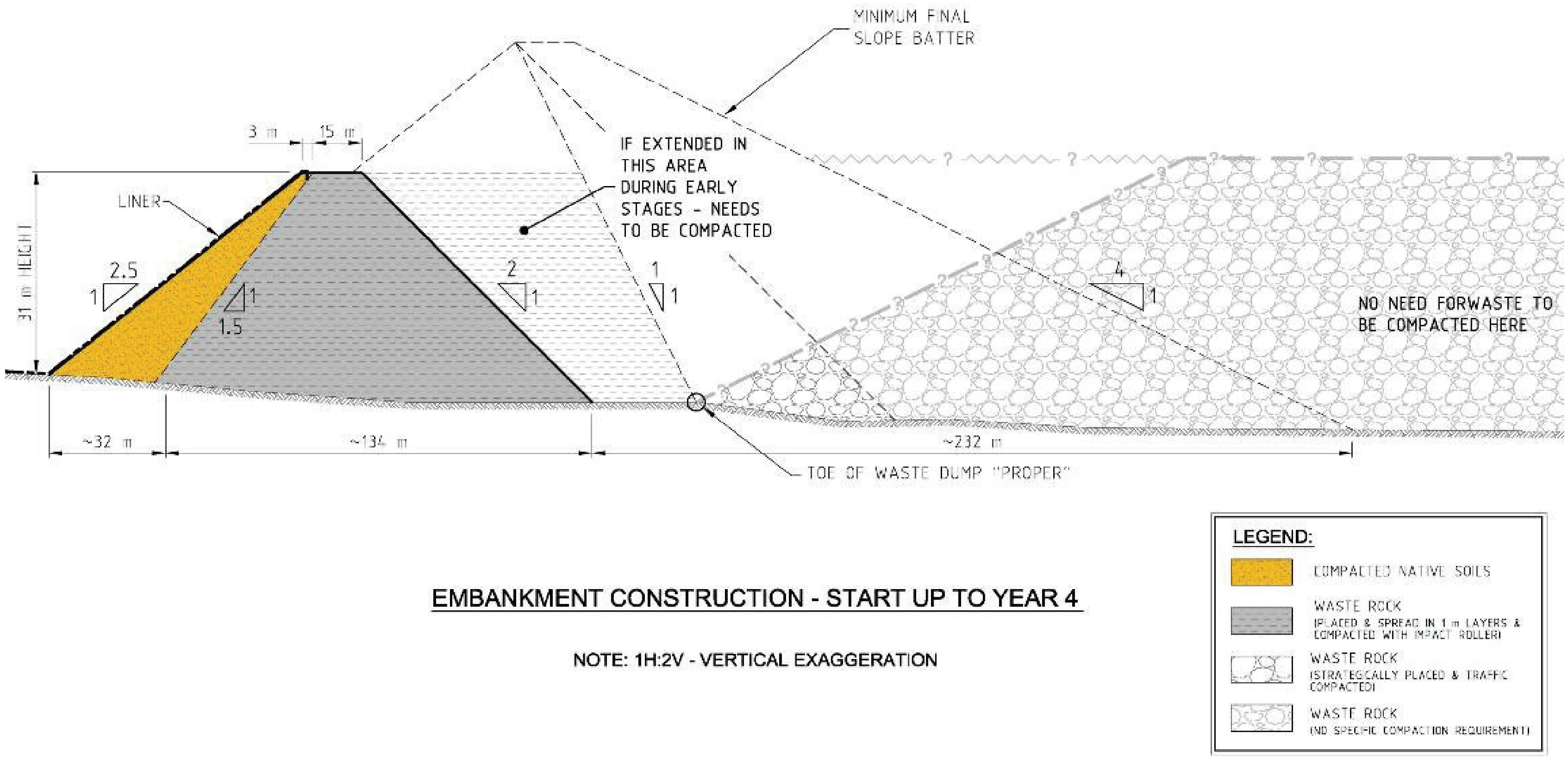


Table A4.5-2 Total Storm Rainfall for 24 and 72-Hour Events

Return Frequency (Year)	24-hour (mm)	72-hour (mm)
50	150	199
100	160	216
1,000	257	327
10,000	412	496

Seismic design of the dam has been undertaken using an operating basis earthquake of 0.12 gravity units peak ground lateral acceleration.

A4.5.3.4 Water Management

The tailings storage facility has been designed to accommodate at least a one in 100 year wet season, or a normal wet season, plus the occurrence of a probable maximum flood. This is accomplished through lining the impoundment and maintaining sufficient freeboard to contain high precipitation events.

Storm Water Management

The tailings storage facility has been designed to contain more than the one in 100 year wet season. The embankments will be constructed of compacted waste rock and the main embankments will be buttressed with the waste rock facility, minimizing erosion and overtopping dangers. The tailings storage facility will have a spillway, constructed near the end of the tailings storage facility life, over natural ground. It will be used to manage runoff from the closed facility. The tailings storage facility impoundment will be built in stages and runoff from uncontaminated catchment will be contained within the tailings storage facility and used in the processing plant.

Collection Channels

The tailings storage facility does not require collection channels for storm water runoff diversion around the facility. The outer dam embankments will be constructed of natural soils and/or waste rock. The main embankments are in contact either with the waste rock facilities or the RWD and cannot directly discharge storm water to a natural waterway.

A4.5.3.5 Tailings Deposition

Deposition will be managed to maintain a clear water pool at a preferred location adjacent to the natural ground near the northwest flank of the main embankment.

This location will become the site of the permanent spillway, to be activated after closure of the tailings storage facility.

A4.5.3.6 Tailings Water Balance

A water balance has been prepared to estimate the available water for recycling to the processing plant. It also has been used to estimate the freeboard required to prevent a release of water from the tailings dam, including during the probable maximum precipitation. In addition, a rainfall simulation was run to confirm that the tailings storage facility can contain multiple years of high rainfall. A simplified schematic of the project water balance is provided in Figure A4.5-3.

Inputs to the tailings storage facility water balance include rainfall over the tailings storage facility as well as the tailings slurry water. Outputs include evaporation from the pond and the tailings beach area, as well as residual water retained in the tailings indefinitely. Seepage through the TSF and RWD liners, which is calculated to be very minor, also is considered.

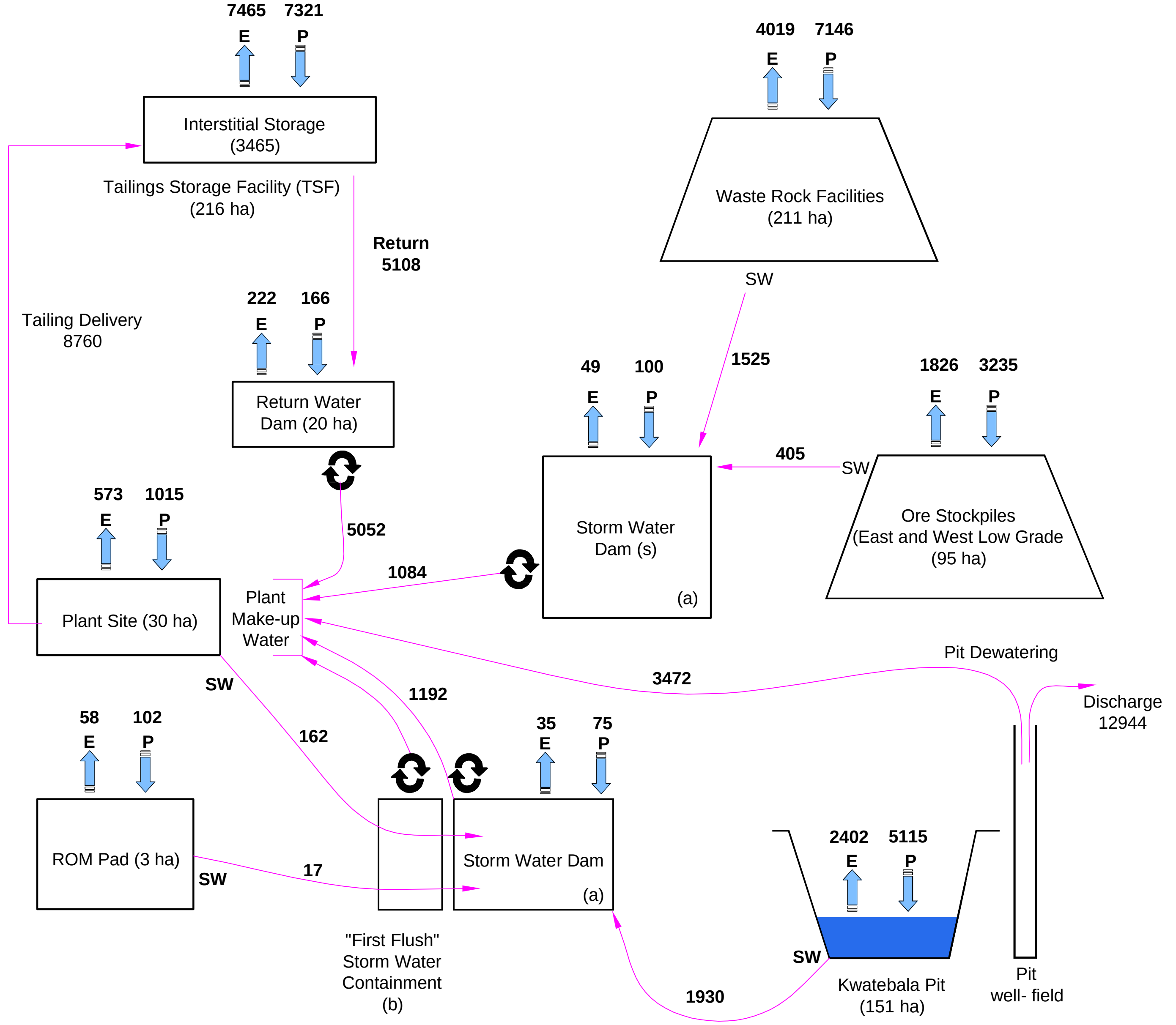
In an average year, the water balance indicates that, at a tailings production rate of 6,980[12] tonnes per day at 54 percent moisture, about 8,760 cubic meters per day of water will enter the facility in tailings and an average of 7,321 cubic meters per day from rainfall. About 3,465 cubic meters per day will be retained indefinitely within the tailings, while about 7,465 cubic meters per day will be lost in evaporation. Seepage losses from the lined tailings storage facility will be insignificant. In an average year, the tailings storage facility will return approximately 5,108 cubic meters per day back to the return water dam, which will return 5,052 cubic meters per hour to the processing plant.

Rainfall during the rainy season results in a positive water balance during the rainy sesason for the processing circuit.

A4.5.3.7 Tailings Supernatant Characteristics

Tailings supernatant characteristics are provided in Section B2.3-I.

[12] This estimate assumes the processing plant will not operate at 100 percent (24 hours per day) capacity. The tailings water balance is calculated at 7,469 tonnes per day, which assumes that discharge would occur 100 percent of the time.



LEGEND

- **P** Precipitation
- **E** Evaporation/Evapotranspiration
- **SW** Storm Water
- Recycle (Make-Up Water to Process Plant)

NOTES

- All flows in cubic meters per day (m^3/day).
- Water balance provided for full facility footprints (footprint areas in hectares [ha] shown for each facility).
- Seepages reporting to groundwater not shown in this figure. A more detailed water balance (including seepages) is provided in the Feasibility Study (MinProc 2007).
- Pit groundwater dewatering values are for groundwater model Scenario b (Section C2.10).

(a) Storm water dams designed for a spill frequency of once every 10 years, on average.
(b) "First flush" storm water containment designed to capture ROM and plant site runoff from first 10 minutes of a 1 in 50 year, 24 hour storm event.
(c) Excess pit dewatering water discharged or used for streamflow mitigation.

PROJECT

tfm

TENKE FUNGURUME PROJECT

TITLE

SCHÉMA POUR LA MOYENNE DE LA BALANCE D'EAU PAR JOUR - EAU EN SURFACE (MÈTRES CUBES PAR JOUR)/ AVERAGE DAILY WATER BALANCE SCHEMATIC - SURFACE FLOWS (m^3/day)

Golder Associates
Calgary, Alberta

PROJECT 05-1334-035.9310			FILE No. Water Balance	
DESIGN	BR	29/03/07	SCALE AS SHOWN	REV. 0
CADD	SWD	02/04/07	**FIGURE: A4.5-3**	
CHECK	GJ	31/03/07		
REVIEW	MR	02/04/07		

L:\2005\1322-EA\1334\05-1334-035\9300\9310\Tailings Storage Figures\Fig A4.5-3_SCHEMATIC Water Balance-Surface Flows.dwg Apr 02, 2007 - 1:22pm

A4.5.4 Return Water Dam

The RWD is designed to receive water decanted from the tailings storage facility and store it until it can be used in the process water circuit. It will be designed, in a staged approach, to hold about 1.4 million cubic meters of water. The RWD basin will be lined to inhibit seepage of the process waters to the groundwater or surface water. Pumps will be installed in the RWD to return the water to the plant.

The Stage 1 RWD will be located to the west of the initial stage tailings storage facility basin. The division between the tailings storage facility and the RWD arises from the objective of minimizing the liner footprint, while providing a tailings storage facility basin to accommodate two years' capacity (including acceptable freeboard). The majority of the western division wall will be absorbed into the tailings storage facility during later stages of development. However, it is planned to use the northern part of the wall as an access causeway to the final tailings storage facility's decant facility. This decant facility also will serve as a RWD decant during Stage 1, from where recovered supernatant water and captured rainwater will be pumped back to the plant.

To minimize the risks relating to piping erosion failure of the western division wall during the early stages of operation, a liner will be placed on the tailings storage facility (eastern) face of the wall. This liner will not be extended as the wall is converted into a decant access causeway. The division wall is to be predominantly constructed from nominally (traffic) compacted waste rockfill. To ensure liner continuity, the temporary embankment will be placed on top of the tailings storage facility liner. Appropriate cushion layers will be required to reduce the stresses on the liner that may be imposed through the placement and compaction of the rockfill.

A wall also is to be provided at the eastern extremity of the Stage 2 facility, to provide for the permanent RWD, which is to be located in the valley to the south-east of the tailings storage facility.

Due to the natural low area being at the northern extremity of the tailings storage facility basin, supernatant and rain water will gravitate to this point during the early stages of deposition. To facilitate water removal and transfer it back to the plant, a floating pontoon and associated access causeway (Jetfloat) is to be provided with pumps to transfer the water to the Stage 1 RWD, from where it will be pumped to the plant. In later stages, the permanent tailings storage decant facility will be used to pump water to the permanent RWD, from where it will be transferred to the plant. The Jetfloat will not be required after about Year 3.

The RWD serves to reduce sediment in the water returning to the process circuit, allows faster removal of impounded storm water, evens out the chemistry of the water returning to the process circuit, and allows the tailings storage facility to be operated with a smaller supernatant pool. A smaller clear water pool allows quicker consolidation of the tailings and promotes a flatter overall beach slope. These measures also serve to maximize the tonnage of tailing that can be stored in the tailings storage facility.

The design of this project has embraced a Phelps Dodge corporate policy of a “zero discharge” solution. This means that all process water will either remain permanently in storage, recycled to the processing plant for re-use, evaporated or treated to meet acceptable water quality standards prior to being discharged. Maximum recycle of water back to the metals recovery process(es) is included in the project design. Therefore, supernatant from the TSF will be directed to RWD for storage and return to the processing plant. However, water balance calculations performed around the total TSF/RWD system indicate a probable net excess of water.

A4.5.5 Dam Break Assessment

Consistent with accepted international recognized design practice a dam break assessment has been carried out on the proposed tailings storage facilities and associated RWD facilities. A “dam break” has been judged only likely to be possible under one or more of the identified scenarios below:

- Overtopping of perimeter embankments.
- Piping erosion of perimeter embankments.
- Instability of perimeter embankments.

With each of these considered the likelihood of a dam break is judged to be sufficiently low to obviate the need for a fully quantitative risk assessment. The risks are judged to be in a zone commonly referred to as the ALARA region (As Low As Reasonably Achievable).

A4.5.6 Tailings Storage Facility Closure

The final landform of the tailings storage facility will be formed with a gently sloping upper surface towards the north. It will thus be possible to create a landform that contains the poor quality TSF supernatant plus run-off water and evaporates it. Providing a permanent spillway channel will allow the tailings storage facility to ultimately shed rainwater, which will be advantageous.

The current closure plan includes the stockpiling of the available topsoil from the facility footprint, prior to facility construction. At the end of facility life, the closed tailings facility will be capped with a layer of coarse waste rock to minimize capillary action, and then covered with salvaged topsoil and seeded with suitable seed mix.

A4.6 SULFURIC ACID PLANT

Two of the key reagents required in the process are sulfuric acid and sulfur dioxide gas, which will be manufactured on site from formed elemental sulfur. This process is described in the following sections:

A4.6.1 Process Description

Sulfur from the sulfur storage area is fed into a storage bin and conveyed to the sulfur burners. Molten sulfur is filtered before burning with dry air in a furnace at a temperature range between 600 and 1,750 degrees Celsius. The sulfur dioxide gas is cooled in a waste heat boiler generating high-pressure steam. The cooled sulfur dioxide gas (14 percent) after the boiler is split into two main streams:

- The main gas flow to the sulfuric acid plant.
- The gas flow into the sulfur dioxide gas plant.

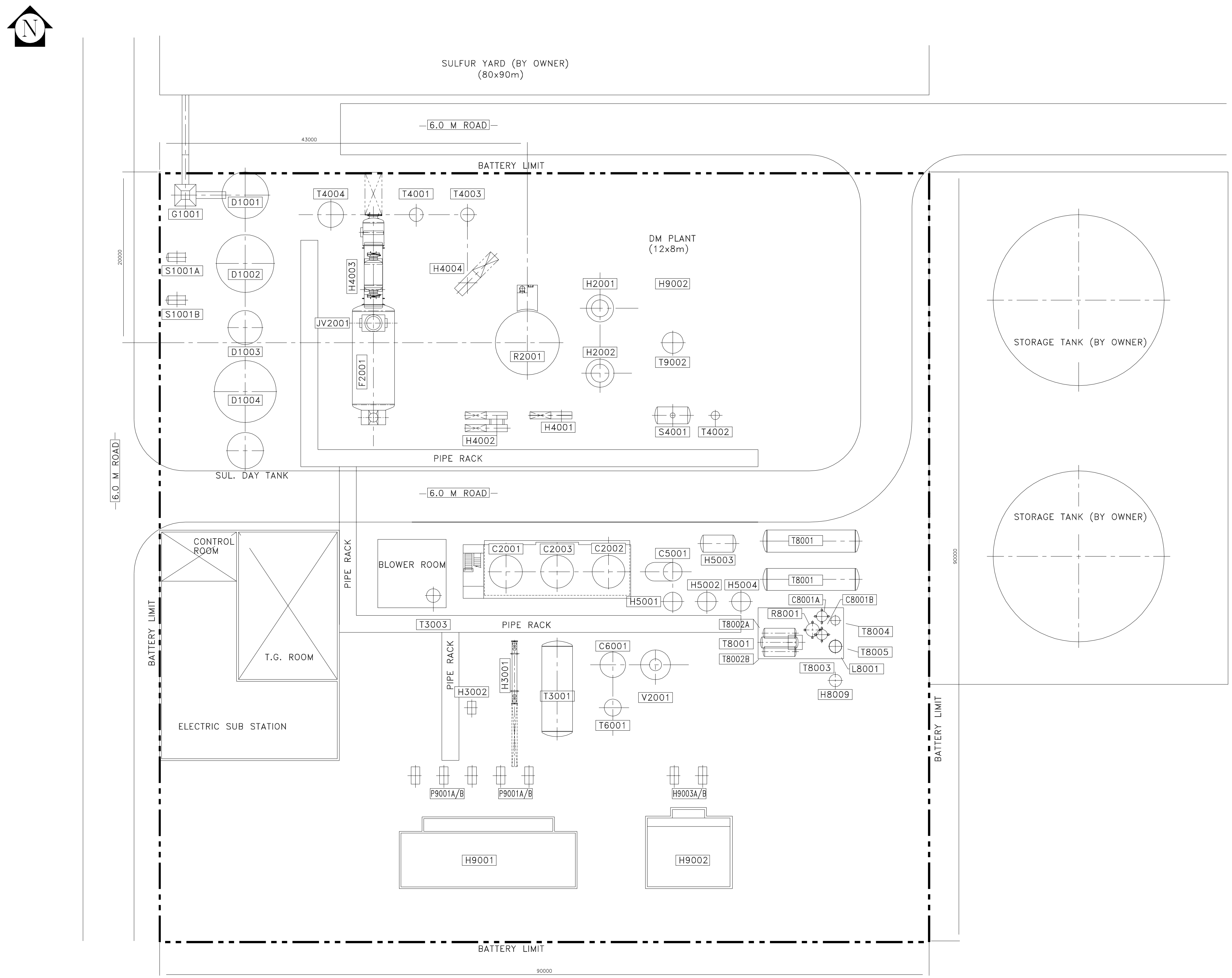
For acid production, the main flow is further diluted with dry air to 11.5 percent (maximum) and the sulfur dioxide is oxidized to sulfur trioxide in each of the catalyst layers. The gas is cooled after each catalyst layer and the sulfur dioxide/sulfur trioxide reaction progressed to a conversion level of over 90 percent. The gas mixture is then cooled and the sulfur trioxide removed in an intermediate absorption tower. The residual gas of approximately one percent sulfur dioxide is then reheated with process gas and converted in the final conversion with a total efficiency of over 99.7 percent from sulfur dioxide to sulfur trioxide. The sulfur trioxide generated is absorbed in the final absorber as sulfuric acid.

The sulfur dioxide is compressed to 4 bar pressure and cooled to 150 degrees Celsius (maximum) and delivered to the process plant.

A4.6.2 Site Layout

The site layout of the sulfuric acid plant is shown in Figure A4.6-1. The tail gas stack from the absorber will be 50 meters in height. The buildings in the sulfuric acid plant area will be limited to switching and motor control centers and a small control room area.

PROPOSAL NO. 03-06M02-B-SBT-015-00



OWNER TO CONFIRM
PLOT SIZE & PLANT NORTH

EQUIPMENT SCHEDULE

TAG NO.	DESRIPTION	REMARKS
A1002	PAY LOADER	NOT SHOWN
A1001	SULFUR BAG SPLITTER SYSTEM	NOT SHOWN
G1001	SULFUR FEED HOPPER	
E1002	SULFUR CONVEYOR	
A1003	LIME FEEDER	NOT SHOWN
A1004	TROLLEY FOR THE SEDIMENT COLLECTION	NOT SHOWN
D1001	SULFUR MELTER	
D1002	DIRTY SULFUR TANK	
P1002	DIRTY SULFUR PUMP	NOT SHOWN
D1003	PRECOAT SULFUR TANK	
P1003	PRECOAT SULFUR PUMP	NOT SHOWN
D1004	CLEAN SULFUR TANK	
P1004	CLEAN SULFUR PUMP	NOT SHOWN
S1001	SULFUR FILTER	
S2001	AIR FILTER	NOT SHOWN
B2001	MAIN AIR BLOWER (TURBINE DRIVEN)	NOT SHOWN
C2001	DRYING TOWER	
F2001	SULFUR BURNER	
JV2001	JUG VALVE	
R2001	CONVERTER	
H2001	HOT HEAT EXCHANGER	
H2002	COLD HEAT EXCHANGER	
C2002	INTERPASS ABSORPTION TOWER	
C2003	FINAL ABSORPTION TOWER	
V2001	STACK	
B2002	START UP BLOWER	NOT SHOWN
V2003	DIESEL FIRED START UP BURNER	NOT SHOWN
T3001	ACID PUMP TANK	
H3001	ACID CIRCULATING COOLER	
P3001	ACID CIRCULATION PUMP	NOT SHOWN
H3002	PRODUCT ACID COOLER	
T3002	ACID SUMP	NOT SHOWN
P3002	ACID SUMP PUMP	NOT SHOWN
T3003	DILUTION WATER TANK	
S4001	DEAREATOR	
T9002	DM WATER TANK	
H9002	DM PLANT	
P9002	DM WATER PUMP	NOT SHOWN
P4001	BFW PUMP	NOT SHOWN
H4001	ECONOMIZER 3B	
H4002	ECONOMIZER 4A/4C	
H4003	WASTE HEAT BOILER WITH STEAM DRUM	
H4004	SUPER HEATER	
T4001	BLOW DOWN TANK	
H4005	BLOW DOWN SAMPLE COOLER	NOT SHOWN
T4002	HYDARZINE TANK	
P4002	HYDRAZINE PUMP	NOT SHOWN
T4003	TSP TANK	
P4003	TSP PUMP	NOT SHOWN
T4004	CONDENSATE TANK	
P4004	CONDENSATE TRANSFER PUMP	
H4007	TURBO GENERATOR	
H4008	DUMP CONDENSOR	NOT SHOWN
C5001	27% OLEUM TOWER WITH PUMP BOOT	
P5001	27% OLEUM CIRCULATION PUMP	NOT SHOWN
H5001	27% OLEUM COOLER	
P5002	SO3 GENERATION PUMP	NOT SHOWN
H5002	OLEUM PREHEATER	
H5003	SO3 EVAPORATOR	
H5004	SO3 CONDENSER	
C6001	ALKLAI SCRUBBER	
P6001	ALKALI CIRCULATION PUMP	NOT SHOWN
P6002	ALKALI TRANSFER PUMP	NOT SHOWN
T6001	ALKALI PREPARATION TANK	
T8001A/B	LIQUID SO3 STORAGE	
T8002A/B	LIQUID SO3 DAY TANK	
P8001A/B	SO3 FEED PUMP	NOT SHOWN
T8003A/B	MOLTEN SULFUR DAY TANK	
P8002A/B	SULFUR FEED PUMP	NOT SHOWN
R8001A/B	JACKETED REACTOR	
T8004A/B	HOT WATER TANK	
P8003A/B	HOT WATER PUMP	NOT SHOWN
C8001A/B	SO2 POLISHING TOWER	
T8005A/B	SPARGER TANK	
L8001A/B	MIST ELIMINATOR VESSEL	
H8009	SO2 CONDENSER	
T8001	SO2 STORAGE TANK	
H9001	COOLING TOWER – 1	
P9001	COOLING TOWER–1 PUMP	
P9002	COOLING TOWER – 2	
H9003	COOLING TOWER–2 PUMP	
B9001	LP BOILER	NOT SHOWN
C9001	CHEMICAL TREATMENT SYSTEM	NOT SHOWN
C9002	INSTRUMENT AIR COMPRESSOR	NOT SHOWN

TYPICAL

ALL DIMENSIONS ARE IN MILLIMETERS & CO-ORDINATES ARE IN METERS UNLESS NOTED OTHERWISE

REVISIONS NO.	DATE	DESCRIPTION	BY	BY	BY
0	05MAY	ISSUED FOR PROPOSAL	RBP	GRD	PBS

REFERENCES

ISSUE DATE	PURPOSE OF ISSUE
05 MAY 06	PROPOSAL

FIGURE A4.6-1

LAYOUT FOR
SULFURIC ACID AND GASEOUS SO2 PLANT
TENKE FUNGURUME (DRC)

	BY	DATE	APP'D.	DATE	JOB NO.	REVISION
DRAWN	RBP	26APR06	PBS		06M02	A
CHECKED	GRD				DRAWING NO. 301-101	
SCALE	1:250					

DOC NO. 09-06M02-B-301-101- A

A4.6.3 Sulfur Storage

Sulfur will be stored in an undercover storage facility and there will be provision to receive bagged material. The sulfur will be recovered by forklift and fed via a bagsplitter and conveyer to the sulfur melting pit. Sulfur storage and handling facilities are designed to prevent the generation and ignition of explosive sulfur dust. The storage facility will be covered to protect the sulfur from rainfall. This will improve the handling characteristics of the material as well as limit the potential for corrosion of containment surfaces. The cover also will limit the potential for contamination of storm water runoff.

A4.6.4 Sulfuric Acid Storage Tanks

There will be two carbon steel-covered sulfuric acid storage tanks. These tanks will have secondary containments sufficient to capture the full capacity of one of the tanks plus ten percent, and will also be instrumented to prevent overfilling.

A4.6.5 Hours of Operation

The sulfuric acid plant is scheduled to be operated 24 hours per day, 365 days per year.

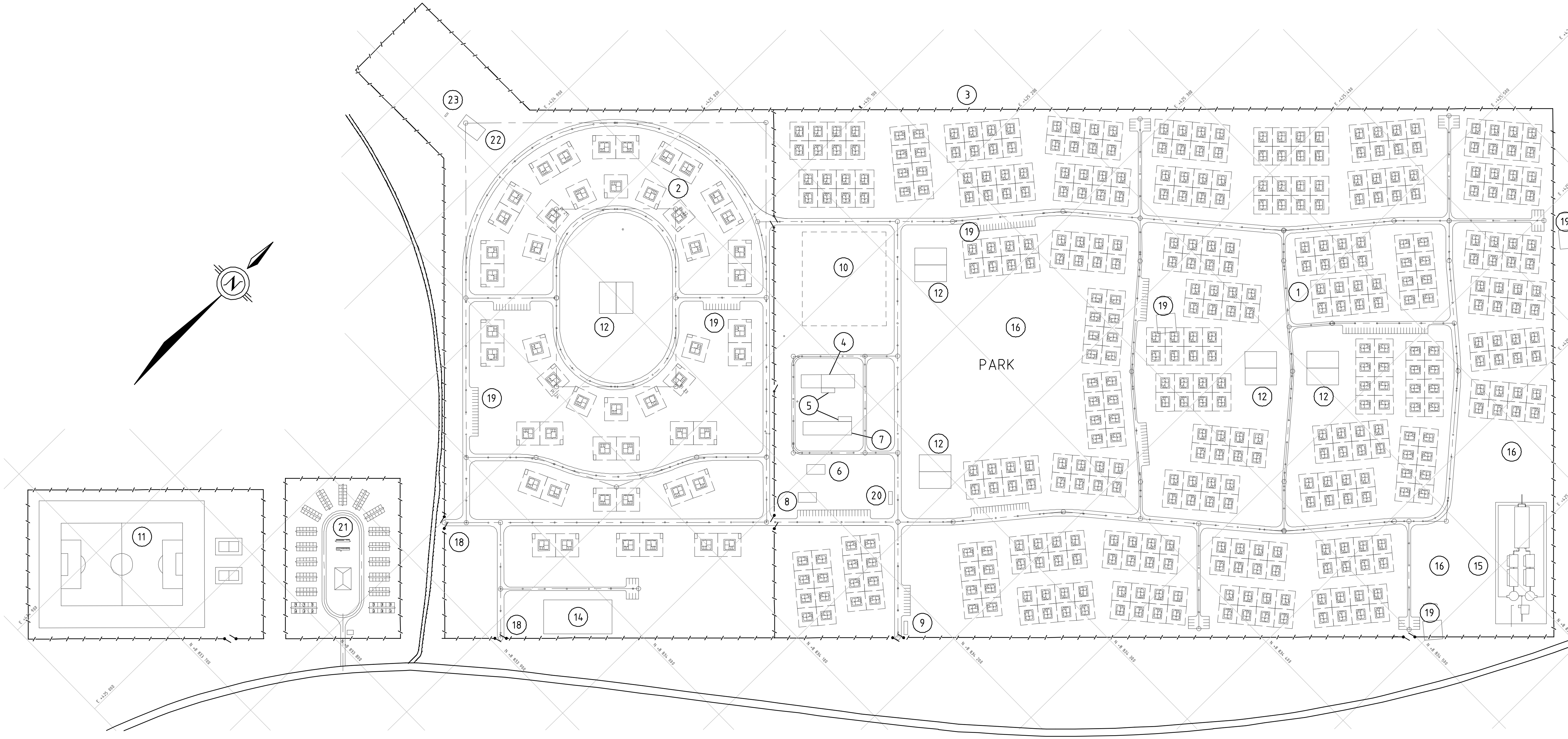
A4.7 ANCILLARY FACILITIES

Brief descriptions of the principal elements of mine infrastructure are provided below.

A4.7.1 Construction Camp/Permanent Village

A construction camp for construction workers will be developed at a site north of Fungurume, as shown in Figure A4.7-1. The camp will provide secure, serviced accommodation, canteen, domestic support and recreational facilities. The village initially will be developed to house construction workers, engineering supervisors and management staff during the construction phase. As the construction phase comes to an end, some of the residences will be converted to a permanent village. However, it is envisioned that additional camp space will be needed for future expansions of the TFM operations (Section A4.17). The construction camp/permanent village is referred to as the construction village in this report.

The following sub sections describe facilities planned for the construction village. It is intended that this camp will be managed by an outside contractor.



NUMBER	DESCRIPTION	NUMBER	DESCRIPTION
1	WORKFORCE 4 PERSON - 400 OFF	13	TRANSFORMER
2	SENIOR STAFF 1 PERSON - 50 OFF	14	POTABLE WATER TREATMENT PLANT
3	SECURITY FENCING	15	SEWAGE TREATMENT PLANT
4	MESS - 800 SITTING	16	OPEN SPACE AREAS
5	ABLUTIONS BUILDINGS	17	BUS PICK UP POINTS
6	LAUNDRY BUILDING	18	ALTERNATE GATES (NORMALLY CLOSED)
7	RECREATION BUILDING	19	PARKING BAYS
8	ADMINISTRATION BUILDING/SECURITY	20	FUEL STATION
9	FIRST AID/FIRE/GUARD BUILDING	21	TEMPORARY CONSTRUCTION CAMP
10	FUTURE TENTS/MARQUEE	22	SWIMMING POOL (EXISTING)
11	FOOTBALL PITCH	23	SQUASH COURT (EXISTING)
12	BASKETBALL COURTS - 5 OFF		

No. OFF & SIZE TO BE DETERMINED

REFERENCE

Drawing prepared from drawing provided by GRDMinproc
(52018-0170-01-121-500.dgn.pdf)

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SCALE 1:4 000 METRES
ÉCHELLE 1:4 000 METRES

PROJECT/PROJECT
tfm
PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITLE/TITRE
PLAN AMENAGEMENT PROPOSÉE POUR LE VILLAGE/ PROPOSED VILLAGE LAYOUT

Golder Associates
Calgary, Alberta

PROJECT/PROJET	05-1334-035	
DESIGN/DESSIN	GJ	31 Oct. 2006
CADD/CAD	PSR	31 Oct. 2006
CHECK/VERIFIE	GJ	31 Oct. 2006
REVIEW/APPROUVE	MR	31 Oct. 2006

FILE No. Prop Village layout
SCALE/ECHELLE AS SHOWN/tel que montré REV. 0

FIGURE: A4.7-1

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A4.7.1.1 Accommodation

Accommodation at the camp will be provided for approximately 1,600 construction personnel on the following basis:

- 400 units with four-person accommodation.
- 35 units with two-person accommodation.
- 15 units with single-person quarters.

Additional accommodation will be available at the existing TFM camp, and many local workers will live in their homes in the region such that the peak workforce of construction and operations staff (3,100 staff, see Table A4.13-1 in Section A4.13.3) will be housed. During operations, the camp will be converted to a permanent village with a total capacity for 2,500 persons. The preferred construction type for the units will be fired brick buildings, equipped with running water and electric power. The bricks, windows and doors are proposed to be produced locally. Each building unit will contain sleeping and washroom facilities.

The accommodation area will be provided with potable water, power and a sewage collection system. Area lighting will be installed throughout the housing area.

A4.7.1.2 Catering and Food Supply

During construction, meals will be prepared in a central kitchen and dispensed in the adjoining mess hall, designed to accommodate 800 personnel at one sitting. Mid-day meals will be packed individually before departing for the plant site, and consumed at the plant site mess.

Entry to the mess hall will be controlled, and will admit employees and authorized visitors only.

Sufficient food storage, both refrigerated and non-refrigerated, will be provided for kitchen use.

A4.7.1.3 Domestic Water Supply

It is proposed to provide water for camp use from the existing 50-meter diameter concrete water tank at Fungurume. Water quality from borehole P3, which feeds this water tank, has been investigated, and chemical analyses have proved it to be of a quality acceptable for drinking, with disinfection treatment.

Piping will be connected to the existing distribution system and run to outlets throughout the camp. If required, a separate camp water tank and pumping system may be installed. All potable water supplies will be treated with filtration and disinfection facilities as required to ensure compliance with applicable standards.

A4.7.1.4 Sewage and Waste Disposal

A sewage treatment plant will be installed to treat waste from individual dwelling units, communal buildings and the kitchen and mess. The plant will be located some distance from the accommodation units and will be fed by a piping system connected to all sewage outlets. Services such as power and water will be provided at the treatment plant. The plant will produce both a solid and liquid waste product. The solids either will be composted and used as a soil amendment or will be disposed of in a landfill adjacent to the camp (Figure A4.1-1). The effluent water should meet all applicable discharge standards for use in agriculture or discharge to the Kabomboy River. The appropriate standard for use in agriculture is the recently revised World Health Organization Guidelines for the Safe Use of Wastewater, Excrete and Greywater (2006).

These systems are specified by the manufacturer to produce an effluent quality of 20 milligrams per liter five-day biochemical oxygen demand (BOD5), 30 milligrams per liter suspended solids, and 10 milligrams per liter ammonia as nitrogen. Similar systems that are used widely throughout Europe and Africa achieve these standards.

Domestic and other waste will be disposed of in accordance with the waste management concepts described in Sections D3.1.8, D3.1.9 and D3.1.10.

A4.7.1.5 Domestic Support Facilities

The following facilities will be provided at the camp:

- Village administration and security.
- Laundry and storage buildings.
- First Aid. This will provide basic first aid only with treatment for more serious cases provided at Fungurume.

A4.7.1.6 Entertainment Facilities

Recreational facilities will cater to both indoor and outdoor pursuits.

The facilities provided will include a recreation building equipped for television viewing, indoor games and general relaxation. A gymnasium will be constructed next to the recreation building.

For outdoor activities, a soccer pitch and basketball courts will be built.

A4.7.2 Growth Centers

It is recognized that TFM operations near Tenke and Fungurume will attract additional population into the mining concession. The population of existing communities will increase, even with the provision of the construction camp and permanent village for direct employees of the project. Since there is currently virtually no infrastructure in the urban population centers of Tenke and Fungurume, these communities will become distressed even more if there is no planning to prepare for this influx.

An approach that will be closely examined is to plan growth centers next to major population centers where basic infrastructure such as roads, water and common areas may alleviate some of the worst impacts of this ‘induced development’. An analysis of alternatives was performed as part of the FS and ESIA preparation to determine the best locations for such investment (Section A3). The conclusion of this analysis was that two growth centers should be planned, one next to Tenke and the other next to Fungurume.

It also was decided that exact locations of these facilities should not be established without consulting local government and community leaders, and the sitting and management of these the growth centers should preferably be part of the larger community development effort, described in Section A4.14. The TFM contribution will be to provide the needed land on the concession, and to provide on-going urban planning technical assistance to help define town-planning requirements and to formulate long-term approaches for meeting community needs through the growth center concept.

As the process now is conceived, TFM would assist in the design and establishment of basic infrastructure for each growth center. At a minimum, this would include constructing access roads, a market and recreation area and providing potable water. If desired by the communities, a portion of the funds derived from the local development fund (Section A4.1.2.4) could be used to put in place infrastructure to manage sewage and solid wastes, to establish schools and possibly to bring electrical power to the growth centers. These decisions should best be made as part of the formal community development process, with priorities established by the communities themselves.

A4.7.3 Limestone Quarry and Crusher

The Mofia limestone quarry is located about 10 kilometers north of Fungurume and about two kilometers northwest of the proposed construction camp (Figure A4.1-1). The limestone will be used for chemical neutralization at the processing plant. Approximately 110,000 tonnes of crushed limestone will be produced annually from this installation and transported by truck to the processing plant. The truck route will be by the Mulumbu access road, as shown in Figure A4.1-1.

A4.7.4 Fencing

The Kwatebala pit and mining operations including workshops will be fenced in a common area with the processing plant. The TFM camp is currently fenced and the construction camp village, limestone quarry and airstrip individually will be fenced.

A4.8 WATER MANAGEMENT

Impacts to surface and groundwater, both during construction and operation of the mine, processing facilities and ancillary facilities, will be carefully managed. The general approach for managing these impacts is described below.

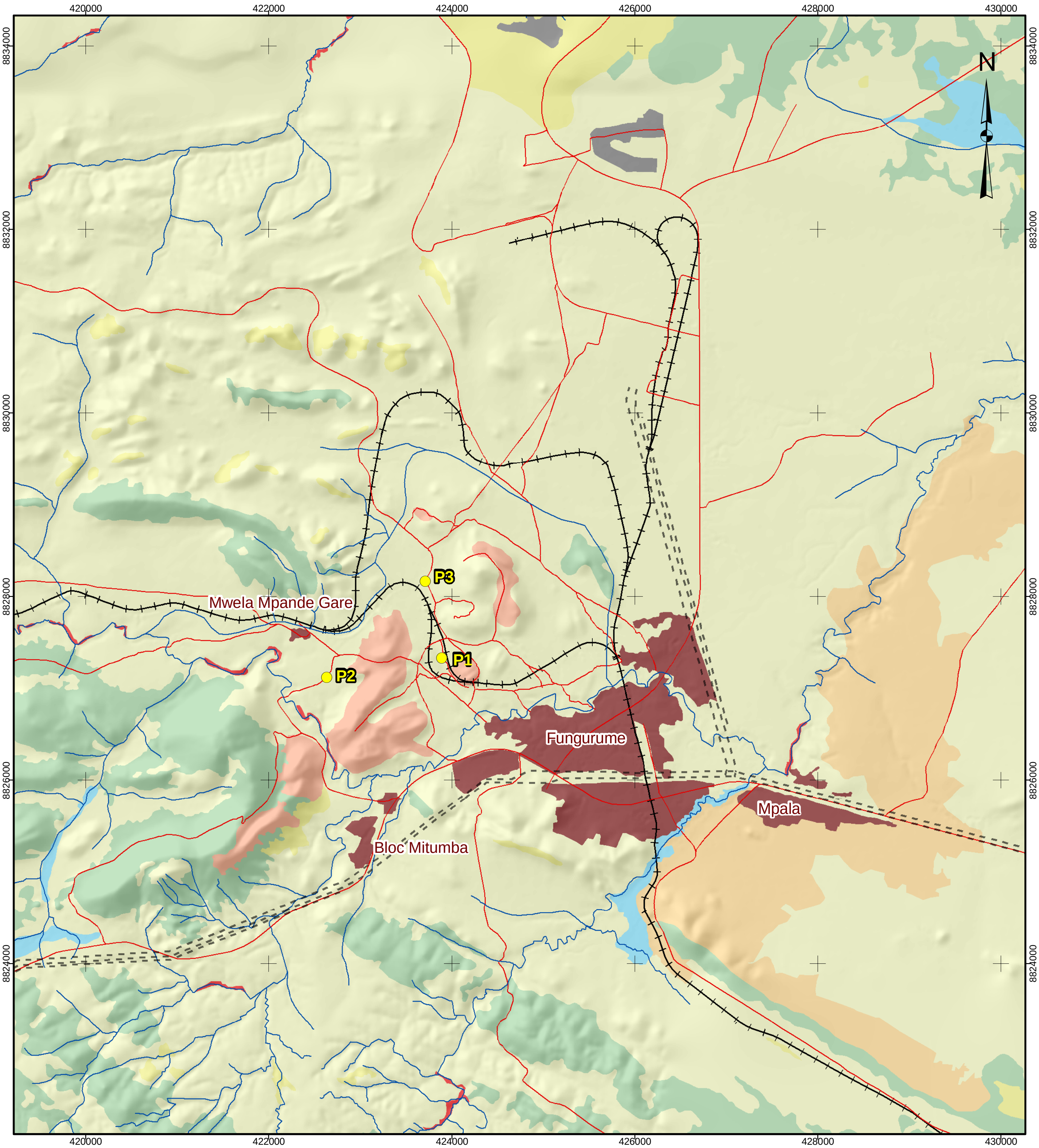
A4.8.1 Construction

A4.8.1.1 Water Use

Water use during construction primarily will consist of supplying the construction camp with water for municipal uses, placing engineered fill materials, washing down equipment, concrete batching, dust control and pump testing of potential new water supply sources.

A4.8.1.2 Water Sources

Raw water supply to the construction village will be from the existing production wells near Fungurume. Production wells P1 through P3 are shown in Figure A4.8-1. These wells will be inspected and refurbished to provide reliable water sources. The preliminary estimate of abstraction rates is in the order of 25 to 35 liters per second. A new pipeline will be constructed from the existing 50-meter diameter concrete tank (Viper Hill Tank) north of Fungurume, which is about one kilometer from the proposed construction camp. Water will flow under gravity from these tanks to the construction village.



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ÉCHELLE 1:60000 MÈTRES
SCALE 1:60000 METRES

LÉGENDE / LEGEND

- PUITS / GROUNDWATER WELLS
- LIGNE DE TRANSPORT D'ÉNERGIE / POWER LINE
- RIVIÈRE / RIVER
- RIVIÈRE INTERMITTENTE / SEASONAL RIVER
- ROUTE / ROAD
- VOIE FERRÉE / RAILWAY

COUVERTURE VÉGÉTALE / UTILISATION DU TERRAIN / LANDCOVER

- STEPPE-SAVANE SUR SUBSTRAT CUPRO-COBALTIFÈRE / COPPER-COBALT STEPPE-SAVANNA
- FORÊT DE MIOMBO / MIOMBO WOODLAND
- FORÊT DE MIOMBO DÉGRADÉE / MIOMBO WOODLAND DEGRADED
- FORÊT GALERIE / GALLERY FOREST
- ZONE HUMIDE / WETLAND
- MOSAÏQUE AGRICOLE / AGRICULTURAL MOSAIC
- ANCIENNE JACHÈRE / OLD FALLOW FIELD
- PERTURBATION / DISTURBANCE
- ÉTABLISSEMENT HUMAIN / SETTLEMENT

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S / Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE / TITLE **PUITS D'EAU SOUTERRAINE QUI SERVIRA COMME SOURCE D'APPROVISIONNEMENT EN EAU (VILLAGE PERMANENT) / GROUNDWATER WELLS TO BE USED AS WATER SOURCES (PERMANENT VILLAGE)**

Golder Associates
Calgary, Alberta

N° projet / project no. 05-1334-035.9000			Échelle telle qu'indiquée Scale as Shown	REV. 0
DESSIN / DESIGN	GJ	22 Jun. 2006	**FIGURE: A4.8-1**	
SIG / GIS	CW	02 Jan. 2007		
VÉRIFIÉ / CHECK	MR	31 Oct. 2006		
APPROUVÉ REVIEW	MR	31 Oct. 2006		

Project: I:\CLIENTS\PHELPS_DODGE\05-1334-035\mapping\mxd\Tenke_ESIA\Volume_A\FigureA4.8-1_GroundWaterWells.mxd - Plot: I:\CLIENTS\PHELPS_DODGE\05-1334-035\mapping\pdf\Tenke_ESIA\Volume_A\FigureA4.8-1_GroundWaterWells.pdf

Water used for constructing the plant and tailings storage facility and for pre-stripping operations at the mine will be extracted from new groundwater wells, which will be located near Kwatebala Hill (Figure A4.8-2). Process water also will be obtained from these wells.

A4.8.1.3 Surface Water Management Plan

Surface water impacts were considered as part of the evaluation of alternatives for locating the proposed facilities (Section A3). Where possible, impact to existing waterways was avoided. Protection of the water quality within these waterways will be accomplished during construction through the use of BMPs. These BMPs are a collection of simple technologies for reducing the energy in runoff water, so that it does not carry significant sediment from disturbed areas. These technologies include such installations as diversion channels, sedimentation ponds, rock filters, plastic water dams, etc. These BMPs are outlined in Section D3.1.1.

Sewage wastes from the construction camp and the construction activities at Kwatebala primarily will be managed through installation of package sewage treatment facilities. However, small engineered septic systems may be required on a temporary basis at some locations. Solid wastes will be managed by establishing solid waste landfills near the processing plant and construction camp.

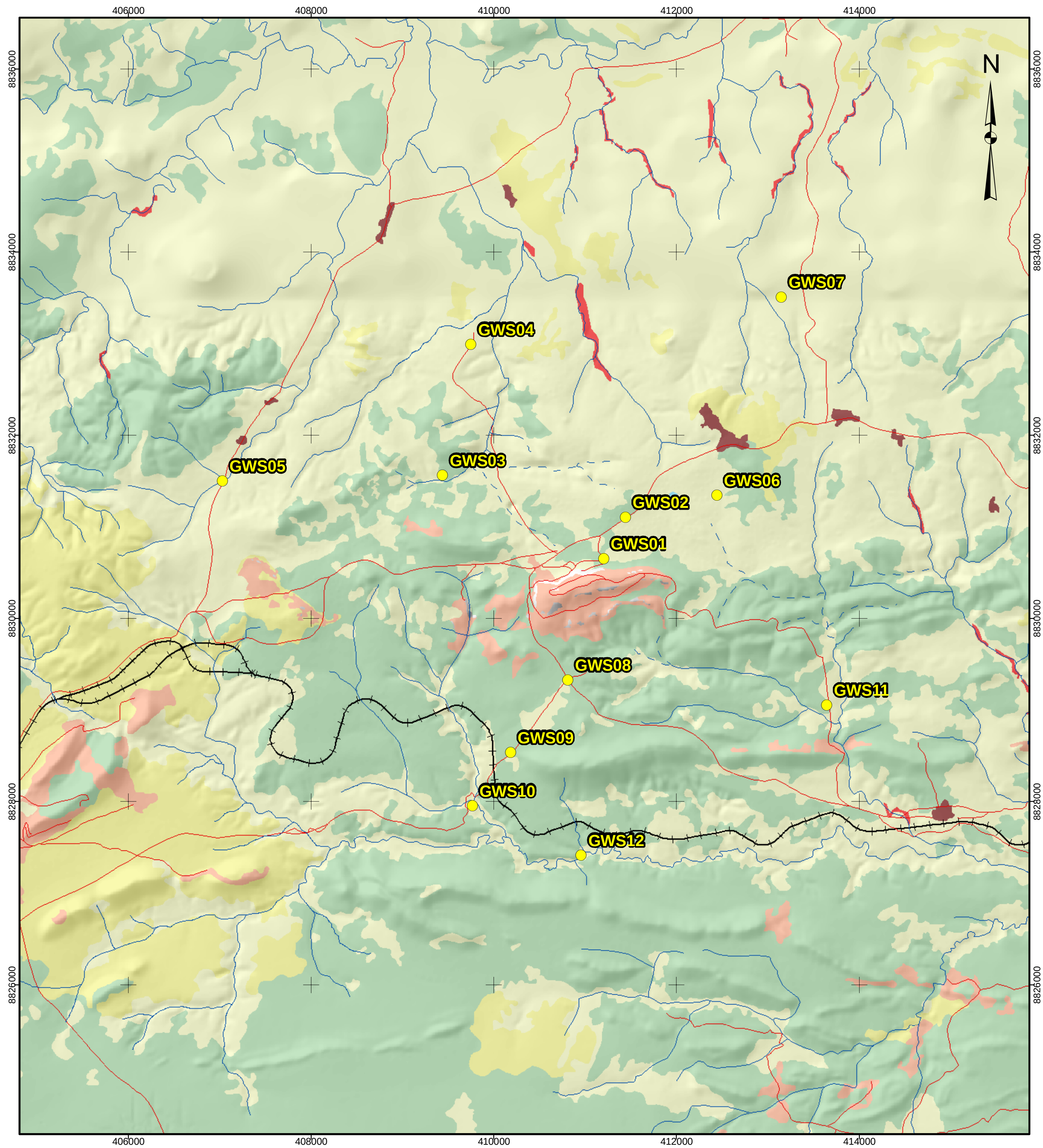
In addition, construction activities will involve fueling and equipment maintenance activities, which carry the potential of leakage and spillage. Fuel and oil tanks will be established with secondary lined containments. Equipment maintenance areas will be located away from surface waters and bermed to prevent runoff of equipment fluids.

A4.8.1.4 Erosion and Sediment Control Plans

Each proposed construction area will have its own erosion and sediment control plan, incorporating the safeguards listed above and the appropriate BMPs. An action plan for soils is described in Section D3.1.1.

A4.8.1.5 Groundwater Management Plan

Groundwater quality will be protected with primary and secondary containments for all fuel and oil storage facilities put in place for the construction activities. It also will be protected by installing engineered sewage treatment facilities at the processing plant and the construction camp and by using a sanitary landfill.



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ÉCHELLE 1:60000 MÈTRES
SCALE 1:60000 METRES

LÉGENDE / LEGEND

- PUITS / GROUNDWATER WELLS
- LIGNE DE TRANSPORT D'ÉNERGIE / POWER LINE
- RIVIÈRE / RIVER
- RIVIÈRE INTERMITTENTE / SEASONAL RIVER
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- PERTURBATION / DISTURBANCE
- ÉTABLISSEMENT HUMAIN / SETTLEMENT

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S / Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE / TITLE **PUITS D'EAU SOUTERRAINE QUI SERVIRA COMME SOURCE D'APPROVISIONNEMENT EN EAU (SECTEUR DE L'USINE DE TRAITEMENT) / GROUNDWATER WELLS TO BE USED AS WATER SOURCES (PROCESSING PLANT AREA)**

Golder Associates
Calgary, Alberta

N° projet / project no. 05-1334-035.9000			Échelle telle qu'indiquée Scale as Shown	REV. 0
DESSIN / DESIGN	GJ	22 Jun. 2006		
SIG / GIS	CW	03 Jan. 2007	**FIGURE: A4.8-2**	
VÉRIFIÉ / CHECK	MR	31 Jul. 2006		
APPROUVÉ REVIEW	MR	31 Jul. 2006		

A4.9 OPERATIONS

The primary goals of the operations water management program are to protect the existing uses of the water by the local population, to the extent practicable, and to mitigate impacts that cannot be prevented. This will be accomplished through the implementation of BMPs and project designs that will minimize potential chemical degradation to ground or surface waters, and assure that a supply of water for downgradient uses is maintained. Specific means to maintain surface water flow quantity and quality are listed in Section D3.1.5, and specific measures to maintain groundwater quality are listed in Section D3.1.6.

A4.9.1.1 Water Use

The primary use of water will be feed water to the processing plant. This water is used for milling, leaching, and metal extraction operations at the plant. A total of about 450 cubic meters of make up water per hour will be required to operate the processing plant. However, during average operating conditions, much of this water will be recycled from the tailings storage facility, as well as captured from storm waters within the plant site and storm water dams (see Table A4.9-1). On average, the contributions from these facilities will be as follows: tailings storage facility via the return water dam (226 cubic meters of water per hour, less at times in extended dry periods); main waste rock storm water dam (100 cubic meters per hour peak); and, Kwatebala pit and plant site storm water dam (100 cubic meters per hour peak). Therefore, additional water demand will range from a minimum of 24 to 224 cubic meters per hour in the wet season and an average of 224 cubic meters per hour in the dry season, peaking at a maximum of 450 cubic meters per hour should the TSF return circuit dry up. In addition, water will be needed for dust control along haul roads and plant access roads, drinking water and sanitary waters at the construction camp and at the processing plant site, vehicle wash water, water for general cleanup within the processing plant, and water for material movement dust control along conveyors and transfer points. This water will be supplied from wells located around the open pit (which will later become part of the mine dewatering system). From Year 8 forward, the pit dewatering wells will provide the process plant make up water, the balance of the dewatering being discharged.

Table A4.9-1 Process Make Up Water Contributions

Description	Wet Season (m^3/hour)	Dry Season (m^3/hour)
total plant make up requirement	450	450
return from TSF/RWD	226	226 but may be 0 at times
return from storm water dams	0 to 200 max	0
shortfall from groundwater supply	24 to 224	224 to 450

Groundwater modeling predicts that pit dewatering rates may range from about 720 cubic meters per hour (200 liters per second) to potentially as much as 2,340 cubic meters per hour (650 liters per second) at the end of mining. Therefore, during dry periods, more than adequate groundwater is predicted to be available to meet the entire processing plant demand (i.e., 450 cubic meters of water per hour or 125 liters per second) as well as dry season flow mitigation requirements (162 cubic meters of water per hour or 45 liters per second) (Section C2.11).

A4.9.1.2 Water Sources

Water supply to the TFM project will be from deep wells. Water for the permanent village will be supplied as described in Section A4.8.1.2 for the construction camp. Water for the mine and processing plat will be obtained from new deep wells near Kwatebala. The number of wells needed will depend on the yield from each well, but it is estimated that four to six wells will be required to produce the average required volume of about 224 cubic meters per hour. The general location of the proposed groundwater supply wells and supply pipeline is shown in Figure A4.8-1. A groundwater numerical model will be used to predict the impact of the extraction of this water on the water table beneath the proposed Kwatebala pit, and how extraction could affect the continuing supply of this water for downgradient users (Section C2.10). The modeling will allow the design of mitigation measures to assure that downgradient water uses can be maintained.

A4.9.1.3 Surface Water Resources Action Plan

Surface water resource action plans (Section D3.1.5) will include design of each facility to contain potential contaminants within the process water circuit. Protection of water resources from chemical degradation includes the installation of BMPs in controlling storm water. These practices include the use of diversion ditches and berms to reduce the amount of surface waters entering the mining and process areas. It includes incorporation of potentially impacted storm water into the process water circuit, essentially supplanting a portion of the need to extract new groundwater. Runoff from the waste rock and ore stockpiles will be returned to the processing plant in this manner. Also important to this effort is the lining of the tailings storage facility and the RWD, along with paving process areas within the processing plant facility that have the potential to impact groundwater resources through infiltration. This underlying groundwater eventually will report to downgradient surface waters.

This protection program involves monitoring and testing of process water, captured storm waters and underlying groundwater on a regular basis, to assist in refining and confirming the effectiveness of this program. This program is further elaborated on as an environmental and social management system in Volume D.

Perimeter ditches will be constructed as required to intercept runoff and to prevent inflow of water to the pit. Sump water, resulting from rainfall and minor residual groundwater seepage, will be pumped periodically from the pit and incorporated into the process water circuit.

Diversion of a portion of the Dipeta River headwaters will be required before mining the Goma deposit. Only conceptual level plans have been developed for this diversion; however, the plans call for diverting only the drainage around the proposed pit and returning the water to the same downgradient reach of the Dipeta River. Construction of a dam is not contemplated currently. Goma is not scheduled for production until about 2017 or later. Detailed engineering and an environmental assessment of the diversion structures will be performed at a later date. As indicated in Section A4.1, TFM will prepare full environmental assessments prior to development of any future ore bodies (i.e., Goma and Fwaulu) including disclosure and community engagement as per international standards.

A4.9.1.4 Erosion and Sediment Control Plan

Erosion and sediment control will be attained through the use of BMPs, tailored for each facility, as described in Sections D3.1.1 and D3.1.5. The goals of this plan are to stabilize disturbed areas as quickly as possible, contain all potentially impacted waters, test the contained water, and allow sediment to drop out before release to surface water drainages. In all instances where chemical contamination could have occurred, the waters will be chemically tested to assure that they meet water quality criteria acceptable for unrestricted use.

A4.9.1.5 Groundwater Resources Action Plan

The groundwater resources action plan (Section D3.1.6) has the objectives of managing both the quality of groundwater around the mining and processing facilities, as well as managing the quantity of groundwater available for downgradient use. This management requires an understanding of how the extraction of groundwater for use by the plant or through mine dewatering will affect surface and groundwater supplies downgradient from this extraction, and providing mitigation for any unavoidable loss of water resources.

The process water circuit has been designed to be self-contained. All vessels and ponds containing process water will be contained/lined. This includes the tailings storage facility, the RWD dam, and all piping/tankage associated with the process circuit. This containment has been designed to protect groundwater from chemical degradation. In addition, portions of the processing plant facility will be paved and will have a lined storm water containment pond to allow all potentially contaminated runoff water to be incorporated into the process water circuit.

The groundwater management program involves monitoring and testing of process water, captured storm waters, and underlying groundwater on a regular basis to assist in refining and confirming the effectiveness of the groundwater management program.

In about Year 8, the proposed open pit at Kwatebala will intersect the present groundwater levels and dewatering measures will be required to lower the groundwater level to prevent flooding of the pit. This will be accomplished by controlled pumping of groundwater from the perimeter of the Kwatebala pit. The wells supplying water to the processing plant may contribute to this effort. The wells will be constructed in the most productive zone of the aquifer, the "roche siliceuse cellulare" or RSC dolomitic rock strata beneath areas near the Kwatebala pit. However, it will probably be necessary to pump more water than can be used by the processing plant. Based on groundwater modeling results, current estimated extraction volumes are estimated to range from about 720 cubic meters per hour (200 liters per second) to as much as 2,340 cubic meters per hour (650 liters per second) in the latter stages of mining. A portion of the excess dewatering water will be used to mitigate streamflow losses.

Perimeter ditches will be constructed as required to intercept runoff from the deposits and to prevent inflow of water to the pit. Sump water, resulting from rainfall and minor residual groundwater seepage, will be pumped periodically from the pit to a storm water dam and either incorporated into the process circuit, or released, depending on its water quality.

It is probable, given the present water table elevation in Tenke village, that dewatering measures also will be required at the Goma pit. An investigation program to obtain further hydrogeological data is planned, which will allow the requirements for dewatering at Goma to be determined.

A4.10 WASTE MANAGEMENT

Plans have been formulated to control the disposal of all waste streams generated by the mine, processing plant, construction camp and other facilities. The main waste streams include domestic, industrial, medical and hazardous wastes. Examples of domestic waste are household wastes and sanitary wastes from the construction camp and the TFM camp. The main industrial wastes are the mining wastes of tailings and waste rock, chemical water treatment residues from the processing plant, used petroleum hydrocarbon wastes from the mining equipment fleet, used tires from the mining equipment fleet, used packaging and laboratory wastes. Medical waste will be produced from the clinic facilities. Wastes predicted to be generated by the TFM project are listed in Table A4.4-1 and Table A4.10-1.

Table A4.10-1 Waste Streams from the Processing Plant

Stream	Solids (t/h)	Water (t/h)	Total (t/h)	% Solids
evaporation from process plant	-	59	59	-
final residue from neutralisation	314	369	683	46
Total waste to tailings	**314**	**369**	**683**	**46**

t/h = tonnes per hour.

Management of sanitary wastes is covered in Section D3.1.8. Management of chemical residues is addressed in Section D3.1.7. Mine waste handling, including waste rock and tailings, is addressed in Section D3.1.9. Management of clinical wastes is discussed in Section A4.10.4. This section outlines the management plan for the remaining wastes predicted to be produced by the project.

A4.10.1 Waste Streams

The mining and processing operations will produce waste streams that will require handling in a variety of ways, depending on the characteristics of the waste. The remote underdeveloped location of the project reduces the choices on how a waste may be handled, compared to a setting where highly regulated recycling facilities and waste handling specialty companies/facilities are available. The management plan for these facilities therefore will require a high level of on-site management of these materials.

Air emissions will be managed through a combination of mitigation and control systems, as well as through careful design of the facilities, to assure that levels of air emissions do not create ambient conditions where a contaminant level is above applicable concentration thresholds. This kind of analysis has been performed for the facility and the results are provided in Section C2.8.

A strategy for dealing with all other wastes consists of selecting a waste management option for each of the waste streams listed in Table A4.4-2. The waste management options are:

- Waste minimization.
- Waste treatment.

- Waste disposal.

Each of these options is discussed below.

A4.10.2 Waste Minimization

In most cases, minimizing or eliminating the amount of waste produced is the most efficient way to deal with a waste stream. This is especially true at a remote facility such as the TFM project. The techniques used in waste minimization are:

Reduction: Reducing the amount of materials and packaging by purchasing in bulk, and using more environmentally friendly products to minimize material that must be disposed of on site.

Recycling: The processing of a waste to produce a raw material or product that can be reused several times. This method of waste minimization is limited to certain waste streams, such as tires for retreading, worn parts for scrap, and used oils.

Reuse: Putting an item to another use after its original function has been fulfilled, therefore offering added value and utility before disposal. Examples include return or reuse of packaging, and also secondary reuse such as blending used oil with fuel oil for use in preparation of explosives used in the mine.

Composting reduces the amount of putrescible waste which would otherwise be disposed of to an engineered landfill site. Composting involves the aerobic processing of biologically degradable organic wastes such as kitchen and garden waste, and sewage sludge, to produce a stable, granular material that frequently contains plant nutrients and which can be used as a soil amendment. At present, TFM is considering composting as an option for dealing with some waste that otherwise would end up in an engineered landfill facility. Composting would be done in a dedicated area with specialized equipment, to minimize the potential for any pathogens to be harbored in the remaining waste materials.

A4.10.3 Waste Treatment

Waste treatment can render a potentially hazardous waste material non-hazardous. Non-hazardous wastes then can be handled and potentially disposed of in facilities such as the tailings storage facility or an engineered landfill. This treatment can sometimes be accomplished through chemical neutralization, as in the case of a highly corrosive or chemically reactive material. Chemical precipitation can be used for some soluble metals, to render them non-hazardous.

Some materials produced in the analytical laboratory and cleanup wastes at the acid plant are candidates for this kind of treatment. Hydrocarbon wastes can be treated through bacterial action, rendering the wastes innocuous. Clinical wastes can be rendered non-hazardous through high-temperature incineration.

A4.10.4 Waste Disposal

All waste streams will be classified and segregated at the source. Wastes will be disposed of by five methods, in the following order of preference:

1. Sale or scrap

   Clean, non-degradable worn parts, scrap machinery.

2. Waste rock facilities

   Clean, non-degradable worn parts with no scrap value, cleaned drums.

3. Tailings storage facility

   Tailings, neutralized, non-hazardous process solids, non-hazardous treated laboratory wastes.

4. Managed storage/on site and/or off-site disposal

   Materials to be staged for later handling include used hydraulic and lubricant oils, batteries, fluorescent tubes, used anodes and lead flake. Clinical waste will be stored only within the clinic boundary, until it can be incinerated at an on-site incinerator. Used oils will be stored only until they can be used as a blasting agent or otherwise recycled. Other materials will be stored until they can be shipped for recycling or until it is clear that a reliable recycler cannot be found. In the case that no recycler can be found, the materials will be packaged in such a way that they can be retrieved, and will be relocated to either a secure, lined storage area or buried in the engineered lined landfill facility. It is likely that reliable recyclers of these materials will be found at some point during the life of the TFM project.

   Disposal of waste to waste rock facilities will be undertaken only in selected areas, and will only include non-hazardous waste that cannot be otherwise recycled or managed.

5. Engineered disposal

Two separate landfills are proposed, one receiving general waste and one receiving hazardous waste[13], some industrial waste and ash from the medical waste incineration. A cellular development is proposed. The general waste landfill will initially have two lined cells with dimensions of 60 x 30 x 2.5 meters. A single lined cell with dimensions of 60 x 25 x 2.5 meters is proposed for the hazardous waste landfill site. The proposed lining for both landfills consist of double-lining systems with a leachate collection system above the primary liner and a leakage collection system between the primary and secondary liner system. The generated leachate is collected in a leachate detention pond from where it must be transported to a disposal facility (for hazardous waste leachate) or pumped to the sewage treatment work (for nonhazardous waste leachate)

In the absence of any standards that specifically govern waste management in the DRC, the South African "Minimum Requirements for Waste Disposal by Landfill – Waste Management Series" have been used as the principal guideline as it represents best practice for developing countries.

A number of non-mining waste streams have been identified. The streams are:

- General waste from the mine village and offices.
- Industrial waste from the plant and service buildings/operations, some of which could potentially be hazardous waste.
- Medical waste from the mine clinic.

The waste produced by the mine village and office may be classified as general municipal waste. General waste is a generic term for waste that, because of its composition and characteristics, does not pose a significant threat to public health or the environment if properly managed. Examples include domestic, commercial, certain industrial wastes and builders' rubble. General waste may contain insignificant quantities of hazardous substances dispersed within it, for example insecticides and weed killers. A landfill receiving this waste will be near the construction village, north of Fungurume.

In addition to the general waste, some materials containing potentially hazardous residues, including solvents, oils, paints, fluorescent tubes, batteries, oils, incinerator ash, etc. will also be produced by the mine operations. A landfill receiving this waste will be classified as low hazardous. Its planned location will be between the mine and processing plant site at Kwatebala.

[13] TFM is currently investigating the feasibility of exporting all hazardous waste to a licensed hazardous waste facility in South Africa.

A third facility has been planned for treating materials contaminated by fuels and oils and its proposed location is adjacent to the Kwatebala pit. The treatment will be accomplished through bacterial breakdown of the hydrocarbons. The viability of this facility should be further investigated and for this study it is assumed that this material will be deposited at the low hazardous site.

The maximum daily rate of deposition (MRD) is estimated from the number of people that produce the waste. A factor of 1.1 kilograms per person per day has been adopted and this is typical for developed countries (US EPA 1996). The standard of accommodation and facilities at the mine village suggests that the developed country factor is appropriate despite that in general terms DRC is a developing country. During the mine construction phase which is expected to last for two years, the work force is approximately 2,000 people. Once construction has been completed the size of the work force and associated family members in the permanent village is expected to be approximately 2,500 people. The LOM is estimated as 20 years for the purposes of this study and thus the mass of waste can be estimated for the construction period and LOM (Table A4.10-2).

Table A4.10-2 General Waste Stream Estimate

Period	MRD (tonnes/day)	Waste Per Year (tonnes/year)	Total Waste (tonnes)
construction (minus 2 to 0 years)	2.2	803	1,606
mining (0 to 20 years)	2.8	1,004	20,075
Total			**21,681**

MRD = Maximum daily rate of deposition.

In developing an on-site storage or off-site disposal management system consideration is given to:

- The option of a single waste site that receives both hazardous and general wastes which are disposed of in separate cells should be considered.
- Determining the availability of suitable recyclers for industrial wastes.
- Determining the availability of a licensed off-site hazardous waste disposal facility.
- The viability of treating materials contaminated by fuels and oils through bacterial breakdown of the hydrocarbons.
- Geotechnical investigations of potential sites (Table A4.10-3).

Table A4.10-3 Proposed Landfills

Waste Stream	Landfill Location
general waste	north of Fungurume: near the construction village
industrial and medical	Kwatebala: adjacent to mine and plant site
industrial: oil and fuel related waste	Kwatebala: adjacent to mine and plant site

The size of the hazardous waste stream is difficult to predict. At this stage it has been estimated as 50 percent of the total general waste stream (i.e., 10,840 tonnes).

Methane and gas collection measures will be incorporated into the design of the facility. Gases will be vented at surface and allowed to disperse.

A4.11 ENERGY SUPPLY

TFM will require reliable power from the state owned utility, La Societé Nationale D'Electricité (SNEL). A power study performed by Fichtner GmbH & Co. KG identified a SNEL hydro electric power plant near the TFM mine site, the Nzeke power plant, and the 220-kilovolt high voltage transmission system connecting the power plant to the TFM substation as the closest and largest potential source of power within the Katanga region. The Fichtner study identified a list of rehabilitation projects required to the 50 year old SNEL infrastructure to provide a reliable supply of quality power to TFM.

TFM will fund rehabilitation projects for both the SNEL Nzeke power plant and the 220-kilovolt transmission system as described below and shown in Figure A4.11-1. This rehabilitation work will be performed parallel to the construction of the TFM mine site. No people or third party infrastructure will be impacted as all work will be within existing rights of way or immediately adjacent to existing electrical substations. Therefore, ESIA work is not required for this rehabilitation.

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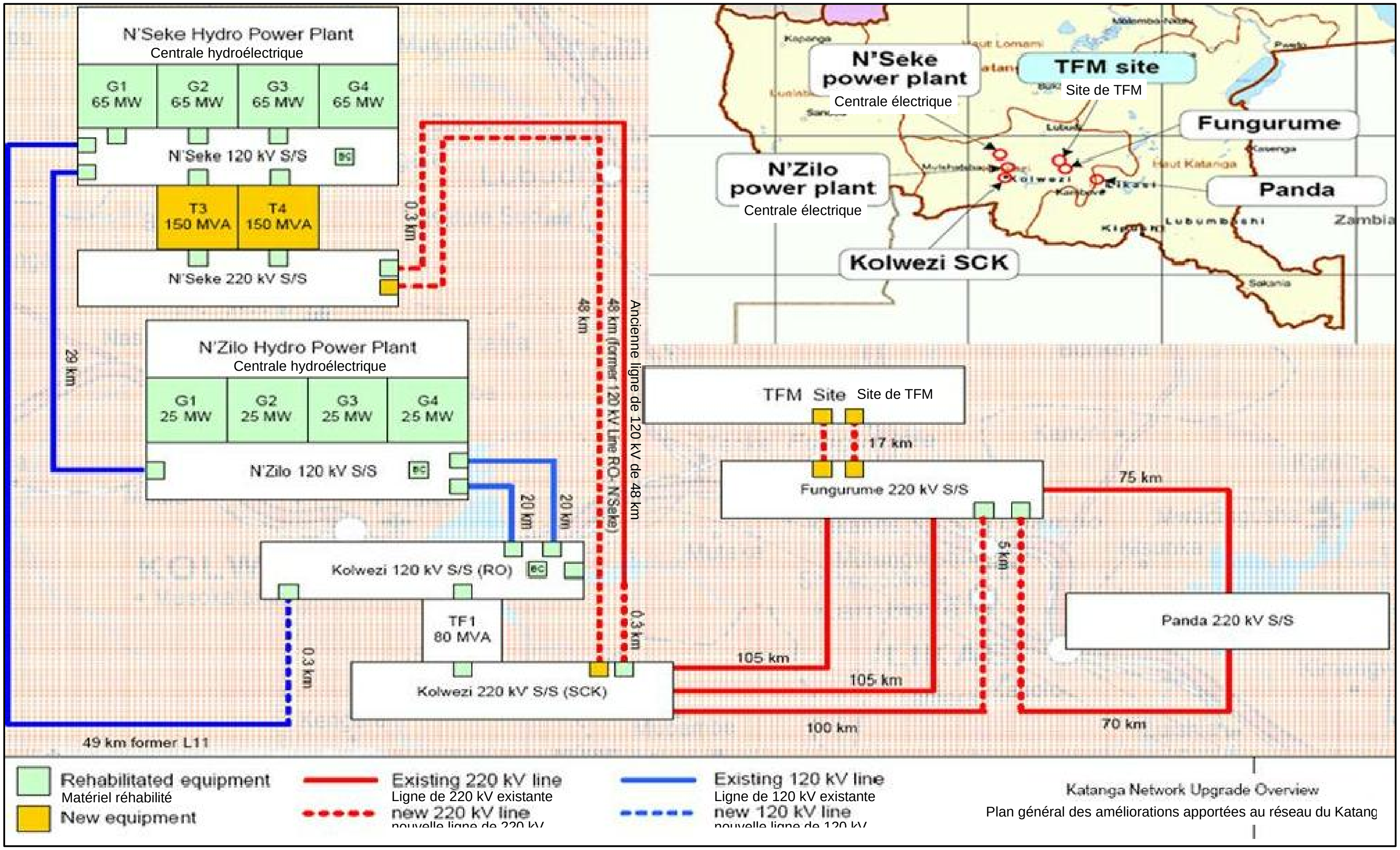


PROJECT/PROJET

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITLE/TITRE

PROPOSED IMPROVED POWER INFRASTRUCTURE / AMÉLIORATION PROPOSÉE DES INFRASTRUCTURES ÉLECTRIQUES

Golder Associates
Calgary, Alberta

PROJECT/PROJET		05-1334-035
DESIGN/DESSIN	GJ	18 Dec. 2006
CADD/CAD	PSR	04 Jan. 2007
CHECK/VERIFIE	GJ	04 Jan. 2007
REVIEW/APPROUVE	MR	04 Jan. 2007

FILE No. Proposed Imprv Power
SCALE/ECHELLE AS SHOWN/tel que montré REV. 0

FIGURE: A4.11-1

A4.11.1 Nzeke Hydro Power Plant Rebuild

TFM will rebuild three of the four existing 65 mega watt power generation units in the power house. This includes replacing all external cables from the three power generation units to the step up transformer in the Nseke power plant substation. The 13.8 kilovolt to 120 kilovolt step up transformer for each generator will be replaced as will both of 120 kilovolt to 220 kilovolt transformers in the Nseke power plant substation. All related switchgear, breakers and associated equipment to be replaced in the power house and substation. General common works operation and maintenance will be performed in the power house as required to facilitate efficient operation of the rebuilt generation units.

A4.11.2 Transmission Line Projects

The Katanga region is served by both the original 120-kilovolt and newer 220-kilovolt interconnected transmission system. 220-kilovolt power flows from the Nseke substation to the Kowezi substation then to the Fungurume substation where TFM will interconnect for its mining project. TFM will focus its reinforcement efforts on these sections of the 220-kilovolt transmission system to perform the following work:

A4.11.2.1 Nseke 120 to 220 Kilovolt Line Conversion

One of the existing 120-kilovolt transmission lines connecting the Nseke substation to the Kolwezi substation was built with the idea of later converting it to 220 kilovolt, thus the transmission towers can operate at 220-kilovolt without modification. This line will have additional insulators installed to accommodate the 220-kilovolt voltage. The transmission line will be disconnected from the 120-kilovolt bus at both Nseke and Kolwezi and reconnected to the 220-kilovolt bus in both substations. One additional transmission tower will be removed and one installed at each substation to accommodate this upgrade. The new configuration will amount to 0.3 kilometers of transmission line realignment at each substation. Associated switchgear and circuit breakers will be replaced.

A4.11.2.2 Nseke 220 to 120 Kilovolt Line Conversion

The first 220-kilovolt transmission connecting the Nseke substation to the Koweszi substation was built with too much sag to withstand the seasonal brush fires without tripping. To replace the 120-kilovolt circuit lost to the above conversion to 220-kilovolt, this old 220-kilovolt line will be re-connected to the 120-kilovolt bus at both Nseke and Kolwezi substations. One additional transmission tower will be removed and one installed at each substation to accommodate this conversion. The new configuration will amount to 0.3 kilometers of transmission line realignment at each substation. Associated switchgear and circuit breakers will be replaced.

A4.11.2.3 220 Kilovolt Additional Transmission line from Nseke Substation to Kolwezi Substation

Reference the 120-kilovolt to 220-kilovolt transmission line conversion above. The existing transmission towers were designed to carry double circuits, but currently only one circuit is installed. TFM will install 48 kilometers of conductor and insulators on the existing towers and extend the 220-kilovolt busbar at the Kolwezi substation. New associated switchgear and circuit breakers will be installed with the new line. No right of way or new transmission towers are required for this work.

A4.11.2.4 220 Kilovolt Interconnection at Fungurume Substation

Currently three 220-kilovolt transmission lines run from Kolwezi substation to Fungurume substation, before continuing on to other substations. Only two of these transmission lines interconnect at the Fungurume substation. TFM will interconnect the third transmission line at the Fungurume substation to provide a more reliable power supply to the TFM mine. One additional transmission tower will be installed in each direction to and from the transmission line to the substation to accommodate this interconnection. The new configuration will amount to 0.5 kilometers of new transmission line both to and from the substation parallel to the existing rights-of-way. An additional bay at the Fungurume substation and associated switchgear and circuit breakers to be installed as part of this interconnection project.

Primary transformers at the TFM switchyard will step the supply voltage down to 33-kilovolt, which will be the principal distribution voltage for the mine.

33-kilovolt buried cables will supply the main processing plant substation, which will feed the plant loads. An overhead 15 kilovolt line will feed the tailings dam and borefields.

Transformers will be mounted on concrete plinths surrounded by a gravel-filled, concrete bund pit. Individual transformer pits will be drained to local oil/water separation chambers. All transformers of 33-kilovolt rating and lower will use IEC 60296 standard insulating oil. PCB based oils will not be used.

An emergency diesel generator facility will be established at the plant site. Bulk fuel storage on site will be refurbished and will hold sufficient fuel.

A second distribution transformer will be installed at the Fungurume substation to feed the new construction camp/permanent village, airport, aggregate quarry and bores. They will be fed via 15-kilovolt powerlines.

A4.12 COMMUNICATIONS

Communications systems have been installed that are capable of reliably handling national and international speech, fax and data links, including Internet access. A PABX system was installed in September 1997, and is connected to the Gécamines network by a microwave link between Antenna Hill and Kakanda Mine, 20 kilometers away. This system can handle all external communications requirements, but a satellite phone will be retained to provide emergency communications during power failure incidents. In addition, two cellular phone networks have been installed on the concession. The current carriers are Vodacom and Celtel. Communications to the processing plant will use secured fiber optics to connect the new plant to the existing communication systems.

Communications within the plant will use fiber optic cables to support independent systems such as the fieldbus systems, process control, general computer systems / phones, site security systems and closed-circuit televisions.

Remote-located equipment from the processing plant such as bores, tailings decant, airport, and village will communicate to the plant with radio telemetry. Proposed installations may have line of sight and therefore will not require repeater systems.

The site's computer systems will support a voice over internal paging (IP) (VoIP) phone system, which will be integrated to the existing data communication. Network integrity will be secured with current technology such as a firewall, routers, anti-virus and anti spy-ware software.

A4.13 WORK FORCE

A4.13.1 Construction Requirements

The construction phase of the TFM project is expected to start in the first quarter of 2007 and continue for at least 18 months. During that period, the construction work force will peak at about 2,000 workers, and the comined construction/operation workforce will peak at 3,100 at year minus 1. These workers primarily will be a skilled workforce, working under the direction of independent construction companies.

Construction shifts will consist of half-hour travel times to and from the construction site and eight-hour work days. Personnel will work no more than six days per week, although construction will take place seven days per week. Night construction activities will not be undertaken as normal practice, however, it may be required occasionally. Actual shift schedules and the number of employees on each shift will be established on the completion of final project engineering. The number of hours, shift rotations and the number of hours worked per work week will be in full compliance with the DRC Labor Code.

A labor policy is being drafted that will contain the following provisions:

- Preference for employment of local people, when evaluating employees of otherwise equal skills and qualifications.
- Full compliance with DRC Labor Code.
- Full compliance with Collective Agreements with the labor representatives of TFM employees.

Payment levels will be established to attract skilled, competent workers. TFM recently has completed negotiations with the recognized unions representing its employees. Wages will be paid according to the agreed upon terms of these Collective Agreements and in full compliance with DRC Labor Code.

A4.13.2 Operations Requirements

Operation of the proposed TFM facilities will require about 1,100 employees and contractors. The mining and processing operations will be run on a continuous basis, (i.e., 24 hours a day, 365 days a year). Certain positions and departments will be able to work only in daylight or will not be required on a round-the-clock basis, and will work a single shift, but production and operations support positions will require a continuous shift system. Actual shift schedules and the number of employees on each shift will be established on the completion of final project engineering. The number of hours, shift rotations and the number of hours worked per work week will be in full compliance with the DRC Labor Code.

A labor policy is being drafted that will contain the same provisions as indicated for construction.

Payment levels will be established to attract skilled, competent workers. TFM has completed negotiations recently with the recognized unions representing its employees. Wages will be paid according to the agreed upon terms of these Collective Agreements and in full compliance with DRC Labor Code.

A4.13.3 Staffing

The current estimated project staffing levels are displayed in Table A4.13-1. These figures will be refined as the operational requirements of the mine become more clearly defined.

Table A4.13-1 Estimated Project Staffing Levels[a]

Year	Construction	Operations	Total
minus 2	0-2,000	250	2,250 (peak)
minus 1	2,000 (peak)	400-1,100	3,100 (peak)
1	50	1,100	1,150 (peak)
2	0	1,100	1,100
3	0	1,100	1,100
4	depends on pending new expansion feasibility study	1,100	at least 1,100
5-15	depends on pending new expansion feasibility study	at least 1,100	at least 1,100

(a) Includes about 100 contractors for operations.

A clearly defined recruitment policy will be used to fill positions. TFM has developed its hiring and recruitment policies around several criteria. These include compliance with the DRC Labor Code, and serving TFM business needs for both skilled and unskilled labor. Positions will be widely advertised, and also will be passed to Gécamines, who may elect to provide candidates for consideration. All candidates will be assessed on the basis of their skills profile regardless of geographical location.

When candidates are of equal merit, employment preference will be given to local people. There is no obligation in the TFM recruitment and hiring policy to provide employment priority to former employees of Gécamines.

Where necessary, candidates from outside the DRC will be selected, subject to a limit of 50, as specified in the Amended and Restated Mining Convention (ARMC). The selection policy outlined above should result in the employment of many mine workers from Katanga and from the region surrounding Tenke Fungurume in particular.

Recruitment will take place within local villages as well as in Likasi, Kolwezi, Lubumbashi, and possibly in other areas for people with specific skills, if not available locally.

Senior qualified staff will be recruited on an international basis although it is considered that many excellent candidates may be sourced within the DRC. It is expected that the number of senior DRC staff will increase with time as skill transfer from the many operations currently under development allows local supervisory staff to develop and rise to higher positions.

Contractors will perform non-core functions where possible, and off-site operations such as rail transport, port unloading, etc. will be handled by contractor's workers, and/or established existing service providers.

A more detailed breakdown of labor requirements is provided in Table A4.13-2.

Table A4.13-2 Estimated Local and Non-Local Labor Requirements

Area of Operation	Number of Personnel
Operations	
general	2
occupational health and safety	6
environmental and social	5
financial control	11
laboratory	61
engineering and maintenance	38
Sub Total	**123**
Mining	
operation	348
maintenance	3
engineering and geology	12
Sub Total	**363**
Processing	
general	58
ore treatment	112
copper	104
cobalt	128
Sub Total	**402**
Total Operations	**888**
Administration	
general	1
materials management	17
human resources	6
medical	22
quality systems	2
security	82
Sub Total	**130**
Total Workforce	**1,018** [a]

[a] About 100 contractors will also be utilized.

A4.13.4 Training and Technology Skill Transfer

TFM will train its own workforce. All employees will be given an induction course, as well as basic safety and environmental orientation and site/workplace specific safety training, before they are allowed to go on site. The workforce will be trained on site. A computer-based customized training package will be available before operational personnel start working. This will enable individual and group training sessions to be held as personnel start on site. A training supervisor will coordinate the workforce training program.

The training program partly will meet the requirements for skill transfer under the ARMC. The introduction and transfer of modern management techniques will be a primary objective for management and supervisory teams, in order to meet these requirements and to establish a skilled management population in the Tenke Fungurume area, which will benefit future operations.

A4.13.5 Accommodation and Housing

TFM will address housing in full compliance with the DRC Labor Code and in full compliance with the terms of its collective agreements with the recognized representatives of its employees. TFM will be evaluating the appropriate use of houses that might be built and provided to employees, once construction is completed.

A4.13.6 Workforce Transportation

All workers will be picked up from locations at Tenke and Fungurume for transportation to their workplaces.

This service will be provided by TFM initially, but may eventually be contracted out. Transportation will be on 85-seat and 20-seat buses.

A4.13.7 Health and Safety

TFM will adopt the world-class safety and health practices of Phelps Dodge Corporation, the managing partner of TFM. These practices are driven by the philosophy that nothing is more important than the health, safety and well-being of employees and their families. The primary objectives of the health and safety programs will be to eliminate workplace injuries and occupational illnesses, and to influence employee behavior so that safety becomes a way of life both on and off the job.

Fundamental to this initiative is the idea that each employee must take individual responsibility for safety. It is the job of each employee to create a work environment that eliminates occupational health and safety hazards whenever possible. If a hazard cannot be eliminated, then employees must work together to ensure that it is effectively controlled.

TFM will integrate the Phelps Dodge Health and Safety Management System (HSMS) into the TFM project, as well as comply with the applicable occupational health and safety laws and regulations of the DRC. The implementation of the HSMS will assist in the minimization of workplace risks, increased consistency of safe behaviors, and a reduction in the occurrence and cost of occupational injuries and illnesses.

This HSMS format uses recognized management system principles in order to be compatible with quality, environmental, and health and safety management system standards such as (ISO) 14001, (OHSAS) 18001, (SA) 8000, (ANSI) Z-10 and other internationally recognized standards.

This management system approach is characterized by its emphasis on continual improvement and systematically eliminating the underlying or root causes of deficiencies. This systematic approach seeks a long-term solution rather than a one-time fix.

Details on the HSMS to be implemented for the TFM project are contained in Section D6.

A4.13.8 Emergency Response Plan

TFM will develop an emergency response plan to be executed in situations such as fires, seismic events, chemical spills, landslides, non-scheduled explosions, medical emergencies and vehicle accidents (Section D7).

The emergency response plan will include clear and precise directions about procedures and communications in case of emergencies as well as the responsibilities of individual personnel and the Emergency Operations Committee and the Emergency Brigade that will be formed. Likewise, the plan will define and identify critical areas such as:

- Mine operations.
- Grinding.
- Leaching.

- Industrial plant.
- Heavy equipment maintenance.

TFM will develop a contingency plan with detailed response procedures to address emergencies with sulfuric acid, hydrocarbons and other relevant chemical substances. The contingency plan will include all hazardous materials to be handled within the proposed facilities. The contingency plan shall specifically outline action plans to be implemented if the immediate surroundings are exposed to environmental, material and personal risks.

A4.14 COMMUNITY AND SOCIAL ISSUES

TFM has developed procedures to manage public safety risk, including measures to secure areas needed for mining activities, protect company assets, control access to mineralized areas within the concession and for relocating people living within the industrial zone. Superimposed on these policies and procedures will be additional contributions to local community development and land use planning.

A4.14.1 Security Measures

There are a range of security objectives that TFM must attain in order to conduct their mining business at the level of performance expected by project stakeholders, as summarized below:

- Assure public safety by controlling access to operational areas, including the mine pit, haul and access roads, ore and waste rock facilities, processing plant and ancillary facilities, tailings impoundments, limestone quarries and stores of hazardous materials.
- Maintain the mine's operational readiness and performance by protecting materials, equipment and other assets from theft or damage.
- Provide a lawful and safe working environment in the concession's extensive rural and urban environments, in particular by directing and reinforcing the capacity of the Mines Police.
- Assure the ongoing economic viability of all mineralized areas in the TFM concession for future industrial mine development, specifically by enforcing legal entry and exit from the concession area by truck traffic, and by patrolling surface deposits to prevent their unauthorized exploitation.

The key players responsible for attaining these objectives include TFM security personnel, contract security personnel and the Mines Police, each of whom have distinct responsibilities, as described in the following sections.

A4.14.1.1 TFM Security Personnel

Security personnel on the TFM permanent staff during the current planning and startup phase include a director, superintendent and assistant superintendent of security. The mission of these management-level security staff positions is to assure that the security objectives listed above are attained, and furthermore attained in a manner consistent with corporate values on safety and human rights. They are responsible for the tactical deployment of contract security personnel and the Mines Police in the field, and also responsible for overseeing the conduct of security personnel during security operations. The security director and security superintendent also are operationally responsible for implementing company policies on safety and human rights, including assurance that training and other capacity-building efforts are implemented for both the contract security personnel and the Mines Police. The number of TFM security management staff will increase as the project enters construction and operational phases, and additional contract and Mines Police personnel are assigned to various facilities within the operation.

A4.14.1.2 Private Security Personnel

There are approximately 65 contract security personnel working during the current planning and start-up phase. The TFM security personnel are not armed and conduct no police operations, both of which are the legal domain of the Mines Police. However the contract personnel work alongside the Mines Police in the operation of security checkpoints on the national highway and on internal concession roads. Contract security personnel also are assigned to police outposts on the major ore bodies in the concession, where they conduct periodic patrols of the mineralized areas in their zone of responsibility. The contract personnel also are responsible for providing security at TFM installations on the concession, as well as at the homes of management staff in Lubumbashi.

Private contractors are employed by TFM in a planning and technical assistance capacity. These contractors assess specific security risks, identify the company's needs in addressing those risks, and deliver training to TFM staff, contractors and Mines Police in areas such as law enforcement fundamentals, safety and basic human rights.

A4.14.1.3 Mines Police

The Mines Police are a branch of the National Police under the Ministry of the Interior. Their mission is to provide security within mine installations and to enforce the legal conduct of mining businesses in the DRC. The Mines Police mission seeks to provide the following general assurances:

- Unencumbered access to mineralized areas by rightful concession-holders.

- The general rule of law within legal mining perimeters.
- Legal control over the movement and export of minerals along transportation corridors in mining regions.

There are about 140 Mines Police assigned to the TFM concession area, where their specific responsibilities include the following:

- To operate control checkpoints on the national road to validate the origin of minerals on trucks that enters and exits the TFM concession.
- To maintain outposts on major surface deposits, and as requested by TFM security personnel, to conduct periodic patrols of these and other mineralized portions of the concession areas to assure that unauthorized operations are not taking place.
- To conduct law enforcement activities as needed, including the seizure of minerals illegally mined on the TFM concession area, and the arrest of individuals who are conducting the unauthorized artisanal mining operations.

Though an autonomous government police force, the officers responsible for the Mines Police in the TFM region work closely with the TFM Security Superintendent in the development and execution of operations in the TFM area and in establishing policy for police conduct in the concession area.

A4.14.1.4 Security and Artisanal Mining

The unauthorized presence of significant numbers of unauthorized artisanal miners on industrial mineral concessions is arguably the most significant security risk posed to mine development in the DRC. However, unauthorized artisanal miners have not been active in the TFM concession since late 2005, though they have been present in large numbers in its recent history.

The low levels of artisanal mining in the TFM concession largely have resulted from the tactical advantage provided by restricting transportation of heavy loads out of the area only on the national road or the SNCC railroad. Checkpoints have been established on the national road at the concession's eastern and western boundaries, and jointly staffed by contract security and Mines Police personnel. At these checkpoints the contract security teams are responsible for inspecting loads and documents on trucks as they enter and exit the concession area in the direction of either Kolwezi or Likasi, and for relaying data from these inspections to security personnel at the TFM base and at the checkpoint on the opposite (i.e., outbound) boundary.

According to DRC law, any minerals that are under transport must be accompanied by documents attesting that they originate from a legally designated mining operation. The control points can check and validate this documentation as trucks carrying mineral cargo enter the concession. If mineral cargo is properly documented, truck drivers are issued a safe conduct pass for the transit through the TFM concession along the national highway. The pass is surrendered at the outbound checkpoint to security personnel, who have been notified of the truck's passage through the area by radio.

Trucks that arrive at a checkpoint from the concession interior without documentation, without a safe conduct passage and without prior notification by security personnel at the inbound checkpoint are therefore presumed to be carrying unauthorized minerals artisanally mined within the TFM concession area. These trucks are seized by the Mines Police personnel, and drivers may be delivered to the national police post in Fungurume, from where they also may be remanded to Kolwezi judicial authorities, who can oversee legal proceedings against the truck's owner. Confiscated minerals are stored at the TFM base camp.

Additional security personnel are assigned to observe the Tenke and Fungurume rail stations. Mineral cargo that arrives at the Tenke or Fungurume rail stations without prior validation at one of the checkpoints at the eastern and western boundary is presumed to have been artisanally mined in the concession's interior and SNCC management is notified to initiate legal action.

Significant additional data and analysis are presented in the socio-economic baseline and impact sections of this report regarding the social and economic aspects of informal mining in the TFM concession area.

A4.14.1.5 Security and Human Rights

Though not directly responsible for police actions TFM is nonetheless a major driver for law enforcement operations in the concession area. This role introduces a risk of human rights abuse for which TFM may be held accountable, given the country's recent history of conflict, the impunity with which some uniformed elements have abused civilian populations during conflict, and the common lack of training provided to police.

The Mine Police are the organization authorized to maintain order on a concession.

In numerous venues TFM has stated its commitment to observe the basic dignity and human rights of people within the company's sphere of operations, including and especially in the conduct of security. TFM does not tolerate human rights abuses and has initiated training of the Mine Police on the Voluntary Principles on Security and Human Rights. TFM has also hired a security manager and two security superintendents in order to provide the proper level of scrutiny related to these type of issues.

The Voluntary Principles on Security and Human Rights (Voluntary Principles 2006) are a set of guidelines jointly developed by the governments of the United States, United Kingdom, Netherlands and Norway as a collaborative approach between extractive industries, government and the non-governmental organization (NGO) community for managing human rights issues and risks in developing countries.

TFM considers the Voluntary Principles a useful framework for managing human rights risk in its concession area, and is implementing the basic elements of these guidelines before starting construction and operations. TFM has contracted expertise in human rights and security management for the extractive industries sector to assess specific risks posed to the TFM project, and the following actions have been initiated as a result:

- Training of TFM security staff in operational aspects of the Voluntary Principles.
- Training of TFM security contractors in basic law enforcement techniques and conduct around human rights principles.
- Establishment of documentation processes for security operations, especially where enforcement and control actions may entail arrest and detainment.

TFM will continue implementation of Voluntary Principles processes and training leading into the project construction period, and will also continue consultation with the NGO community active in human rights issues in the Congo. Consultation thus far has included field staff of NGO groups active in the DRC, as well as with their management staff in Washington and London.

As another important element of its human rights program, TFM has hired and fielded a community liaison officer (CLO), whose picture and contact information has been distributed throughout the concession area. Residents of the rural and urban communities in the concession area are encouraged to contact, and have contacted, TFM with specific issues related to security, particularly at the control points. The company has investigated and taken action as appropriate. One example has been the addition of female security personnel to the staff at checkpoints along the national highway so that they are the ones interacting with female passengers on trucks.

A4.14.2 Land Use

Land will be needed by TFM for several facilities and functions, as identified below:

- Mine pit, low-grade ore stockpiles and waste rock facilities.
- Processing plant site and associated infrastructure.
- Administrative facilities.
- Employee accommodation.
- A buffer zone around operations to limit the impact of daily activities and to provide a safe working environment.

A land use map (Figure A4.1-2) and land use plan have been prepared and will be used to identify approved land uses. The following areas have been identified on the land use map:

- An active mining area that will be occupied by TFM for the exploitation of the mineral deposits. People living within this zone will be relocated for their own safety and to avoid any conflict with the industrial use.
- Growth centers in the concession that will be designated in collaboration with local authorities for accommodating an anticipated influx of new population once construction has been initiated.

A safety buffer will be also established around the active mining area, with access granted only to authorized personnel. An important objective in all land use planning initiated by TFM is to provide incentives for development and in-migration outside of the mineralized areas rather than in the interior of the concession. Success with this objective will minimize future need for displacement of populations as successive mineralized zones are targeted for mine development.

A4.14.3 Impact Compensation and Involuntary Relocation

Though project planning has emphasized the avoidance of involuntary displacement from the inception, the construction and operation of the TFM project as described in previous sections will generate impacts that require compensation and resettlement. TFM is committed by the terms of its ARMC to implement best practice approaches in the management of environmental and social issues. Best practice for resettlement planning emphasizes elements such as the restoration of livelihoods rather than cash compensation for displacement impacts and robust public consultation. Criteria that will guide TFM resettlement planning are derived from the policies and guidelines of the Equator Principles, with key points summarized below:

- Both economic (e.g., farm fields) and physical (e.g., homes) displacement will be addressed if resettlement planning is needed.
- If the source of any individual's livelihood is affected by more than 10 percent (more than 10 percent of their farm fields), the replacement of that livelihood and not simple cash compensation will be required.
- Affected people must be left no worse off, and preferably better off by the project.
- Losses must be compensated at full replacement cost and informal occupation rights will be taken into consideration.
- If a resettlement plan is needed, it will be carried out in a consultative manner, particularly when it comes to the selection of resettlement sites, with the affected people, the host communities and local authorities. The objective will be to reach broad community consensus.
- A comprehensive Resettlement Action Plan (RAP) has been prepared, consulted upon and submitted to the public, based on a complete census of affected assets and people.
- The RAP will be tied to the ESIA process, and provisions will be made for long-term monitoring of affected people and their livelihoods.

Detailed description of the involuntary displacement impacts anticipated during construction and operation of the TFM project is presented in Section D4.4.

A4.14.4 Community Development

Mining operators are required by law to invest in social development, and TFM's ARMC requires this to be carried out in coordination with the state or local communities. More importantly, TFM recognizes the importance of building its social license to operate, and is committed to investing with local government for the benefit of the surrounding communities above and beyond the statutory royalties, an additional amount that will be equivalent to 0.3 percent of net sales revenue from mine production. TFM also is investing a dedicated amount ahead of production during the development phase to assure a sustainable start-up to social development and is investing in a positive relationship with communities and the government of the DRC.

To assist conceptually in the early start-up programs, and in preparation of the long-term community development program, TFM has commissioned NGO assistance in the preparation of a "road map" for social development. This will serve as the conceptual basis for an evolving and flexible strategy for sustainable and participatory social development related to the TFM concession site (Section D4.1).

The strategy behind the road map is to make the communities in the Fungurume and Tenke region independent from the mining operations within a 20-year timeframe. The TFM mining project has an expected life of 20 years or more and during this period the TFM Social Development Plan (SDP) and TFM Foundation could contribute and effectively make this region economically sustainable.

To attain this economic sustainability the strategy will focus on the following four components:

- Basic needs of the communities.
- Income generation and livelihoods.
- Social and community infrastructures.
- Good governance.

With regard to basic needs of the communities, one of the development plan objectives is to assure that the rural and urban populations in the active mining area have access to potable water, basic primary education and basic health facilities and are better informed and able to provide better nutrition to decrease malnutrition. Those basic needs are necessary for a community to evolve and grow.

With regard to income-generating activities, TFM will help the communities to transition beyond subsistence agriculture and develop more commercial agriculture activities. As described in the conceptual roadmap, the plan will concentrate on building market linkages between Tenke Fungurume needs and also linkages among regions close to Fungurume and Tenke. Income-generating activities will permit the different communities to have increasing revenues, contribute more taxes to the local governments and restart the building of a developing economic and social region.

For infrastructure, good roads and road communications are essential and the base for a sustainable socio-economic development. The community development plan will address this specific issue and start to build and create some small and micro-enterprises that will then be in a position to work on road construction and rehabilitation of roads. International donors will be contacted to contribute to the completion of road networks to make sure that the SDP contributes to opening this isolated region to Lubumbashi and Kolwezi.

Good governance and transparency are essential for sustainable development. TFM understands that mining royalties when returned to the territorial and provincial levels, along with the income generating activities, will bring more and more revenues to the communities. These communities will generate increasing revenue to the local governments and authorities and these taxes should be used to build roads, schools and hospitals and maintain various required infrastructures. The community development plan will provide capacity building with the local authorities and local government along with local NGOs. Training will be provided to ensure the revenues from taxation are managed in an increasingly transparent manner.

Additional details on the TFM community development plan are provided in Section D4.4.

A4.15 BORROW MATERIAL

Borrow materials for construction and operations will predominantly be derived from within areas already slated for disturbance. For example, the tailings embankments will be constructed from native soil materials removed from within the proposed footprint of the tailings facility as well as from waste rock, slated to be mined as part of overburden stripping at the mine. Similarly, engineered fill at the plant site is planned to be obtained from cut surfaces from within the plant footprint. Aggregates for concrete, drainage structures and road surfacing will either be obtained from the Mofia limestone quarry or from a contracted source outside of the concession. Materials required for closure will be from stockpiles salvaged from beneath the proposed facilities prior to construction.

A4.16 CLOSURE

The intent of the TFM project is to establish and apply an accepted standard of reclamation based on the following underlying objectives and on industry best practices and international standards, such as those set forth by the World Bank and International Finance Corporation (IFC):

- Return the site to a safe and stable condition, free of safety hazards (such as unsafe buildings, equipment, open holes, etc.).
- Return the site to a viable and, wherever practicable, self-sustaining ecosystem that is compatible with the surrounding environment and post-mining land use.
- Develop measures to prevent or minimize discharges of contaminants to surface water, groundwater, air and soils.

- Meet applicable regulatory requirements and standards for protection of human health and the environment (physical, biological and socio-economic resources).
- Use proven, demonstrated technologies, including passive closure strategies where feasible and other new technologies and practices that may emerge over the life of the project, as practicable.
- Design a durable and cost-effective closure strategy that minimizes the long-term cost of post-closure maintenance and monitoring.
- Reduce post-mining liabilities by incorporating closure considerations into the design and operation of mine facilities, and implementing closure and reclamation activities concurrently with mining, to the extent feasible.
- Assess the social and economic implications of mine closure and develop appropriate transition strategies for Tenke project employees and the local community, as defined in the TFM community development plans (CDP) (Section D4.4).

Conceptual closure plans for the Tenke project have been developed (Section D5) and are briefly discussed below. These plans must be integrated into future land use and community development planning. They will require periodic updating and refinement, to meet closure objectives and utilize technologies that are not currently known.

A4.16.1 Plant Site

The conceptual closure plan for the plant site involves removing all process materials from the site and either salvaging the equipment and buildings, or retaining them as useful infrastructure for future business opportunities, possibly in pursuit of local sustainable community development opportunities. All waste facilities in the plant area will be closed permanently. If the buildings are salvaged, the foundations will either be buried in place or removed and buried within the mine waste rock facilities.

A4.16.2 Mine

Long-term closure of the mine will involve allowing the water to rise within the pit. The water quality within the pit will be monitored to assure that seepage from the area does not impair downstream uses of the water. Active treatment of this water is not predicted to be needed, once the pit has filled. Waste rock berms or similar preventative measurements will be built to limit access to the open pits.

A4.16.3 Waste Rock and Ore Stockpiles

Closure of the rock stockpiles will involve final grading the top surface of the stockpiles to promote drainage, compaction of the surface of the piles, construction of rock channels adequate to direct runoff water to local waterways, and replacement of topsoil on the tops of the stockpiles. The sides shall be left as exposed rock. The topsoil shall be reseeded with native grasses and forbs.

A4.16.4 Tailings

The surface of the tailings will be revegetated as quickly as practical following completion of tailings placement. The surface will be covered with a waste rock layer to minimize capillary action, and then covered with salvaged topsoil and seeded with suitable seed mix.

A4.16.5 Ancillary Facilities

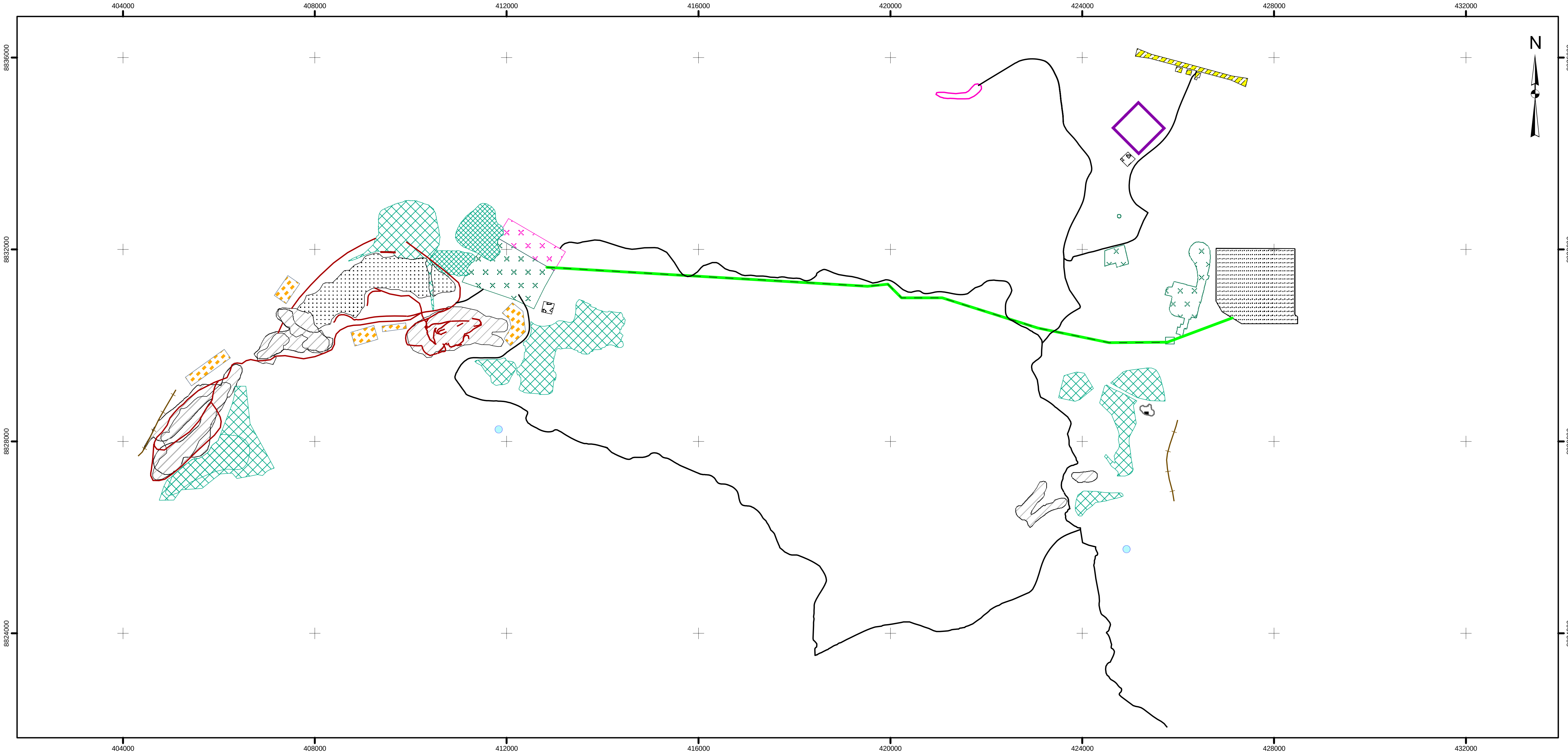
Ancillary facilities have the potential to be used in local business development, or as facilities to be used by a municipality. Individual closure plans for these facilities can be developed only at a future date.

A4.17 EXPANDED PROJECT CASE

Expansion of the project to a production rate of 400,000 tonnes per year of copper is considered in the cumulative effects assessment described in Section A5.8.3 and presented in Volume C. The expansion would include construction of a second processing plant and tailings storage facility north of Fungurume.

A conceptual outline of the expansion is shown in combination with the proposed TFM project footprint in Figure A4.17-1. Because of the conceptual nature of the expanded project at this time, the following assumptions were made:

- Mining of ore at Kwatebala, Goma, Fwaulu and Fungurume.
- Expansion of the proposed Kwatebala processing plant to a production of 200,000 tonnes per year of copper.
- Construction of a second processing plant north of Fungurume with a production of 200,000 tonnes per year of copper.
- Construction of an above-ground 249-hectare tailings facility north of Fungurume.



3 0 3

ÉCHELLE 1:80000 KILOMÈTRES
SCALE 1:80000 KILOMETERS

LÉGENDE / LEGEND

- BANC D'EMPRUNT / BORROW PIT
- CHEMINS DE ROULAGE/ HAUL ROAD
- LIGNE DE TRANSPORT D'ÉNERGIE / POWER LINE
- PIPELINE / PIPELINE
- ROUTE / ROAD
- VOIE D'ÉVITEMENT / RAILWAY SIDING
- AÉROPORT / AIRFIELD
- CARRIÈRE / QUARRY
- CLÔTURE / FENCE
- FOSSE DE LA MINE / MINE PIT
- LIMITES DE L'IMPLANTATION FUTURE / FUTURE EXPANSION BOUNDARY
- LIMITES DE L'USINE (ÉTAPE DE CONCEPTION) / PLANT DESIGN BOUNDARY
- PARC À RÉSIDUS / TAILINGS SITE
- PILE DE STOCKAGE - SOL / STOCK PILE - SOIL
- SITE D'ENFOUISSEMENT / LANDFILL
- STÉRILES / WASTE ROCK
- MINERAI À FAIBLE TENEUR SUR STÉRILES / LOW GRADE ORE ON WASTE ROCK
- VILLAGE PERMANENT / PERMANENT VILLAGE
- PILE DE STOCKAGE DE MINERAI À FAIBLE TENEUR / LOW GRADE STOCKPILE

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S / Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

PROJET / PROJECT

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE
TITLE

EMPREINTE DU PROJET ÉTENDUE POUR LE SCÉNARIO DE 400 000 TONNES PAR ANNÉE / EXPANDED PROJECT FOOTPRINT FOR THE 400,000 TONNES PER YEAR CASE

Golder Associates
Calgary, Alberta

N° PROJET / PROJECT NO. 05-1334-035		ÉCHELLE TELLE QU'INDIQUÉE SCALE AS SHOWN	REV. 0
DESSIN / DESIGN	MR	30 May 2006	
GIS / SIG	CW	02 Jan. 2007	
VÉRIFIÉ / CHECK	MR	19 Oct. 2006	
APPROUVÉ REVIEW	MR	19 Oct. 2006	

FIGURE: A4.17-1

- Deposition of waste rock near Goma, Fwaulu, Kwatebala and Fungurume pits.
- Expansion of the construction camp and ancillary facilities as required.

The land use potentially affected by the expanded project includes approximately 1,700 hectares of agricultural land and 80 hectares if woodland (Table A4.17-1).

Table A4.17-1 Approximate Land Use Affected by the Expanded Project

Land Use	Regional Study Area (ha)	Expanded Project (ha)	% Land Cover Loss
copper-cobalt rock outcrop	11	9	83.7
old fallow field	994	0	0.0
airfield	5	0	0.0
miombo woodland	14,794	757	5.1
miombo woodland degraded	2,890	475	16.4
gallery forest	118	5	3.8
agricultural mosaic	29,318	1,722	5.9
disturbed area	41	9	20.8
copper-cobalt steppe-savannah	598	239	40.0
wetland	147	0	0.0
settlement	550	14	2.5
Total	49,466	3,230	n/a

ha = hectares.

A5 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT APPROACH

The environmental and social impact assessment (ESIA) has been prepared in accordance with the terms of reference (ToR) for the Tenke Fungurume Mining S.A.R.L. (TFM) project (Appendix E8). The ToR include the following tasks:

- Identify the environmental and socio-economic resources potentially affected by the project.
- Predict positive and negative effects and the extent to which positive effects can be enhanced and negative effects can be mitigated.
- Quantify and assess the significance of effects where possible.
- Identify means to monitor the resources that may be affected by the project.

This section of the ESIA:

- Provides an overview of the ESIA methods, including how environmental, social and economic aspects were integrated into the assessment.
- Describes the methods for issue scoping and the determination of key questions.
- Outlines the means of selection of indicators.
- Discusses the spatial and temporal boundaries for the ESIA.
- Describes the use of linkage diagrams.
- Discusses the impact assessment methods to be used.
- Indicates how effects will be described.
- Presents the assessment cases.

The ESIA complies with internationally accepted mining practices, including the Equator Principles (EP) (IFC 2006a). The ESIA uses the following tools and procedures to analyze and address potential effects:

- Quantitative and qualitative information on the existing environmental and socio-economic conditions.
- Predictive tools (models) and methods to quantitatively and qualitatively describe future environmental and socio-economic conditions.

- Quantitative and qualitative evaluation of the significance of potential effects, including reference to management objectives, baseline conditions and the views of the proponent and stakeholders.
- Characterization of potential positive and negative residual effects and their consequences for people and the environment.

A5.1 SUSTAINABILITY

This ESIA is structured with a sustainable development focus. The vision for the ESIA is to strive to move the project "towards sustainability". TFM and Phelps Dodge Corporation (PD) recognize the needs of society and the value of economic prosperity, national security and a healthy environment. They are committed to integrating social, environmental and economic principles in their mining operations from exploration through development, operation, reclamation, closure and post-closure activities and in facilities associated with preparing products for further use.

For the project, sustainable development is achieved by:

- Striking a balance between the operational activities and the social, political and economic dynamics within the regional settings.
- The ability to provide society with access to recyclable mineral resources (e.g., copper) otherwise not accessible.
- Achieving an adequate profit on the invested capital for their shareholders while contributing to improve quality of life in nearby communities.
- The positive management of the environmental resources on which the mine may impact.

TFM and PD aim to be a catalyst in development beyond their own operations. They work to ensure that their sites will operate in ways that do not deter other development and contribute to a net positive impact to host communities where they operate. This net impact embraces social, economic and environmental conditions and builds capacities necessary to provide for the needs of current and future generations.

The ESIA addresses numerous disciplines (hydrology, flora, cultural and others) in each of the physical, biological and social realms. The ESIA is structured to assess two aspects for each discipline:

- How can the project be designed to reduce or eliminate negative effects?

- How can the project have a positive effect that will last beyond the life of the mine? This is the main goal of a sustainability approach.

Further, within each component, both ideas on actions and indicators will be selected. “Actions” outline the specific steps to be taken to reduce negative effects and to enhance positive benefits. “Indicators” are selected and used to monitor the success of actions in achieving the desired goals. Actions identified in the ESIA are not to be considered as commitments by TFM. Rather, they are ideas or concepts for actions that could be considered. TFM proposes that a Sustainable Development Forum be created to select, fund and track the success of sustainable actions over the construction and operation phases of the project. The forum would be composed of members of local government, citizens, non-governmental organization (NGOs) and TFM. The forum and the procedures taken to address sustainability are described in further detail in Section A5.9.5.

A5.2 ISSUE SCOPING

Issue scoping is a critical first step of the ESIA, as it allows important issues (as defined by stakeholders and specialists familiar with the potential effects of the project) to be clarified and given proper emphasis in the assessment.

The ESIA is divided into three main sections: the physical disciplines (hydrology, water quality, air quality and so on); the biological disciplines (flora, fauna, fish and aquatic habitats and so on); and the social disciplines (socio-economics and cultural resources and so on). For each discipline, a list was created to identify the environmental and social changes (both from an assessment and sustainability perspective) that could result from the project. This list was derived from public consultation input (Section A6.1), international best practice and the knowledge of the study team.

A draft ToR and scoping document were prepared and presented in a further round of consultation. All the potentially important positive and negative impacts were identified. All stakeholder issues and TFM responses to them were put in an Issues and Response Report as part of the consultation record (Appendix E6). The scoping report and ToR were then finalized taking into account stakeholder comment (Appendices E4 and E8, respectively). An example of an issues section (in this case, for surface water quality) is provided below.

Assessment issues related to surface water quality include:

- Effluent releases from the project may result in changes to downstream surface water quality.

- Erosion from the project may result in increased sediment levels in local watercourses.
- Accidental spills from the project may result in changes to downstream surface water quality.
- Induced development brought about by the project may exacerbate water quality issues.

In addition, actions the TFM could take to have a long-term, positive effect on water quality were identified. If the capacity to maintain these actions in the long term could be established, these measures could contribute to sustainability. Some examples are provided below:

- Improved sanitation for local residents by provision of, and training in, simple sanitation technology.
- Training in improved soil conservation and agricultural techniques.
- Reforestation of riparian buffers.

A5.3 KEY QUESTIONS

One of the main purposes of an ESIA is to provide answers to questions that people have about how a project could affect something that matters to them. To focus the assessment and ensure that the ESIA clearly addresses the issues of concern, questions were formulated that capture the concerns relative to a particular issue. In this report, those concerns are expressed as “key questions,” and they form the basis of the investigations of potential project impacts.

Two kinds of key questions are used in this assessment:

- “Impact” key questions ask to what degree a particular effect of the project may impact on physical, biological or social resources.
- “Sustainability” key questions ask how specific, positive long-term effects for physical, biological or social resources can be achieved during and after the project.

Key questions were developed from of a list of the issues identified through consultation and the experience of the assessment team.

Examples of key questions are provided in Table A5.3-1.

Table A5.3-1 Example Key Questions for Water Quality

Impact Assessment
WQ-1[(a)] What effect will the project have on water quality in receiving waterbodies?
WQ-2 What effect will the project have on suspended solids levels in receiving waterbodies?
Sustainability Assessment
WQ-3 How can the project have a positive effect on water quality in local waterbodies?
WQ-4 How can the project have a positive effect on suspended solids levels in local waterbodies?

(a) WQ= Water Quality.

The actual key questions for the ESIA are provided for each project component in Volume C.

A5.4 KEY INDICATORS

Indicators are measurable parameters that can be used to help evaluate key questions. Many indicators have been established either through past environmental assessment practice or by agencies such as the Global Reporting Initiative (GRI) and the International Federation of Consulting Engineers (FIDIC).

The GRI is a multi-stakeholder process and independent institution whose mission is to develop and disseminate globally applicable sustainability reporting guidelines. The International Federation of Consulting Engineers (FIDIC) has a sustainable development task force that has been drafting project indicators for sustainable development. Both GRI (2005a) and FIDIC (2006) have a list of indicators for the social, economic and environmental sectors. A recent advance that GRI (2005) has made is the identification of mining sector-specific indicators. These organizations do not intend to offer a comprehensive list of indicators; rather, they are meant to be suggestions that can be adapted on a project-by-project basis.

For the purposes of the ESIA, indicators were selected for each discipline. Each specialist reviewed the GRI and FIDIC indicator lists (as well as other indicator lists that were applicable) and derived a list for the TFM project for their field of study. Table A5.4-1 outlines an example list of applicable indicators and their context for one discipline, water quality.

Table A5.4-1 Potential Project Indicators for Water Quality Key Questions

Key Question[a]	GRI Indicator	FIDIC Indicator	ESIA Indicators	Context
WQ-1	EN12. significant effluent discharges to water by type	n/a	water quality at point of discharge water quality at compliance points	PD strives for zero discharge concept. When zero discharge is not feasible to reach, it strives to meet WHO or US EPA drinking or irrigation water standards. Water quality targets are set out based on internationally accepted standards in Section A2.7.
WQ-2	n/a	n/a	total suspended solids at point of discharge	Suspended solids targets are set out based on internationally accepted standards in Section A2.7.
WQ-3	n/a	n/a	water quality at compliance points	The project will strive to have positive impacts over the long term.
WQ-4	n/a	n/a	total suspended solids at compliance points amount of sediment in streams	The project will strive to have positive impacts over the long term.

[a] Example only.

n/a: Not applicable.

A5.5 SPATIAL AND TEMPORAL CONSIDERATIONS

A5.5.1 Spatial Scope

Defining the geographic extent of study areas is a key element of ESIA. For the assessment of local impacts, the area should be large enough to efficiently analyze and mitigate the obvious potential effects from the project on the receiving environment, but not too large as to dilute or confound the potential project-related effects with other human-induced and natural influences.

Typically, the assessment of impacts within the local area of the project, or Local Study Area (LSA), is based on the spatial extent of the footprint and an associated buffer zone that includes potential immediate indirect effects on the receiving environment. Alternately, the assessment of potential broader or regional cumulative effects from the project in association with other anthropogenic activities and natural factors requires a larger geographic area. Study areas also may be specific to environmental disciplines (e.g., air, soils, geology, ground water, surface water, aquatic organisms, flora, and fauna) and individual components of the project such as the mine site, waste rock, tailings, processing plant facilities and construction and operation camps.

The more widespread, indirect effects of the project such as population-related impacts or wider air quality effects are considered within a Regional Study Area

(RSA). The RSA is specific to the discipline, and typically encompasses all of the LSA for that discipline plus a large area around it.

Study areas were selected for each discipline based upon the anticipated areas of influence of the project. Study areas for the baseline field programs are presented in Section B1. These included the various alternatives considered for the project (Section A3). Once the preferred alternatives were selected, discipline-specific impact assessment study areas were derived (Section C1).

A5.5.2 Temporal Scope

This ESIA is designed to evaluate a specific project plan that occurs in a specific period of time. By defining a temporal scope, clear boundaries are established for the time period being assessed. The project is defined as having:

- A construction phase of two years, from 2007 to 2008.
- An operation phase of about 20 years, from late 2008/early 2009 through 2027. Note that processing of stockpiled ore will continue for another 20 years past this date.
- A closure phase (during which active reclamation and decommissioning is completed) of two years, from 2027 to 2028. (Note: facilities such as the processing plant may remain open.)
- A post-closure phase (during which reclamation monitoring and follow up is completed) from 2028 on, until project-related monitoring and mitigation is satisfactorily complete.

Not all ESIA disciplines characterize impacts for each phase. Some only determine effects for those phases that represent the maximum impact (e.g., most air quality effects from emissions occur during the operation phase), while other disciplines evaluate potential effects at several phases (e.g., comparing the maximal extent of disturbance to flora during operation to the amount that will be reclaimed at closure). For the terrestrial assessments, post-closure was defined as ten years following reclamation.

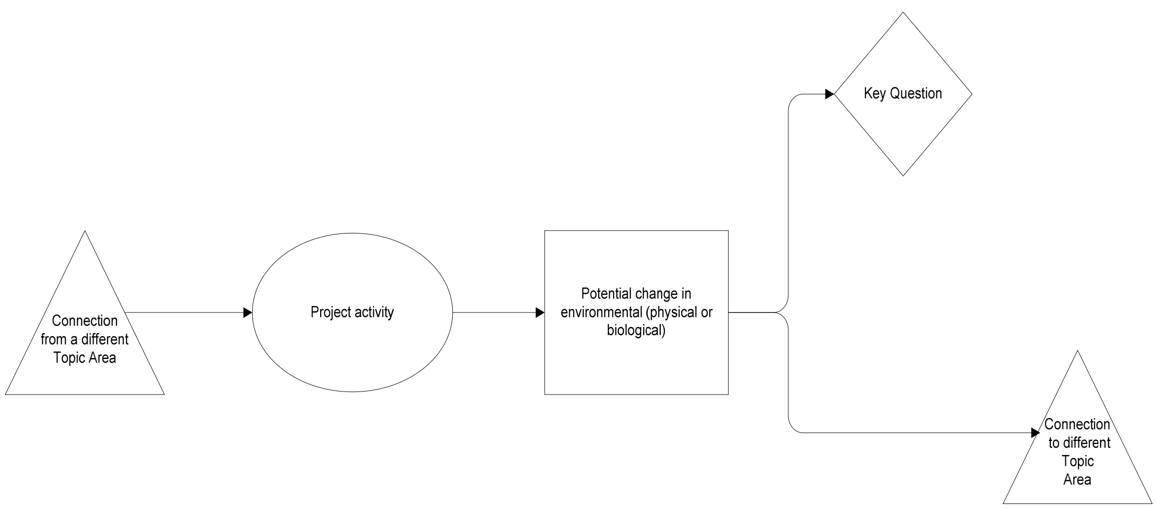
A5.6 LINKAGE DIAGRAMS

The “linkage diagram” is a tool meant to assist specialists in their work and to enable readers to understand what has (and has not) been included in the impact analysis. Linkage diagrams initially define what specific project-related impacts have the potential to affect physical, biological or social features relating to a given discipline, and can be modified as the specialist determines which linkages are valid and which are not. The linkage diagram is also useful to indicate which potential impact linkages have been evaluated.

Each linkage diagram depicts the relationships between the project, environmental changes or the issues raised during consultation, and the key questions derived for the final assessment. In this way, it can be readily determined if there is a valid connection, or linkage, between a project element and a potential issue. If a linkage is found to be valid, it is carried forward to the assessment. If not, it is stated that the linkage is not valid and no further analysis is required.

As impacts in one discipline can affect or be affected by other disciplines, the linkage diagram also shows connections to and from other key questions or topics. Figure A5.6-1 illustrates the typical format of a linkage diagram.

Figure A5.6-1 Example of a Linkage Diagram



Preparation of linkage diagrams requires the following key elements:

- Identify project components that may affect an environmental resource (illustrated by an oval).
- Predict the environmental changes that may result from the project (illustrated by a rectangle).

- Clearly identify the issue that is being investigated. This is the purpose of the key question, which is illustrated by a diamond icon.
- Identify other components of the environment, and thus the ESIA analyses, that are inter-related. A triangle illustrates information that either is provided from the analysis of a different key question, or is used in the analysis of another key question.

A5.7 LINKAGE ANALYSIS

The process of assessing potential linkages is closely related to the process of setting up the linkage diagram, as described above. By defining the possible impact pathways between project activities and environmental changes, a determination is made as to the relevant impacts to be assessed. The validity of each potential impact linkage is determined through a scoping-level analysis of the way the project activity will (or will not) result in an environmental change that could be considered an impact on either people or the environment. In cases where changes attributable to the project do not affect specific social or environmental characteristics being assessed, this is clearly stated, and further analysis is not done.

For example, for water quality, it is clear that two of the three project phases (construction and operations) will involve some level of alteration of water quality parameters and sediments in receiving watercourses. However, with appropriate reclamation, such impacts may not occur in the post-closure phase. Therefore, linkages in the diagram for construction and operations are likely to be valid, while linkages for post-closure would not need to be considered in the assessment.

A5.8 ASSESSMENT CASES

Three ESIA cases, or scenarios, are considered for the ESIA:

- Baseline (scenario considering conditions prior to any large-scale project activity).
- Project (scenario considering the changes that the project alone will cause).
- Cumulative effects (scenario considering the changes that the project and any other foreseeable projects planned for the RSA will have during the defined temporal scope of the assessment).

Each of these scenarios is discussed in this section.

A5.8.1 Baseline Case

The baseline is first established in the ESIA to develop an understanding of the physical, biological and social conditions that the project will be acting upon. Baseline for the ESIA is defined to include current (2006) conditions including all existing disturbances. Baseline therefore includes existing disturbances from agriculture and grazing, houses, roads and trails, plus disturbances from artisanal mining and mine exploration activities.

From a resettlement perspective, the baseline case includes all current inhabitants of the study area, as determined by homes and fields delineated on May 2006 aerial photographs. Thus, resettlement is included as part of the project and will be assessed in the ESIA.

A5.8.2 Project Case

The project case is used to assess the impact of the project itself on the environment. The project description (Section A4) reflects the following:

- Input from public consultation and technical data (Section A6).
- Conservative estimates of the layout, project duration and emissions.
- Environmental and social considerations to reduce potential negative impacts and enhance positive impacts.

The impact assessment focuses on the Kwatebala mine and its associated infrastructure, including waste rock and low grade ore facilities, a tailings storage facility, access roads, powerlines and the limestone quarry. Mining and mineral processing is expected to begin in late 2008 with a copper production rate of around 115,000 tonnes per year. To maintain this rate of production, pits probably will be developed at the Goma hills beginning in 2017 and Kaviwafwaulu (Fwaulu) in 2021. The assessment of effects related to the Goma and Fwaulu pits is necessarily qualitative for this ESIA since sufficiently detailed mine plans are not available. An addendum or a new ESIA will be prepared to quantitatively assess potential effects of mining these ore bodies prior to their development.

The assessment of the tailings storage facility was based on the most likely sizing, a 233 hectar structure including a return water dam. The final feasibility study considers a larger structure, with higher embankments and a larger capacity for tailings, that was scaled up from the smaller facility. Impacts of this larger facility were not considered to be substantially different, as no copper-cobalt flora or agricultural or residential lands occur on the periphery where the embankments would be enlarged. Ongoing design work also indicates that the larger facility, while feasible, is not the most likely size to be built.

The project case includes only the mining of shallow (oxide) reserves at Kwatebala Hill. The mining of deeper (sulfide) reserves are not within the scope of this project.

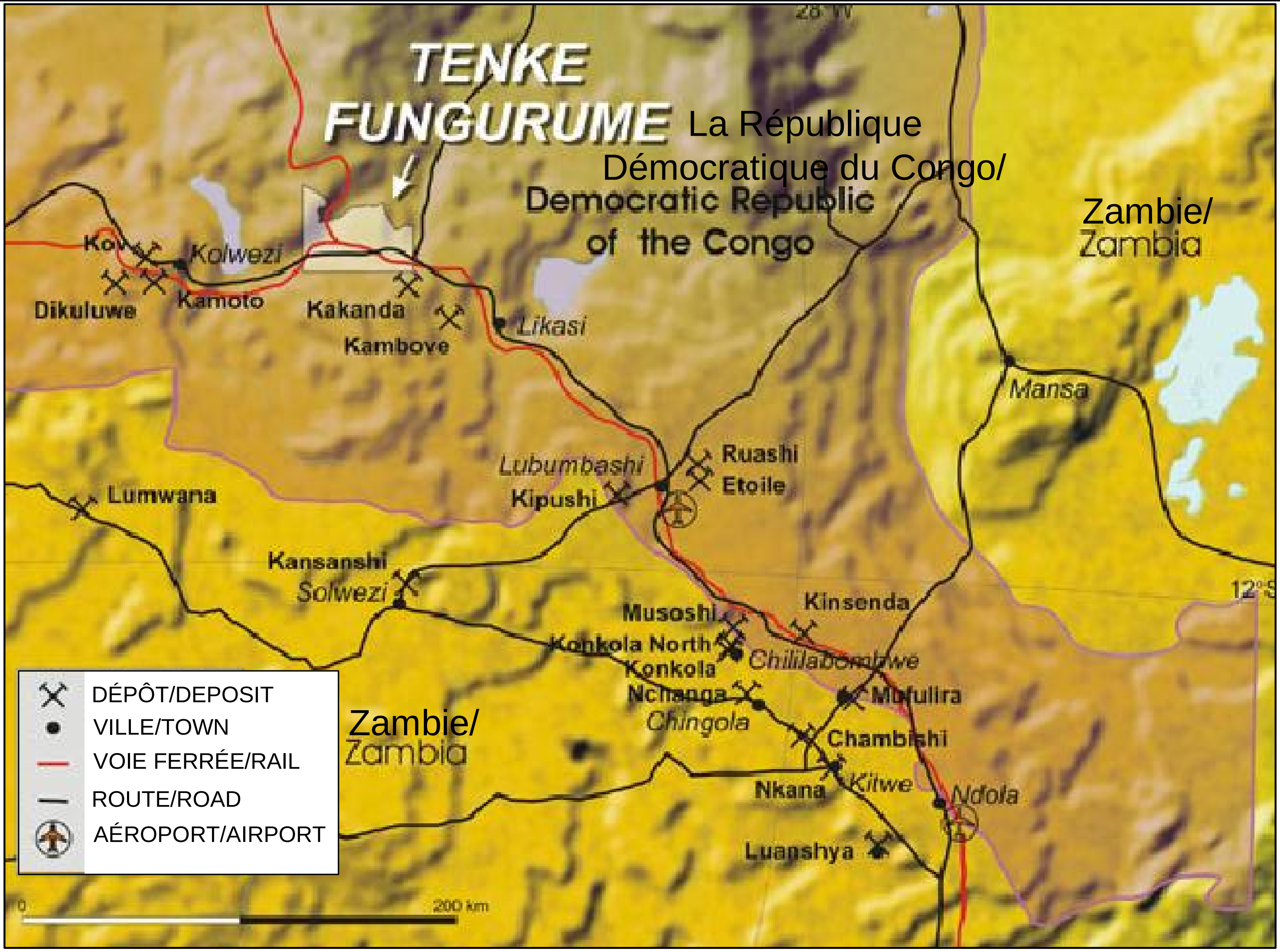
Further refinements to the project design will occur as ongoing public input is received, during the detailed engineering design work, during the contract tendering process, and during construction and commissioning.

A5.8.3 Cumulative Effects Case

Cumulative effects are the impact on the environment that results from the incremental impact of the project when added to other past, present, and reasonably foreseeable future actions regardless of which agency, company or person undertakes such other actions. The cumulative environmental effects of the project and other existing projects or disturbances was limited to an evaluation of those effects within the region in the context of the project that are planned or are reasonably foreseeable. A focus of the cumulative effects assessment was an evaluation of the combined effects of the Kwatebala, Goma and Fwaulu pits, as well as other main pits such as Fungurume. A RSA was selected for each discipline in order to analyze the cumulative effects. These are described in Section C1.

No other significant industry exists or is reasonably foreseeable within the TFM RSAs, although other mines are present in the region. The nearest mine is at Kakanda, about 21 kilometers to the southeast of the proposed Kwatebala mine and plant site (Figure A5.8-1). This mine was considered to be outside the area of influence of the TFM project. Foreseeable development within the RSAs is therefore limited to potential expansion of the TFM project. There is the potential for the TFM project to expand to a production rate of up to 400,000 tonnes per year of copper (Section A4.17). The cumulative effects case therefore considers the potential effects of the TFM project plus expansion to a production of 400,000 tonnes per year of copper (Section A5.9.7).

L:\2005\1322-EA\1334\05-1334-035\9300\9310\Fig A5.8-1_Mines in the Copperbelt.dwg Mar 26, 2007 - 2:37pm



PROJECT/PROJET

tfm

PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITLE/TITRE

MINES DANS LE COPPERBELT/
MINES IN THE COPPERBELT

Golder Associates
Calgary, Alberta

PROJECT/PROJET		05-1334-035	FILE No.	Mines-Copperbelt
DESIGN/DESSIN	MR	30 Jun. 2006	SCALE/ECHELLE: AS SHOWN/ tel que montré	REV. 2
CADD/CAD	PSR	27 Jul. 2006	FIGURE: A5.8-1	
CHECK/VERIFIÉ	MR	27 Jul. 2006		
REVIEW/APPROUVÉ	MR	27 Jul. 2006		

A5.9 IMPACT ANALYSIS

Impact analyses are performed for the key questions for each ESIA discipline. The impact analysis consists of the following five main steps, and is identical for both impact and sustainability assessments:

- Identification of project activities that could contribute to environmental or social change.
- Evaluation of the potential effects.
- Description of mitigation measures for potential effects.
- Analysis and characterization of residual effects.
- Identification of monitoring to evaluate and track performance.

For the purpose of this ESIA, mitigation applies to the construction, operation and closure design principles to minimize or eliminate potential adverse impacts and, where possible, enhance environmental or social quality.

Quantitative methods of assessment are used where possible. Predictive modeling is used as a tool in the air, noise, vibration, hydrogeology, hydrology and water quality assessments. Geographic information systems (GIS) and mapping are tools to assess impacts on terrestrial resources.

A5.9.1 Assessment Methods

Each key question will require specific assessment methods. These will be described, including means of field measurement, modeling techniques and other methods. Sufficient description of methods is provided to allow duplication by others (i.e., a scientific method). For some disciplines, impacts are addressed for each project phase. For others, phases are combined, or only phases with the greatest potential impact are analyzed.

A5.9.2 Mitigation

This section describes the mitigation measures that will be implemented by the TFM project for each key question. All phases (construction, operations and closure) are considered. For each phase mitigation measures are presented as follows:

- What design techniques were used to avoid the impact (e.g., avoid siting the facilities in agricultural areas)?

- What methods will be used to minimize the impact (e.g., use dust suppression on roads in dryer months)?
- What methods will be used to rehabilitate/repair an impact (e.g., reclaim an area after disturbance)?
- What will be undertaken to compensate for impacts (e.g., provide alternate access to a site if original access is blocked)?
- What will be undertaken to have a positive, lasting, long-term effect (e.g., promotion of small businesses)?

A5.9.3 Results

This section provides the results of modeling and data analyses that were conducted in support of the impact assessment. The information is presented so as to be transparent, although if the results are highly detailed, the key results are presented in the text and detailed results in an appendix. Key results include the changes in the specific indicators to be measured to assess key questions.

A5.9.4 Impact Analysis

This section describes the approach used to assess negative effects, while Section A5.9.5 describes the sustainability assessment approach for addressing positive effects. Impacts assessed are residual impacts, i.e., the predicted impacts after all mitigation has been applied. Residual impacts are classified using criteria to determine the overall effect, which is termed the environmental or social consequence. Each impact first is described using the following criteria: direction, magnitude, geographic extent, duration, reversibility and frequency (including seasonal effects). These criteria are defined below:

Direction: May be positive, neutral or negative with respect to the key question (e.g., a habitat gain for a key species would be classed as positive, while a habitat loss would be considered negative).

Magnitude: The degree of change in a measurement or analysis, classified as negligible, low, moderate or high. Categorization of the impact magnitude is based on a set of criteria, ecological concepts and/or professional judgment pertinent to each of the discipline areas and key questions analyzed.

In some cases, magnitude ratings are determined by professional judgment; in other cases, they are based on thresholds that have been validated scientifically. For example, much ecological literature points to changes in measurement endpoints of over 20 percent, as compared to baseline, as having a high-magnitude impact on biological systems. Suter et al. (1995) have identified that the 20 percent rule for the severity of effects from contamination is applicable by analogy to areal scales of ecological effects. Lande’s (1987) demographic model predicted that species with low demographic potential cannot persist if suitable habitat is reduced by more than 20 percent. These impacts are variable; species are predicted to exhibit a diverse array of responses to habitat fragmentation depending upon the specific combination of life history traits and dispersal capabilities (With and King 1999). Species with limited reproductive potential go extinct sooner than predicted by Lande’s model. Therefore, based on the bulk of available literature, the 20 percent criterion is the base case used in the ESIA to define impacts of high magnitude, unless additional data suggest a higher or lower value.

Geographic extent: The area affected by the impact, classified as local, regional or beyond regional. A method of defining impacts within a study area, in terms of the percentage of a certain resource affected, is influenced by the size of the study areas. As such, quantitative values of impacts must be tempered with an overall qualitative approach that considers the project impacts on the overall viability and diversity of ecological units.

Duration: The length of time over which an environmental impact occurs. Short-term is defined as less than the construction phase (less than 3 years); medium-term as longer than short-term and up to the operational duration of the project (3 to 20 years); long-term is greater than medium term (greater than 20 years).

Reversibility: An indicator of the potential for recovery following the impact.

Frequency: How often the effect occurs within a given time period and is classified as low, medium or high in occurrence. Seasonal considerations are discussed when they are important in the evaluation of the impact.

Impact description criteria have been established for all project components based on professional judgment of the ESIA team and the considerations of the issues that were identified as particularly significant to stakeholders. The use of the above system is varied as appropriate for certain disciplines. The results of this analysis are presented in each discipline report in a table such as Table A5.9-1.

Table A5.9-1 Example of Impact Description Criteria for Water Quality

Direction[a]	Magnitude[b]	Geographic Extent[c]	Duration[d]	Reversibility[e]	Frequency[f]
positive, **negative** or **neutral** for the measurement endpoints	**negligible**: releases do not cause guidelines or existing backgrounds to be exceeded **low**: releases contribute slightly to existing background being exceeded **moderate**: releases cause the guidelines to be exceeded (where guidelines were not previously exceeded) **high**: releases cause the guidelines to exceeded substantially	**local**: effect restricted to the LSA **regional**: effect extends beyond the LSA into the RSA **beyond regional**: effect extends beyond the RSA	**short-term**: <3 years **medium-term**: 3 to 20 years **long-term**: >20 years	**reversible** or **irreversible**	**low**: occurs once or rarely per a specified time period **medium**: occurs intermittently **high**: occurs continuously

(a) Direction: positive or negative effect for measurement endpoints, as defined for the specific component.
(b) Magnitude: degree of change to analysis endpoint.
(c) Geographic Extent: area affected by the impact.
(d) Duration: length of time over which the environmental effect occurs. Considers a 2-year construction period and a 20-year operations period.
(e) Reversibility: effect on the resource (or resource capability) can or cannot be reversed.
(f) Frequency: how often the environmental effect occurs.

An overall residual impact is determined to make the results of the impact assessment more understandable to stakeholders. The overall residual impact for each effect is termed the environmental or social consequence, and is classified to one of: negligible, low, moderate or high by evaluation of the rankings for magnitude, geographic extent and duration (Table A5.9-2). For example, an impact with a moderate magnitude, local extent and short duration would be classified as having a low overall environmental consequence. This system is used to ensure that the final classification is consistent among ESIA disciplines.

Table A5.9-2 Screening System for Environmental or Social Consequences

Magnitude (Severity)	Geographic Extent	Duration	Environmental or Social Consequence
negligible	all	all	negligible
low	local	short-term	negligible
low	local	medium-term	low
low	local	long-term	low
low	regional	short-term	low
low	regional	medium-term	moderate
low	regional	long-term	moderate
low	beyond regional	short-term	low
low	beyond regional	medium-term	moderate

Table A5.9-2 Screening System for Environmental or Social Consequences (continued)

Magnitude (Severity)	Geographic Extent	Duration	Environmental or Social Consequence
low	beyond regional	long-term	moderate
moderate	local	short-term	low
moderate	local	medium-term	low
moderate	local	long-term	moderate
moderate	regional	short-term	moderate
moderate	regional	medium-term	moderate
moderate	regional	long-term	high
moderate	beyond regional	short-term	moderate
moderate	beyond regional	medium-term	high
moderate	beyond regional	long-term	high
high	local	short-term	moderate
high	local	medium-term	high
high	local	long-term	high
high	regional	short-term	moderate
high	regional	medium-term	high
high	regional	long-term	high
high	beyond regional	short-term	high
high	beyond regional	medium-term	high
high	beyond regional	long-term	high

For some key questions, impacts have to be assessed separately by project phase (construction, operation, closure and post-closure) or facility type. For most, the key question is answered in terms of post-closure conditions only. Results are presented in a table such as Table A5.9-3.

Table A5.9-3 Residual Impact Classification for Key Question WQ-1

Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Key question: What effect will the project have on water quality in receiving waterbodies?[(a)]						
Potential effluent releases from plant and tailings facilities						
negative	low	local	long-term	no	continuous	low
Potential effluent releases from sewage treatment plants						
negative	low	local	medium-term	no	continuous	low
Potential releases of runoff from project facilities						
negative	low	local	medium-term	no	continuous	low

(a) Example only for table content.

A5.9.5 Sustainability Analysis

Actions that TFM could take to encourage positive, long-term effects were identified through a combination of stakeholder consultation and a series of workshops and discussions among the ESIA specialists, project design teams and management personnel. Each action is assessed by impact criteria for magnitude, reach, duration and probability of success (Table A5.9-4). In addition, each indicator is assessed in terms of its overall effect, or sustainability consequence. The criteria are further described below.

Table A5.9-4 Sustainability Criteria for the TFM Project

Magnitude of Contribution to Sustainability	Span or Reach of the Contribution	Duration	Probability of Success
negligible: no change in sustainability **low**: slight increase in sustainability **moderate**: moderate increase in sustainability **high**: large increase in sustainability	**few**: few people affected **half the community** **the entire community**	**short-term:** ceases at closure **medium-term:** persists for up to 10 years after closure **long-term**: permanent effect	**low**: up to 30% **medium**: >30% to 70% **high**: over 70%

Magnitude: The degree of change in a measurement or analysis, and is classified as negligible, low, moderate or high. The categorization of the sustainability magnitude is based on a set of criteria, ecological concepts and/or professional judgment pertinent to each of the discipline areas and key questions analyzed.

Span or Reach: For sustainability, the number of people affected by a given enhancement or change in the environment. It is classified as either a few people, half the community or the entire community.

Duration: Length of time over which an enhancement for sustainability occurs. Short-term is defined as an effect that ceases at closure (i.e., it is not sustainable). A medium-term effect persists for up to 10 years after closure. A long-term effect for sustainability is defined as being permanent.

Probability of Success: Likelihood of the sustainability enhancement measure being successful over the defined period of time intended. A low probability of success is one that has from a 1 to 30 percent chance of being effective. A medium probability is defined as being from above 30 up to 70 percent. A high probability of success is a probability over 70 percent.

Sustainability actions were selected based on the following four considerations:

- Is a direct mitigation measure required?
- If direct mitigation is not possible, is an offsetting action possible (compensation for effect that cannot be mitigated)?
- Can a modification of the project design enhance project sustainability?
- Is a social investment desirable (no direct link to project, but could provide indirect benefits, such as a healthier work force or community support for project)?

Once the actions were identified and the impact criteria rated for each, the overall effect of the action on the environment, and on sustainability, could be assessed. This assessment is a two-step process, using Tables A5.9-5 and A5.9-6. In the former, the potential sustainability consequence is determined through consideration of the magnitude, span or reach and duration. Subsequently, based on potential sustainability consequence and the probability that each sustainability initiative will be successful, the final sustainability consequence can be determined.

Table A5.9-5 Screening System for Sustainability Consequence

Magnitude	Span or Reach	Duration	Potential Sustainability Consequence
negligible	all	all	negligible
low	few	short-term	negligible
low	few	medium-term	low
low	few	long-term	low
low	half community	short-term	low
low	half community	medium-term	moderate
low	half community	long-term	moderate
low	entire community	short-term	low
low	entire community	medium-term	moderate
low	entire community	long-term	moderate
moderate	few	short-term	low
moderate	few	medium-term	low
moderate	few	long-term	moderate
moderate	half community	short-term	moderate
moderate	half community	medium-term	moderate
moderate	half community	long-term	high
moderate	entire community	short-term	moderate
moderate	entire community	medium-term	high
moderate	entire community	long-term	high
high	few	short-term	moderate
high	few	medium-term	high
high	few	long-term	high

Table A5.9-5 Screening System for Sustainability Consequence (continued)

Magnitude	Span or Reach	Duration	Potential Sustainability Consequence
high	half community	short-term	moderate
high	half community	medium-term	high
high	half community	long-term	high
high	entire community	short-term	high
high	entire community	medium-term	high
high	entire community	long-term	high

Table A5.9-6 Determination of Final Sustainability Consequence

Potential Sustainability Consequence	Probability of Success	Final Sustainability Consequence
negligible	all	negligible
low	low	negligible
low	medium	low
low	high	moderate
moderate	low	low
moderate	medium	moderate
moderate	high	moderate
high	low	moderate
high	medium	moderate
high	high	high

A sustainability assessment table for each discipline was prepared, similar to the impact assessment table. An example is provided in Table A5.9-7.

Table A5.9-7 Summary of Sustainability Assessment for Water Quality

Magnitude	Span or Reach	Duration	Probability of Success	Consequence
WQ-3 How can the project have a positive effect on water quality in local waterbodies?[(a)]				
Implement a Catchment Management Plan				
high	entire community	long-term	medium	moderate
Reforestation				
high	entire community	long-term	medium	moderate
WQ-4 How can the project have a positive effect on suspended solids levels in local waterbodies?				
Implement a Catchment Management Plan				
high	entire community	long-term	medium	moderate
Reforestation of Stream Buffers				
high	entire community	long-term	high	high

(a) Example only for table content.

Process to Select Actions to Implement

The sustainability actions identified and scored in the ESIA are not necessarily the actions that TFM will undertake. They are concepts that the ESIA team believes would have a reasonable chance of success is promoting sustainable development. The next step, following the ESIA, will be to form a Sustainability Steering Forum of local government, citizens, NGOs and TFM representatives. This forum will meet regularly to select actions to undertake, using a similar methodology for ranking actions as presented in the ESIA. Key to the selection process will be to ensure that the desires and needs of the local communities are met. Funding for the actions would largely come from the Social Investment Fund that is based on 0.3 percent of all product sales from the project. Funding will also come from contributions of equipment and labor from TFM.

The forum will also be responsible for developing the appropriate indicators for each action, monitoring work progress and annual reporting on achievements.

A5.9.6 Prediction Confidence

Although not explicitly included in the impact criteria, uncertainty regarding the effects described is inherent, due to the predictive nature of the analytic process. The certainty of an impact analysis depends on several factors, including:

- The understanding of natural/ecological and social processes at work now and in the future.
- The understanding of present and future properties of the potentially affected resources.

The level of confidence for an impact analysis is discussed when there are questions about the factors reviewed above. This is particularly important for sustainability key questions. Where the level of prediction confidence is low, a subjective assessment is made based on the available information, the similar actual examples and on professional opinion.

The level of prediction confidence is sufficiently low in some cases that an estimate of environmental or sustainability consequence cannot be made with a sufficient degree of confidence. In this case, the ratings are accompanied by recommendations for research or monitoring to provide more data in the future.

A5.9.7 Cumulative Effects Assessment

The cumulative effects assessment considers the effects of existing conditions, plus the project, and other planned or reasonably foreseeable projects. No other projects are planned within the TFM concession boundary, other than mining of the limestone quarry and the potential for the TFM project to expand to a production of 400,000 tonnes per annum of copper. Therefore, the cumulative case considers mining of the quarry and other major deposits in the concession such as the Fungurume ore body. Together, these are termed the "expanded project" (Section A4.17).

Methods for the cumulative assessment follow those for the impact assessment, except that sustainability is assessed in general terms.

A6 PUBLIC PARTICIPATION PROCESS

The environmental and social impact assessment (ESIA) for the Tenke Fungurume Mining project (the TFM project) follows the Terms of Reference (ToR) issued in May 2006 as well as the requirements of the IFC Performance Standards, including the associated guidelines relevant to consultation, public participation and information disclosure. The IFC requires that consultation occur throughout the life of the TFM project, from project inception through closure. Two main phases of public participation take place during preparation of the ESIA to provide an opportunity for stakeholders to learn about the TFM project, provide input and raise issues and concerns:

- Phase One takes place during ESIA scoping before guidelines for the preparation of the ESIA are finalized.
- Phase Two takes place when a draft ESIA summary is presented to, and discussed with, stakeholders.

This section provides a summary of the public participation process that was conducted for the TFM project ESIA. Further information can be found in Volume E:

- Appendix E2 - Public Consultation and Disclosure Plan.
- Appendix E3 - Background Information Document.
- Appendix E4 - Scoping Report.
- Appendix E5 - Stakeholder Database.
- Appendix E6 - Issues and Response Report.
- Appendix E7 – Socio-Economics Appendix
- Appendix E8 - Terms of Reference.

A6.1 OBJECTIVES OF PUBLIC PARTICIPATION

The public participation process for the TFM project is designed with two main objectives:

- To provide sufficient project information to interested and affected parties in an accessible and objective manner.
- To seek public input, including acceptance of concepts as well as questions and concerns.

During the scoping phase of the ESIA (November 2005 to May 2006), public participation objectives included:

- Identifying issues of concern and providing suggestions for alternatives and enhanced benefits.
- Receiving contributions of local knowledge and experience.
- Verifying that stakeholder issues, comments and suggestions were captured.

During the impact assessment phase (June to October/late 2006), public participation objectives included:

- Verifying that stakeholder issues, comments and suggestions were considered during the ESIA technical investigations.
- Commenting on the findings of the ESIA, including measures proposed to enhance positive impacts and reduce or avoid negative ones.

A6.2 STAKEHOLDERS

"Stakeholders" are persons who are affected by, or can affect the outcome of, the project. These can be affected communities, local organizations, non-governmental organizations (NGOs) and government authorities. Stakeholders also can include politicians, military authorities, commercial and industrial enterprises, labor unions, academics, religious groups, national social and environmental public sector agencies and the media. The current stakeholder database for the project consists of almost 530 individuals and organizations representing a broad spectrum of all sectors of society from both within the concession area and beyond. The list of stakeholders in the ESIA database includes (Appendix E5):

- National government.
- Provincial/regional government.
- Local government (in Kolwezi, Tenke and Fungurume).
- Organized agriculture.
- Business/commerce.
- Donor organizations.
- Environmental and conservation organizations.
- Health (local hospitals and clinics).
- Industry.

- Education: local universities and academic institutions, including schools and missions.
- Local communities, including tribal authorities and village leaders.
- Women's groups, development committees and other community-based organizations (CBO).
- Media (print and broadcast).
- Mining including mining companies, artisanal mining organizations and chamber of mines.
- NGOs including Democratic Republic of the Congo (DRC)-based NGOs and international NGOs not in the DRC but with a strong presence in Africa.
- Researchers and consultants.
- Tourism.
- Transport.
- Labor organizations.

A6.3 CONSULTATION DURING THE SCOPING PHASE

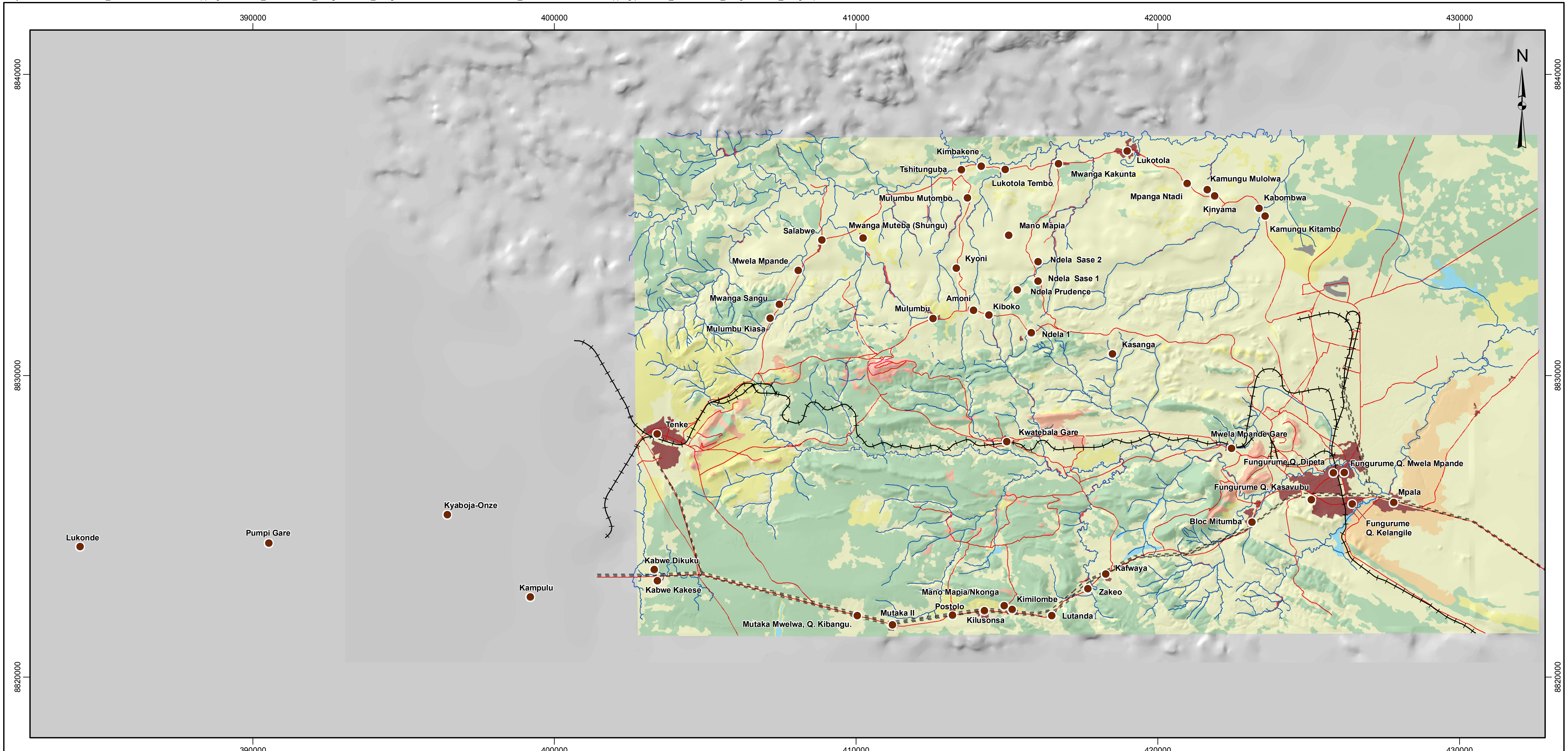
Consultation with stakeholders in the concession area during the scoping phase was conducted by both the socio-economic assessment team and the public participation team.

A6.3.1 Announcement of Opportunity to Comment

The socio-economic assessment team began to meet with stakeholders, both urban and rural, throughout the TFM project concession area in November 2005 (Photograph A6.3-1). These meetings continued until February 2006. At all meetings, a brief verbal overview of the proposed project was provided, the ESIA process was introduced and stakeholders were informed that the public participation process for the ESIA would begin shortly.

Meetings were held by the socio-economic assessment team in 41 rural villages and four urban and semi-urban villages in the TFM project concession area (see Figure A6.3-1).

Project I:\CLIENTS\PHELPS_DODGE\05-1334-035\mapping\mxd\Tenke_ESIA\Volume_A\FigureA6.1-1_Villages.mxd - Plot I:\CLIENTS\PHELPS_DODGE\05-1334-035\mapping\pdf\Tenke_ESIA\Volume_A\FigureA6.1-1_Villages.pdf



LÉGENDE / LEGEND

- VILLAGES
- LIGNE DE TRANSPORT D'ÉNERGIE / POWER LINE
- RIVIÈRE / RIVER
- RIVIÈRE INTERMITTENTE / SEASONAL RIVER
- ROUTE / ROAD
- VOIE FERRÉE / RAILWAY

COUVERTURE VÉGÉTALE / UTILISATION DU TERRAIN / LANDCOVER

- AFFLEUREMENT ROCHEUX DE MINERAI CUIVRE-COBALT / COPPER-COBALT ROCK OUTCROP
- STEPPE-SAVANE SUR SUBSTRAT CUPRO-COBALTIFÈRE / COPPER-COBALT STEPPE-SAVANNA
- FORÊT DE MIOMBO / MIOMBO WOODLAND
- FORÊT DE MIOMBO DÉGRADÉE / MIOMBO WOODLAND DEGRADED
- FORÊT GALERIE / GALLERY FOREST
- ZONE HUMIDE / WETLAND
- MOSAÏQUE AGRICOLE / AGRICULTURAL MOSAIC
- ANCIENNE JACHÈRE / OLD FALLOW FIELD
- AÉROPORT / AIRFIELD
- PERTURBATION / DISTURBANCE
- ÉTABLISSEMENT HUMAIN / SETTLEMENT

RÉFÉRENCE / REFERENCE

Projection : Mercator transverse. Système géodésique : WGS 84 Système de coordonnées : UTM Zone 35S / Projection: Transverse Mercator Datum: WGS 84 Coordinate System: UTM Zone 35S

4 0 4
ÉCHELLE 1:125000 KILOMÈTRES
SCALE 1:125000 KILOMETERS

PROJET / PROJECT
tfm
PROJET MINIER TENKE FUNGURUME
TENKE FUNGURUME PROJECT
TENKE FUNGURUME MINING SARL

TITRE / TITLE
VILLAGES VISITÉS DURANT LES ENQUÊTES SOCIO-ÉCONOMIQUES, 2005/2006 / VILLAGES VISITED DURING SOCIO-ECONOMIC SURVEYS, 2005 / 2006

Golder Associates
Calgary, Alberta

N° PROJET / PROJECT NO. 05-1334-035			ÉCHELLE TELLE QU'INDIQUÉE SCALE AS SHOWN	REV. 0
DESSIN / DESIGN	LH	23 May 2006		
GIS / SIG	CW	14 Feb. 2007		
VÉRIFIÉ / CHECK	MR	14 Feb. 2007		
APPROUVÉ REVIEW	MR	14 Feb. 2007		

FIGURE: A6.3-1

Photograph A6.3-1 Consultation with Women of the Mulumbu Community by Members of the Socio-economic Assessment Team

Formal public participation processes for the ESIA began in February 2006. The opportunity to participate in the ESIA was widely announced in February and March 2006 in three languages (French, Swahili and English). The following methods were used to inform the broadest range of stakeholders of the opportunity to comment:

- Visits by Phelps Dodge Corporation (PD) representatives, TFM community liaison and community development officers to key NGOs, donor organizations and village chiefs to introduce the project and encourage their involvement in the ESIA.
- Distribution of a letter of invitation to comment on the ESIA. This letter was sent along with a background information document (BID) (Appendix E3) containing details of the proposed TFM project including a map of the project area and a comment sheet (see Table A6.3-1). Documents also were distributed to all TFM workers at the TFM office in Lubumbashi and at the TFM camp in Fungurume, including those working off site. In addition, copies were left with stakeholders for further distribution to their colleagues and constituents (Photograph A6.3-2).

Photograph A6.3-2 Community Members Receiving an Overview of the Proposed Project and ESIA Process, to Help Them Interpret the Background Information Document

Table A6.3-1 Distribution of the Background Information Document

Distribution	French	Swahili	English
sent via e-mail	200	0	200
left copies in public places	1,250	700	130
distributed at focus group meetings and community briefings	1,000	300	400
forwarded electronically by others	100	0	100
posted on web sites	n/a[(a)]	n/a	n/a
Total	**2,550**	**1,000**	**830**

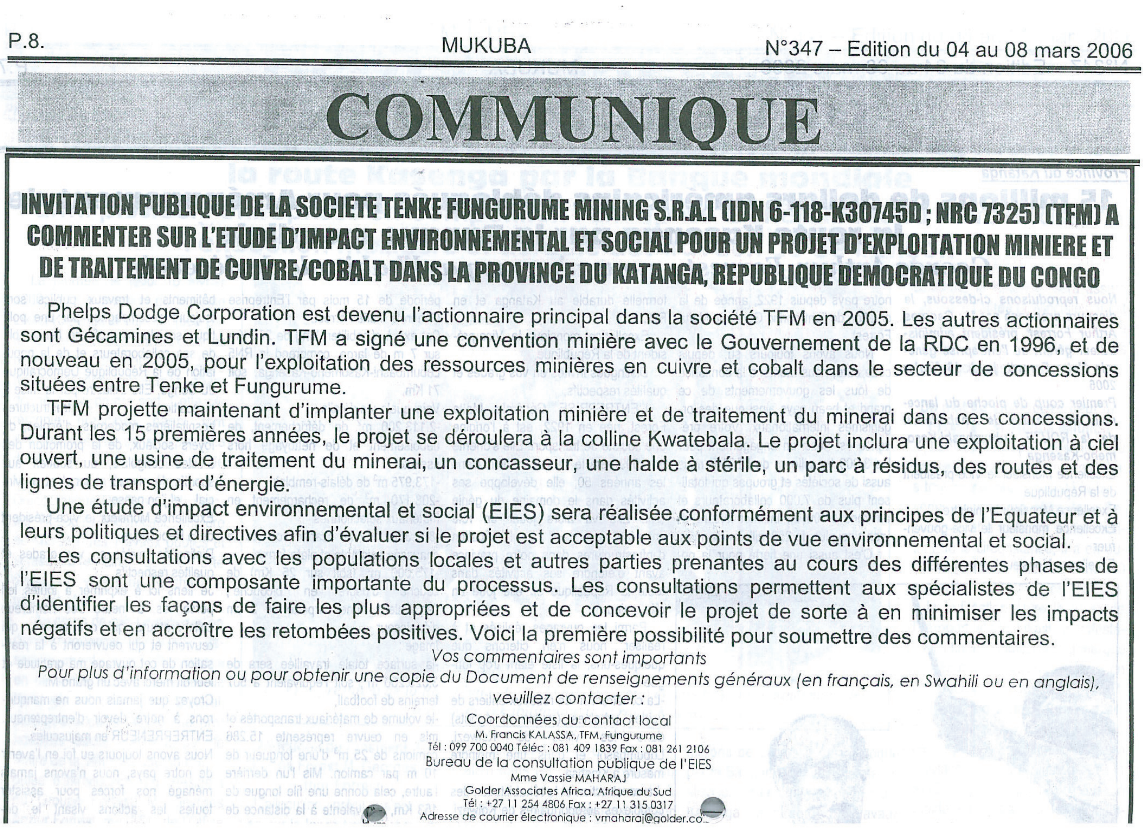
[(a)] n/a = Not applicable.

- Copies of the BID and comment sheet were left, in each of the three languages, at several public places in the TFM project area, such as markets, train stations, schools and clinics.
- Posting the documents in all three languages on the websites of Golder Associates Africa (www.golder.co.za) and Phelps Dodge Corporation (www.phelpsdodge.com).

- Electronic forwarding of the BID and comment sheet by contact persons at NGOs. For example, the United Nations Office for Coordination of Humanitarian Affairs (UN OCHA) sent the BID to more than 40 other NGOs and stakeholders.

- Paid advertisements in 20 newspapers (local, regional and national). For example, advertisements were placed in La Concorde, Trompette Lushoise, Bora Express, La Libre Opinion, Mukuba, Le Tribun du Peuple and Le Cyclone announcing the intention to conduct an ESIA and opportunities to comment. Figure A6.3-2 shows the advertisement published in the Mukuba newspaper, a publication widely distributed in the TFM project and surrounding areas.

Figure A6.3-2 Advertisement Published in the Mukuba Newspaper, Which is Widely Distributed in the Concession and Surrounding Areas



P.8. MUKUBA N°347 – Edition du 04 au 08 mars 2006

COMMUNIQUE

INVITATION PUBLIQUE DE LA SOCIETE TENKE FUNGURUME MINING S.R.A.L (IDN 6-118-K30745D ; NRC 7325) (TFM) A COMMENTER SUR L'ETUDE D'IMPACT ENVIRONNEMENTAL ET SOCIAL POUR UN PROJET D'EXPLOITATION MINIERE ET DE TRAITEMENT DE CUIVRE/COBALT DANS LA PROVINCE DU KATANGA, REPUBLIQUE DEMOCRATIQUE DU CONGO

Phelps Dodge Corporation est devenu l'actionnaire principal dans la société TFM en 2005. Les autres actionnaires sont Gécamines et Lundin. TFM a signé une convention minière avec le Gouvernement de la RDC en 1996, et de nouveau en 2005, pour l'exploitation des ressources minières en cuivre et cobalt dans le secteur de concessions situées entre Tenke et Fungurume.

TFM projette maintenant d'implanter une exploitation minière et de traitement du minerai dans ces concessions. Durant les 15 premières années, le projet se déroulera à la colline Kwatebala. Le projet inclura une exploitation à ciel ouvert, une usine de traitement du minerai, un concasseur, une halde à stérile, un parc à résidus, des routes et des lignes de transport d'énergie.

Une étude d'impact environnemental et social (EIES) sera réalisée conformément aux principes de l'Equateur et à leurs politiques et directives afin d'évaluer si le projet est acceptable aux points de vue environnemental et social.

Les consultations avec les populations locales et autres parties prenantes au cours des différentes phases de l'EIES sont une composante importante du processus. Les consultations permettent aux spécialistes de l'EIES d'identifier les façons de faire les plus appropriées et de concevoir le projet de sorte à en minimiser les impacts négatifs et en accroître les retombées positives. Voici la première possibilité pour soumettre des commentaires.

Vos commentaires sont importants

Pour plus d'information ou pour obtenir une copie du Document de renseignements généraux (en français, en Swahili ou en anglais), veuillez contacter :

Coordonnées du contact local
M. Francis KALASSA, TFM, Fungurume
Tél : 099 700 0040 Téléc : 081 409 1839 Fax : 081 261 2106

Bureau de la consultation publique de l'EIES
Mme Vassie MAHARAJ
Golder Associates Africa, Afrique du Sud
Tél : +27 11 254 4806 Fax : +27 11 315 0317
Adresse de courrier électronique : vmaharaj@golder.co..

- Radio broadcasts (on Mosaique, RCK, Mwangaza and Phoenix Radio) and television broadcasts (on Mwangaza TV) of a simple message in French, Swahili and Lingala informing stakeholders of the intention to conduct an ESIA, opportunities to comment and contact details for submitting comments.

- Distribution of laminated sets of three different posters explaining the project and ESIA process in simple language, and with photographs, announcing the opportunity to become involved in the ESIA. Posters were displayed at public places (see Table A6.3-2) frequently visited by local people.

Table A6.3-2 Display of Initial Set of Posters in Three Languages to Announce the Opportunity to Become Involved in the ESIA, February and March 2006

Posters	Venues Where Posters Were Displayed	Number of Poster Sets
laminated sets of three different posters explaining the project and ESIA process in simple language and with photographs, announced the opportunity to become involved in the ESIA poster displays were erected in the concession area in February and March 2006	• local government offices in Kolwezi, Tenke and Fungurume • some NGO offices in Lubumbashi (e.g., PACT Congo) • University of Lubumbashi • Mining Technical School, Kolwezi • Lukotola Clinic • Center Social Rural Kamalenge (Spanish Catholic mission) Lukotola • public places such as clinics, train stations, markets, churches, schools, academic institutions, police stations and community centers in Tenke, Fungurume, Lubumbashi, Kolwezi and Likasi • all rural and urban villages throughout the project area (e.g., Mulumbu, Amoni, Kiboko, Mwela Mpanda' Mpala Nguba, Kilusonsa, Kwatebala, Kamunga Kitambo) • TFM camp Fungurume • TFM office Lubumbashi	50 Swahili 45 French 7 English

A6.3.2 Obtaining Comments from Stakeholders

During scoping, stakeholders had several opportunities to comment on the proposed project and ESIA process. In addition to submitting comments in writing or by telephone, people could attend focus group meetings, one-on-one interviews, presentations and community meetings. These meetings were held between November 2005 and February 2006 by the socio-economic assessment team and between mid-February and March 2006 by the public participation team. Table A6.3-3 summarizes these opportunities.

Table A6.3-3 Opportunities for Stakeholders to Comment During the Initial Stage of the Scoping Phase of the ESIA, November 2005 to March 2006

Focus Group Meetings, Presentations, Community Meetings, Interviews	Dates	Number of Meetings
meetings in 41 rural and four urban and semi-urban villages throughout the study area, including areas subject to alternatives analysis, conducted by the socio-economic assessment team	November 2005 to February 2006	+/- 100
meetings in Lubumbashi with several key NGOs and donor organizations including: • World Vision-DRC • United Methodist Committee of Relief (UMCOR) • United States Agency for International Development (USAID) • PACT Congo • Mission Observation de UN for Congo (MONUC) • Caritas • Médecins Sans Frontières (MSF) • Cooperation Technique Belge (CTB) • United Nations Office for Coordination of Humanitarian Affairs (UN OCHA) • l'Association laïque pour les bambins d'Afrique (ALBA) • World Health Organization, Congo (OMS) • International Foundation for Education and Self Help Congo (IFESH)	February 16-17, 2006	12
meetings with the professors and students at the Sociology Department and Polytechnique Mining, University of Lubumbashi, also serving as capacity-building for students	February 16-17, 2006	2
verbal and visual briefings to some TFM workers at the office in Lubumbashi and at the TFM camp in Fungurume	February 16-19, 2006	2
meetings with local government officials in Tenke and Fungurume	February 20, 2006	2
multi-stakeholder sector meetings in Tenke and Fungurume and poster presentations to small groups of people at schools, clinics and markets	February 21, 2006	10
meetings with government authorities, NGOs and the artisanal miners' organization (SEASSCAM) in Kolwezi	March 14-15, 2006	6
interviews with village chiefs, meetings and poster presentations in all the villages and most of the hamlets in the TFM project concession area	between 18 February and 31 March 2006	40
one-on-one interviews with key stakeholders, e.g., the King of Bayeke (Mwami des Bayeke et du Garengaze).	mid-March 2006	3
Total		**+177**
Consultation by Telephone		
non-governmental organizations and donors based outside the DRC, including those from Africa that were involved in the World Bank Extractive Industries Review for Africa (2003), and several mining companies in the DRC were telephoned to ensure that they had received TFM project documentation and to encourage their issues, comments and suggestions	throughout March 2006	
Written Comment		
stakeholders with access to fax and e-mail facilities completed and returned comment sheets distributed with the BID or commented by e-mail to either the public participation office or the community liaison officer at the TFM camp in Fungurume others delivered their completed comment sheets by hand to the community liaison officer at the TFM Camp in Fungurume, or the community liaison officer collected completed comment sheets in the villages	mid-February to March 2006	+/- 500

A6.3.3 Issues and Responses Report

The issues and responses report (Appendix E6) provides an ongoing record of stakeholder issues raised and comments provided throughout the public participation process. The report is separated into the disciplines required for conducting the impact assessments, as well as other subjects and responds to each group of issues.

A6.3.4 Draft Scoping Report

A draft scoping report was compiled by the ESIA team, with the main purpose of defining the scope of the ESIA (provided in Appendix E4). The draft scoping report included:

- The most current description of the proposed project at the time the scoping report was prepared.
- The draft terms of reference for the ESIA specialist studies.
- The issues and responses report.

The draft scoping report was available for public review for three weeks from Friday, May 26, 2006, to Friday, June 16, 2006.

The contents of the draft scoping report were communicated widely. This let stakeholders check that their contributions had been captured, understood and correctly interpreted. It also gave stakeholders a chance to raise further issues. The draft scoping report was communicated as follows:

- Display of 20 sets of posters in popular public areas, summarizing the key aspects of the report in simple language and illustrated with photographs, drawings and maps, throughout the TFM project concession area (see Table A6.3-4).
- Distribution of a summary draft scoping report, consisting of a reprint of the full set of posters.
- Distribution of the full text of the draft scoping report and the issues and responses report.
- E-mailing the reports to all stakeholders with e-mail access.
- Placing the reports on the consultant’s and applicant’s Web sites.

All posters and reports were available in English, French and Swahili.

Table A6.3-4 Venues where Posters were Displayed and Draft Scoping Reports Made Available for Public Comment, from May 26 to June 16, 2006

Venue[a]	Number of Poster Sets	Total Number of Full Draft Scoping Reports, Summary Reports and Issues and Responses Reports Distributed
Cadastral Mining Office, Kolwezi	1 English 1 French	30 English 80 French 20 Swahili
Cadastral Mining Office, Lubumbashi	1 French	80 English 90 French 20 Swahili
Chef de Poste, Tenke	1 French	20 English 50 French 40 Swahili
Methodist Church, Tenke	1 Swahili	15 English 20 French 20 Swahili
Chef de Poste, Fungurume	1 French	30 English 50 French 40 Swahili
Methodist Church, Fungurume	1 Swahili	20 English 50 French 30 Swahili
Lukotola Mission	1 French 1 Swahili	30 English 50 French 20 Swahili
Pentecostal Church, Mulumbu Village	1 Swahili	10 English 50 French 60 Swahili
Nguba Village	1 Swahili	30 English 60 French 80 Swahili
Pentecostal Church, Kilosonsa Village	1 Swahili	30 English 40 French 60 Swahili
Mining Polytechnique, University of Lubumbashi	1 French	80 English 80 French 60 Swahili
Gécamines	1 French	5 English 5 French 5 Swahili
La Halle des Etoiles, Lubumbashi	1 English 1 Swahili	130 English 180 French 120 Swahili
TFM office, Lubumbashi	1 English 1 French	80 English 100 French 40 Swahili
TFM camp, Fungurume	1 English 1 French	80 English 120 French 100 Swahili

[a] At most of these venues, the posters were kept by the venue owners for permanent display.

Stakeholders could comment on the reports in several ways, such as:

- Completing the comment sheets accompanying the reports.
- Submitting further comments by mail, e-mail or telephone.
- Attending any of the 10 open houses held during May 2006.
- One-on-one discussions with members of the ESIA team during the open houses.

A6.3.4.1 Open Houses to Enable Comment on the Draft Scoping Report

A series of public open houses was held between Sunday, May 28, and Thursday, June 1, 2006, to assist stakeholders with making comments on the draft scoping report. In addition to the public open houses, separate open houses were held in Kolwezi, Lubumbashi, Tenke and Fungurume for government officials and other key stakeholders who preferred to have separate meetings.

Aims of the Open Houses

The aims of the open houses were as follows:

- To inform stakeholders of the outcome of the scoping phase of the ESIA. It was important to communicate the most recent project description, the location alternatives for infrastructure, and information on the baseline data information collection during scoping.
- To let stakeholders confirm that the issues, concerns and suggestions they had raised during the scoping process to date (i.e., between November 2005 and March 2006) had been captured correctly.
- To allow stakeholders to raise additional issues about the ESIA pertaining to relationships between TFM and local communities.

Table A6.3-5 shows the dates, venues and times of the open houses as well as key participants, approximate number of attendees and total number of documents (full and summary draft scoping reports and issues and responses reports) distributed.

Table A6.3-5 Open Houses to Comment on the Draft Scoping Report, May and June 2006

Date	Venue and Town	Times	Stakeholders Participating	Approximate Number of Attendees	Total Number of Documents Distributed
Sunday, May 28, 2006	Pentecostal Church, Mulumbu	10:00 to 14:00	Chief Kazadi Mulumbu, Chief Kyabondo, Chief Mwela Mpande, Chief Mulumbu Kyansa, Chief Kasanga, Chief Muleji, Chief Salabwe, Chief Kamungu, Chief Mwanga Muteba and members of the Mulumbu, Amoni and Kiboko communities	300	50 French 65 Swahili 14 English
Sunday, May 28, 2006	Pentecostal Church, Kilusonsa	10:00 to 14:00	Chief Lutanda and members of the Kilusonsa community	150	50 French 40 Swahili 15 English
Monday, May 29, 2006	Pentecostal Church, Tenke	10:00 to 14:00	Chief Mwela Mpande, Chef de Poste, Tenke, Chef Agene de National de Renseignement (ANR), Commandant de Police sous – Commissariate de Tenke, teachers and others	30	30 French 20 Swahili 24 English
Monday, May 29,2006	Methodist Church, Tenke	10:00 to 14:00	Community leaders, artisanal miners, Tenke Gare College and others	300	150 French 50 Swahili 20 English
Tuesday, May 30,2006	Methodist Church, Fungurume	09:00 to 12:00	Chief Nguba and his delegation, Chef de Cite-Fungurume and other government officials	40	30 French 20 Swahili 15 English
Tuesday, May 30, 2006	Methodist Church, Fungurume	13:00 to 15:30	Chief Mpala's secretary, community leaders, students, media and members of the community	250	100 French 60 Swahili 25 English
Tuesday, May 30, 2006	Lukotola Mission, Fungurume	10:00 to 14:00	Chief Lukotola Eddie Antoine, Chief Lukotola Binza, Chief Lukotola Kasono, Chef Salambwe Mangi, Chief Sanka, Chief Kilondu Masumu, people from Lukutola Village; scholars of the Lukutola Mission station, community leaders	250	80 French 60 Swahili 10 English
Wednesday, May 31, 2006	La Casa Degli Italiano, Lubumbashi	12:00 to 17:00	Mwami Munongo Mwenda Bantu, Princess Dominique, representative of the Governor of Katanga, President of Ge-camines and delegation, professors from University of Lubumbashi and members of the press	50	50 French 30 Swahili 30 English
Wednesday, May 31, 2006	Hacienda Hotel, Kolwezi	13:00 to 16:00	mainly government, business and mining representatives, representatives of two organizations of artisanal miners, (SEASCAM) in Kolwezi (and EMAK)	20	20 French 10 Swahili 10 English
Thursday, June 1, 2006	La Halle des Etoiles, Lubumbashi	10:00 to 17:00	non-government organizations, businesses, professors and students from the University of Lubumbashi, members of the press, others	300	180 French 80 Swahili 90 English

Format of Open Houses

All open houses took the same format. Two or three sets of posters were displayed in French, Swahili or English. The posters consisted of the following broad topics:

- Company overview.
- Description of the proposed project, including a map showing alternatives for infrastructure.
- The ESIA process.
- Issues and responses.

Each open house consisted of a series of group presentations and discussions around the poster displays (see Photographs A6.3-3 and A6.3-4). Each group ranged in size from 10 to 30 people. The language spoken was the language that each group preferred. Group discussions and presentations were led by Golder and TFM facilitators, speaking either English, French or Swahili. Senior TFM personnel were present to respond to questions (see Photograph A6.3-5).

Documents for Comment

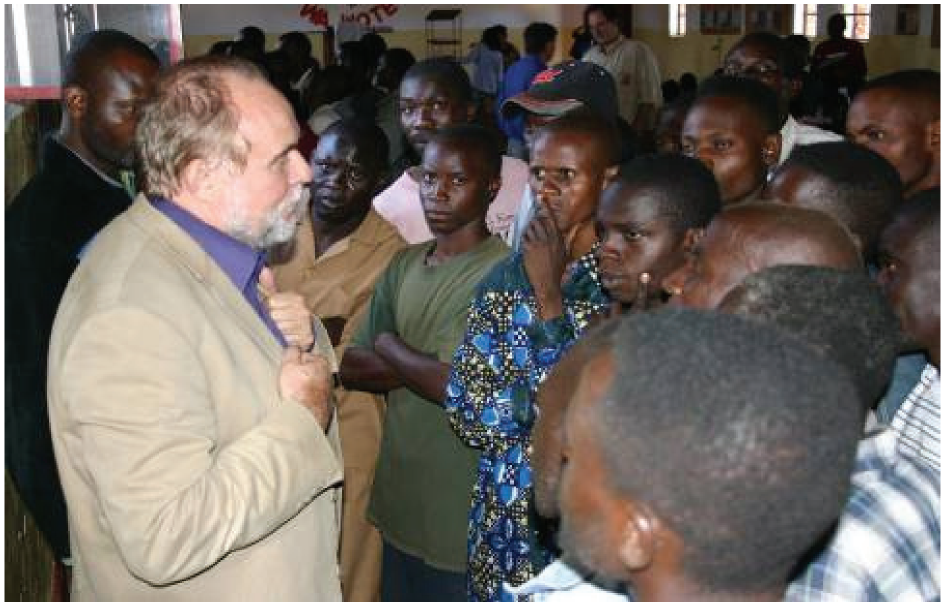
The ESIA documents for public comment were handed out to key members of the community after the group briefings. Key members of the community included chiefs and their secretaries, pastors, priests, teachers, health personnel and others. Community members were requested to read the texts to other people, and to assist those who wanted to comment to complete their comment sheets. At each venue, people were informed as to where they could take their comment sheets once completed.

At all meetings, most of which were attended by several hundred people, requests were made for additional documents and comment sheets to be made available. As a result, several hundred more documents and comment sheets (mainly in French and Swahili) were delivered throughout the study area.

The issues raised at the open houses were included in the issues and response report (Appendix E6).

Photograph A6.3-3 Group Discussions at Open Houses

Photograph A6.3-4 Group Discussions at Lubumbashi Open Houses



Photograph A6.3-5 Mr. Claude Polet, Managing Director of TFM, Answers Stakeholders' Questions at the Tenke Open House

A6.3.5 Progress Feedback to Stakeholders

At the end of scoping, all stakeholders on the database received a personalized letter and the TFM community liaison officer and facilitators visited communities to:

- Report on progress.
- Thank those who commented to date.
- Outline the next steps in the process.

A6.4 CONSULTATION ON THE FINDINGS OF THE ESIA

Consultation on the outcomes of the Impact Assessment Phase, after the completion of the specialist studies, took place at the end of November and in early December 2006.

A6.4.1 Draft ESIA Report

A draft ESIA report containing the findings of the completed specialist studies was compiled by the ESIA team. The report included the most recent description of the proposed project, the findings of most of the ESIA specialist studies with the exception of some additional work still being done on the groundwater and flora studies, the draft resettlement action plan, and the issues and response report described above. A period of three weeks was available for public review of the report (from Monday, November 27 to Friday, December 15, 2006).

The contents of the draft ESIA report were widely communicated to enable stakeholders to comment on the findings of the specialist studies and to verify that their contributions have been considered in the ESIA studies, as follows (see Tables A6.4-1 and A6.4-2):

- Display of a set of 15 posters, summarizing the key aspects of the ESIA report in simple language and illustrated by way of photographs, drawings and maps, throughout the concession area.
- Distribution of a summary draft ESIA Report, consisting of a reprint of the full set of posters.
- Distribution of the executive summary of the draft ESIA report, summary resettlement action plan and the issues and response report.
- Placing the reports on the consultants' and proponent's web sites.

The posters and summary draft ESIA report were available in English, French and Swahili. The executive summary of the draft ESIA report, summary resettlement action plan and issues and response report were available in English and French.

Stakeholders could comment on the reports in various ways, such as completing the comment sheets accompanying the reports, submitting further comments by mail, email, or telephone, by attending any of the ten open houses convened in late November / early December 2006, or by way of one-on-one discussions with members of the ESIA team during the open houses.

A6.4.2 Open Houses to Enable Comment on the Draft Findings of the ESIA

A series of public Open Houses was held between Tuesday, November 28 and Sunday, December 3, 2006 to assist stakeholders to comment on the draft ESIA findings. In addition to the public open houses, separate open houses were convened in Kolwezi, Lubumbashi, Tenke and Fungurume for government officials and other key stakeholders, who preferred to have separate meetings.

Table A6.4-1 Venues Where Posters Were Displayed and the Draft Findings of the ESIA Were Made Available for Public Comment, from 27 November – 15 December 2006

Venue	Number of Poster Sets	Total Number of ESIA Executive Summaries, Summary ESIA Reports, Issues and Response Reports and Summary Resettlement Action Plans Distributed
Cadastral Mining Office, Kolwezi	1 French	20 English 45 French 20 Swahili
Cadastral Mining Office, Lubumbashi	1 French	20 English 35 French 20 Swahili
Chef de Poste, Tenke	1 French	15 English 25 French 20 Swahili
Ecole Ubora, Tenke	1 Swahili	10 English 35 French 20 Swahili
Cadastral Mining Office, Fungurume	1 French	10 English 35 French 25 Swahili
Ecole Mukombozi, Fungurume	1 Swahili	10 English 25 French 20 Swahili
Lukotola Mission	1 French 1 Swahili	20 English 35 French 20 Swahili
Eglise Pentecôtiste, Mulumbu Village	1 Swahili	5 English 10 French 35 Swahili
Nguba Village	1 Swahili	5 English 10 French 35 Swahili
Eglise Pentecôtiste, Kilosonsa Village	1 Swahili	5 English 5 French 35 Swahili
Mining Polytechnique, University of Lubumbashi	1 French	20 English 30 French 15 Swahili
Offices of the Governor of Katanga, Lubumbashi	1 French	20 English 35 French 15 Swahili
TFM Office (Main office), Lubumbashi	1 English 1 French	30 English 20 French 10 Swahili
TFM Camp, Fungurume	1 English 1 French	20 English 20 French 20 Swahili

Table A6.4-2 Open Houses to Comment on the Draft Findings of the ESIA Held in November and December 2006

Date	Venue[(a)] and Town	Times	Stakeholders Participating	Approximate Number of Attendees	Total Number of Documents Distributed
Tuesday, 28 November 2006	Mess P2, Kolwezi	12:00 – 15:00	Mainly government; business and mining representatives; two bodies representing artisanal miners, SEASCAM and EMAK; Radio Mutoshi (RTM); Vodacom; Chef de Bureau des Mines; PNC Kolwezi.	50	38 French 15 Swahili 26 English
Thursday, 30 November 2006	Ecole Mukombozi, Fungurume (Government)	11:00 – 13:00	Chief Nguba and his delegation; Chief Mpala; Chef de Cite, Fungurume; Chef ANR; Commandant Police; other government officials; Gecamines; pastor of Garenganze Church; pastor of Methodist Church and World Vision (Fungurume),	11	20 French 15 Swahili 5 English
Thursday, 30 November 2006	Ecole Mukombozi, Fungurume (Public)	13:00 – 16:00	Chief Mpala's secretary; community leaders; students; teachers; workers; and members of the community; COPEMECO; AFEOA; GCM Development Department.	89	130 French 80 Swahili 15 English
Thursday, 30 November 2006	Lukotola Mission, Fungurume	11:00 – 14:00	Chief Lukotola Eddie Antoine; Chief Lukotola Binza; Chief Lukotola Kasono; Chef Salambwe Mangi; Chief Sanka; Chief Kilondu Masumu; people from Lukutola Village; scholars of the Lukutola Mission station; and community leaders	80	110 French 30 Swahili 15 English
Friday, 1 December 2006	Ecole Ubora, Tenke (Government)	10:00 – 13:00	Chief Mwela Mpanda ; representative of the Chef de Cite, Tenke ; Chef ANR ; representative of the Chef de District Kabila ; Commandant de Police sous – Commissarate de Tenke ; ALBA (Tenke, Fungurume); Director of Ecole Ubora School; teachers; and others	15	25 French 20 Swahili 5 English
Friday, 1 December 2006	Ecole Ubora, Tenke (Public)	13:00 – 16:00	Community leaders; artisinal miners; Tenke Gare College; and others	250	185 French 70 Swahili 20 English
Saturday, 2 December 2006	Communante Helennique, Lubumbashi (Government)	13:00 – 17:00	Mwami Munongo Mwenda Bantu; Governor of Katanga; Gecamines representatives; professors from Lubumbashi University; members of the press; Chef de Mission ALBA; PACT Congo; UNICEF; Chief of Mines	25	80 French 10 Swahili 50 English
Saturday, 2 December 2006	Exilu 2006, Lubumbashi	11:00 – 17:00	NGOs; business; professors and students from the University of Lubumbashi; members of the press; others.	150	180 French 30 Swahili 80 English
Sunday, 3 December 2006	Eglise Pentecôtiste, Mulumbu	11:00 –15:00	Representative of Chief Kazadi Mulumbu, Chief Kyabondo, Chief Mwela Mpande, Chief Mulumbu Kyansa, Chief Kasanga, Chief Muleji, Chief Salabwe, Chief Kamungu, and members of the Mulumbu, Amoni and Kiboko communities	130	80 French 70 Swahili 20 English
Sunday, 3 December 2006	Eglise Pentecôtiste, Kilusonsa	11:00 – 14:00	Members of the Kilusonsa community	80	80 French 70 Swahili 20 English

(a) At most of these venues, the posters were retained by the venue owners for permanent display.

A6.4.2.1 Aims of the Open Houses

The aims of the open houses were as follows:

- To present to stakeholders the draft findings of the ESIA specialist studies.
- For stakeholders to comment on the draft findings of the ESIA.
- For stakeholders to verify that the issues, concerns and suggestions they had raised during the scoping process, i.e., between November 2005 and June 2006, had been taken into consideration in the ESIA studies.

Table A6.4-2 shows the dates, venues and times of the open houses as well as key participants, approximate number of attendees and total number of documents (summary ESIA report, executive summary of ESIA report, summary resettlement action plan and issues and response report) distributed.

A6.4.2.2 Format of Open Houses

All open houses took the same format. Two or three sets of posters were displayed in French, Swahili or English. The posters consisted of the following broad topics:

- Company overview.
- Description of the proposed project, including a map showing the location of the project infrastructure.
- Employment and recruitment.
- Resettlement and compensation.
- Sustainability and community development.
- The environmental and social impact assessment (ESIA) process.
- Draft findings of the ESIA studies.

As with the previous open houses, each open house consisted of a series of group presentations and discussions of the ESIA findings around the poster displays, with groups ranging from 10 to 30 people, and the language spoken being that which the group preferred. Group discussions and presentations of the ESIA findings were led by both the consultants' and TFM's facilitators (see Photograph A6.4-1), speaking either English, French or Swahili. Senior TFM personnel were present to respond to questions (see Photograph A6.4-2).

Photograph A6.4-1 **Members of the ESIA Technical Team Explaining the ESIA Findings to Participants at the Open House in Kolwezi Held at the End of November 2006**

Photograph A6.4-2 **Senior TFM Personnel, Mark Hardin, Sam Rasmussen and Francis Kalassa Responding to Questions from Participants at the Open Houses in Tenke Held in December 2006**

A6.4.2.3 Documents for Comment

ESIA documents for public comment were handed out to key members of the community after the group briefings. Key members of the community included chiefs, pastors, priests, teachers, health personnel and others that could read. Members of the ESIA team requested of these community members to read the texts to other people too, and to assist those that wanted to comment to complete their comment sheets. At each venue, people were informed as to where they could take their comment sheets once completed.

A6.4.2.4 Stakeholders' Comments Raised at the Open Houses

Comments provided by stakeholders during the open houses and public review period are reflected in the issues and response report (Section E6), which will accompany the final ESIA report. All comments have been responded to by the ESIA team.

A6.5 DECISION-MAKING

A final ESIA report has been prepared that includes stakeholders' comments where appropriate. The final ESIA report will be submitted to the DRC authorities and project lenders.

Once TFM and the DRC authorities have decided whether or not to go ahead with the project, all stakeholders will be informed either in writing or by personal visits by TFM's community liaison officer and facilitators.

APPRECIATION

Many stakeholders, including members of the authorities, actively participated during the ESIA process to date by attending meetings and open houses, and by taking the time to prepare written submissions. They contributed considerable local knowledge and information on previous studies done in the area. Many also hosted members of the ESIA team in their homes or offices, and showed them around the area. The ESIA team wishes to express their sincere appreciation for these efforts by stakeholders.

GLOSSARY

25x25	The standard measure for a plot of agricultural land in the concession area is 25 by 25 square meters. People also often use hectares to describe the size of the land.
7Q10	Lowest 7-day consecutive flow in a watercourse that occurs, on average, once every 10 years.
A horizon	The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer. This is the part of the soil generally referred to as “top soil”.
Acheulean	The Acheulean Tradition is an Old World Lower Paleolithic culture, dating from about 1.4 million years ago to approximately 100,000 years ago. Characterized by stone hand axes, the Acheulean tradition originated in Sub-Saharan Africa, such as at Olduvai Gorge.
Acid rain	A complex chemical deposition and atmospheric phenomenon that occurs when emissions of sulfur and nitrogen compounds and other substances are transformed by chemical processes in the atmosphere, often far from the original sources, and then deposited on earth in either a wet or a dry form. The wet forms, popularly called “acid rain” can fall as rain, snow, or fog. The dry forms are acidic gases or particles.
Acidification	The decrease of acid neutralizing capacity in water, or base saturation in soil, caused by natural or anthropogenic man-made processes. Acidification is exhibited as the lowering of pH, a process that can adversely affect aquatic life.
Acoustics	The science or study of sound.
ACRU	The Agriculture Catchments Research Unit hydrological runoff modeling software package used to simulate flow in streams.
Acute	A stimulus severe enough to rapidly induce an effect; in aquatic toxicity tests, an effect observed in 96 hours or less is typically considered acute. When referring to aquatic toxicology or human health, an acute effect is not always measured in terms of lethality.

Acute effect	A stimulus severe enough to rapidly induce an effect.
Ad hoc	For or concerned with a particular purpose or case, without general application.
Adaptation	Changes in the organism's structure or habit that help it adjust to its surroundings.
Aggregate	Composed of a mixture of minerals separable by mechanical means such as sand or stone, used in making concrete.
Agricultural mosaic	An area containing different agriculture classes, grassland and forest extensions.
Agroforestry	A dynamic, ecologically based natural resources management system that, through the integration of trees in farmland and rangeland, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels.
AIDS (Acquired immune deficiency syndrome)	A disease, caused by a virus transmitted in body fluids, in which there is a severe loss of cellular immunity leaving the sufferer susceptible to infection and malignancy.
Air-blast	Air blast (or air concussion, or air vibrations) is a pressure wave traveling through the air produced by the direct action of the explosive on air or the indirect action of a confining material subjected to explosive loading.
Airborne particles	Total suspended particulate matter found in the atmosphere as solid particles or liquid droplets. Airborne particulates include windblown dust, emissions from industrial processes, smoke from the burning of wood and coal, and the exhaust of motor vehicles.
Alkalinity	A measure of water's capacity to neutralize an acid. It indicates the presence of carbonates, bicarbonates and hydroxides, and less significantly, borates, silicates, phosphates and organic substances. It is expressed as an equivalent of calcium carbonate. The composition of alkalinity is affected by pH, mineral composition, temperature and ionic strength. However, alkalinity is normally interpreted as a function of carbonates, bicarbonates and hydroxides. The sum of these three components is called total alkalinity.

Alpha diversity	The diversity within a particular area or ecosystem; usually expressed by the number of species (i.e., species richness) in that ecosystem.
Ambient	Refers to conditions in the environment. For example, ambient air quality represents outdoor concentrations as opposed to indoor air quality, which represents the conditions inside building and structures. As well, the conditions surrounding an organism or area.
Ammonia	A pungent, colorless gaseous alkaline compound of nitrogen and hydrogen that is soluble in water, lighter than air, and can easily be condensed to a liquid by cold and pressure.
ANC (Acid neutralizing capacity)	The equivalent capacity of a solution to neutralize strong acids. ANC can be calculated as the difference between non-marine base cations and strong anions. This is the principal variable used to quantify the acid-base status of surface waters. Acidification is often quantified by decreases in ANC, and susceptibility of surface waters to acidic deposition impacts is often evaluated on the basis of ANC.
Anisotropic	The condition of having different values of hydraulic conductivity (in particular) in different directions in geologic materials. This is especially apparent in fractured bedrock or layered sediment.
Anticline	An arch-shaped fold in rock in which rocks layers are upwardly convex. The oldest rock layers form the core of the fold and outward from the core progressively younger rocks occur.
A-pan	A-pan refers to the instrument that is used to measure evaporation. Different kinds of instruments are used throughout the world such as the symons pan (S-pan). The A-pan is a circular pan measuring 47.5 inches across and 10 inches deep. The pan is filled with water at the beginning of the day and the drop in water level during the day represents the A-pan evaporation for that day.
Aquifer	In hydrogeology, a rock layer or sequence that contains water and releases it in appreciable amounts.
Artifact	Portable items that have been modified by people at some time in the past, such as projectile points, stone flaking debris, cut and modified bone and ceramics.

Artisanal fisheries	Fishing that occurs only in rivers and lakes and is mostly an informal activity carried with no official permits.
Artisanal mining	The term "artisanal" is widely used to distinguish between non-mechanized and mechanized production techniques, and in the economic development literature has most often been applied to the fisheries and mining sectors. The United Nations has reported that several attributes can be used to identify artisanal mining activity, including absence or low degree of mechanization, low safety standards, poorly trained personnel, low pay scale, low productivity, chronic lack of capital, illegality due to mining without concession rights, or little consideration of environmental impact. The Democratic Republic of the Congo (DRC) government and its multilateral stakeholders have sought to address problems posed by the artisanal mining sector through specific provisions of the 2002 Mining Code. The mining legislation provides a definition of artisanal exploitation as "any activity by means of which a person of Congolese nationality carries out extraction and concentration of mineral substances using artisanal tools, methods and process, within an artisanal exploitation area limited in terms of surface and depth up to a maximum of thirty meters" (Article 1, Definition of Terms). The 2002 Mining Code and its accompanying regulations further include requirements for how individual artisanal mining licenses may be obtained, and for how an "artisanal exploitation area" can be established; the latter including prohibition of the activity on mineralized areas that are otherwise commercially feasible for mining by industrial methods. All artisanal mining conducted in the Tenke Fungurume concession area is unauthorized and illegal.
Asymptote	A straight line associated with a curve such that as a point moves along an infinite branch of the curve, the distance from the point to the line approaches zero and the slope of the curve at the point approaches the slope of the line.
Atmospheric dispersion	The physical process that transports and disperses air emissions, resulting in increased concentrations and direct effects to air quality.
Attenuation	Reduction in the volume or intensity of sound.

A-weighted	The frequency range that is most sensitive to the human ear.
B horizon	The mineral horizon below a 0, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.
Backwater	A small, generally shallow body of water attached to the main channel, with little or no current of its own. A body of stagnant water connected to a river.
Base flow	Base flow in rivers is the flows that are seen when there has been no rainfall for some time. Usually rainfall events will generate "storm flow" which is characterized by flow spikes. Once the flow spikes have subsided, base flow conditions will predominate.
Base saturation	The extent to which the exchange sites of a material are occupied by exchangeable basic cations; expressed as percent of the cation exchange capacity.
Basement rock	Igneous or metamorphic rock lying in sedimentary formations in the earth crust.
Benthic algae	Algae that live on the bottom of watercourses or waterbodies.
Beta diversity	A comparison of diversity between ecosystems, usually measured as the amount of species change between the ecosystems.
Bioaccumulation	To become concentrated inside the bodies of living things. Typically occurs with passage up through a food chain.
Bioassay	Using living organisms to measure the effect of a substance, factor or condition by comparing before-and-after data.
Bioavailability	The amount of chemical that enters the general circulation of the body following administration or exposure.

Bioavailable	A substance in a chemical and physical form that allows it to affect organisms or be accumulated by them. As well, it is the portion of a nutrient (or other chemical) that can be absorbed, transported, and utilized physiologically.
Biodiversity	The term used to describe the variety of life forms, the ecological roles they perform, and the genetic diversity they contain. Biodiversity therefore refers to the differences within and between all living organisms at their different levels of biological organization - genes, individuals, species and ecosystems. Three ways of measuring biodiversity are **Alpha diversity**: the diversity within a particular area or ecosystem; usually expressed by the number of species (i.e., species richness) in that ecosystem; **Beta diversity**: a comparison of diversity between ecosystems, usually measured as the amount of species change between the ecosystems; and **Gamma diversity:** a measure of the overall diversity within a large region.
Biological control	The use of animals and organisms that eat or otherwise kill or outcompete pests.
Biome	A major regional or global biotic community characterized by a specific climate and dominant forms of plant life.
Biota	Plant and animal life in a particular region.
Biotope	An area with generally uniform environmental conditions.
Broad-crested weir	A type of weir structure with a thick crest. The broad-crested weirs on site are one meter thick.
C horizon	The mineral horizon or layer, excluding indurated bedrock that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum (the upper layers of the soil profile, affected by climate and vegetation) formed.
Cadastral office	Agencies that maintain cadastral survey and historical data on lands patented, along with information on the mineral estate, resource conditions, and permits or leases.

Canopy forest	Canopy forest is a type of forest that contains *canopy* trees which are the tallest trees in a forest which are distinguished from *secondary* trees which occupy a lower ecological niche.
Capacity building	Actions that improve nonprofit effectiveness. The concept of capacity building in nonprofits is similar to the concept of organizational development, organizational effectiveness and/or organizational performance management in for-profits. Capacity building efforts can include a broad range of approaches, e.g., granting operating funds, granting management development funds, providing training and development sessions, providing coaching, supporting collaboration with other nonprofits, etc.
Catchment	The area of land drained by a creek or river system, or a place set aside for collecting water which runs off the surface of the land. Catchments provide the source of water for the reservoirs that collect draining water. Synonymous with watershed.
Catena	A series of associated habitats.
Catenal slope	A series of associated habitats along a slope.
Cathode	A cathode is a rectangular plate of metal, produced by electrolytic refining, which is melted into commercial shapes such as wirebars, billets, ingots, etc. A cathode is also the electrode at which electrons go into a cell, tube or diode, whether driven externally or internally.
CEC (Cationic exchange capacity)	The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams (meq/100 g) or cmol kg^{-1}, usually when the soil is at neutral pH.
Centimole	One hundredth of a mole.
Ceramic	Clay artifacts, such as vessels, that have been intentionally fired.
Channel	An area that contains continuously or periodically flowing water that is confined by banks and a stream bed. The bed of a stream or river.
Chef de poste	Civil administrators of rural townships.

Chef de cité	Civil administrators of rural townships.
Chef de groupment	Traditional authorities who supervise several village populations.
Chef de quartier	Neighborhood representatives of chefs de posts or chefs de cité.
Chef de terre	Traditional authorities of chefs de posts or chefs de cité.
Chronic	The development of adverse effects after extended exposure to a given substance. In chronic toxicity tests, the measurement of a chronic effect can be reduced growth, reduced reproduction or other non-lethal effects, in addition to lethality. Chronic should be considered a relative term depending on the life span of the organism.
Chronic effect	An effect marked by long duration or frequent recurrence.
Cleanup	Actions taken to deal with a release or threat of release of a hazardous substance that could affect humans, the environment, or both.
Climate	A measure of the long-term averages, that is normal of key atmospheric variables such as temperature, precipitation and wind.
Climate normals	Long-term average conditions of temperature and precipitation.
cmol	Centimole charge of saturating ion per kilogram of soils. Cation exchange capacity is sometimes expressed in terms of cmol kg^{-1}. The cmol weight of the ions commonly found in soils is easily calculated by knowing the relative atomic mass of the ion divided by 100 and the charge on the ion.
Commensalism	A type of symbiosis in which two organisms are associated in a relationship in which one benefits from the relationship and the other is not substantially affected.
Compensation	Measures taken where mitigation techniques and other measures are not adequate to offset or counterbalance project effects.
Concentration	Quantifiable amount of a chemical in environmental media.

Concession area	A grant of land or property especially by a government in return for services or for a particular use. Defined in this ESIA to represent the two TFM concessions in the Democratic Republic of the Congo.
Conductivity	A measure of a waterbody's capacity to conduct an electrical current. It is the reciprocal of resistance. This measurement provides the limnologist with an estimation of the total concentration of dissolved ionic matter in the water. Measurement of conductivity provides a quick check of the alteration of total water quality due to the addition of pollutants to the water.
Confined space	A confined space is an enclosed or partially enclosed space that is not primarily designed or intended for human occupancy; has a restricted entrance or exit by way of location, size or means; and can represent a risk for the health and safety of anyone who enters.
Congolese franc (Fc)	At the time of the study the rate varied between 430 and 450 Fc for a United States dollar.
Contact water	Water that has come into contact with ore, waste rock or fuel or material handling areas and may contain elevated levels of constituents of concern.
Continuous cast copper rod	The key material used in the manufacturing of wire and cable products.
Conversion rates (for vegetation)	Strategies for converting dominant vegetation typically found on older surface mined benches to more favorable forages that can be more effectively utilized by livestock.
Copper cathode	Electrolytically refined copper is produced in the form of copper cathodes of 99.9 percent purity which may be shipped as melting stock to mills or foundries. Cathodes may also be cast into wire rod, billets, cakes or ingots, generally, as pure copper or alloyed with other metals.
Copper hills	Hills in the copper belt of the Democratic Republic of the Congo (Katanga) where heavy metal-rich outcrops occur.
Copper-cobalt flora	Plant communities of the copper/cobalt mineralized outcrops in the copper belt. Different plant communities are all controlled by the nature of the substratum and its chemical composition. Those communities are important because they include some plants unknown from other mineralized sites in the copper belt.

Core habitat	Area of a habitat type not affected by defined edge effects.
Cr horizon	Soft, consolidated bedrock beneath the soil.
Criteria continuous concentration	Estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.
Criteria maximum concentration	Estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect.
Critical natural habitats	The International Finance Corporation (IFC) defines critical natural habitats as areas with existing protection, including (1) areas designated as protected (such as national parks and reserves), (2) areas providing sustainable natural resources for traditional local communities, and (3) areas identified on a supplementary list prepared by the World Bank Group or other authoritative sources (as determined by IFC).
Critically endangered	Based on World Condervation Union (IUCN) criteria, a taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.
Croise rouge	Local people who have received some basic health training through the Red Cross.
Cropping	Cultivated plants or agricultural produce, such as grain, vegetables, or fruit, considered as a group or the total yield of such produce in a particular season or place.
Cult sites	A shrine, where each day the chief of the village goes to pray (morning and night preferably). He also goes there to have sacrificial meals. This area may be considered a church, temple, or simply a place for prayer.
Cultural heritage	The qualities and attributes of places or objects that have aesthetic, historic, scientific or social value for past, present or future generations. These values may be in a place's physical features, but can also be intangible qualities such as people's associations with, or feelings for, a place or object.

Cumulative effect	The impact on the environment which results from the incremental impact of the project when added to other past, present, and reasonably foreseeable future actions regardless of what agency, company or person undertakes such other actions.
Cyanophiceae	Class of the cyanobacteria division.
Dambo	A rich soil type found within the concession area.
dBA	A decibel value which has been A-weighted, or filtered to match the response of the human ear.
Decibel (dB)	A logarithmic scale for sound corresponding to a multiple of 10 of the threshold of hearing. Decibels for sound levels in air are referenced to an atmospheric pressure of 20 micro Pascals (μPa).
Dendrogram	A tree diagram that separates groups of vegetation on more superficial soils from groups of vegetation on more deep structured soils.
Deposit	A body of rock containing valuable minerals; usage generally restricted to zones of mineralization whose size has been wholly or partly determined through sampling.
Dewatering	To remove water from (a waste product or open pit mine, for example). As well, it is the process of natural, chemical, or mechanical removal of water from sludge, thereby reducing it to a damp solid with the lowest level of moisture attainable by the best available technology.
Dipeta syncline	Basin or trough-shaped fold in rock in which rock layers dip downward toward each other. The youngest rock layers form the core of the fold. Progressively older rocks occur outward from the core.
Direction	Positive or negative effect for measurement endpoints, as defined for the specific component.
Discharge	In hydrology, the discharge of a river is the volume of water transported by it in a certain amount of time. The unit used is usually cubic meters per second (m^3/s). The greater the discharge of a river, the more ability it has to carry sediment.

Dispersion model	A computerized set of mathematical equations that uses emissions and meteorological information to simulate the behavior and movement of air pollutants in the atmosphere.
Disposal	Final placement or destruction of toxic, radioactive or other wastes; surplus or banned chemicals, polluted soils and drums containing hazardous materials from removal actions or accident releases.
Diurnal mammals	Mammals that are primarily active during the day.
Dose	The amount of chemical that a person or animal may take into their body.
Drawdown	In hydrogeology, drawdown is a lowering of a reservoir or a change in hydraulic head in an aquifer, typically due to pumping a well.
Dump	A pile of broken waste rock or ore on surface.
Duration	Length of time over which an effect occurs.
EC_{20}	Effects Concentration (EC) is the concentration that results in a decrease of 20 percent of the measured variables.
Ecoregion	A relatively large recurring pattern of ecosystems associated with characteristic landforms, soils and biota.
Ecotone	The transition of physical and biological characteristics, from one community to the next. A transitional zone between two different biological communities.
Edaphic grassland	Grassland defined by soil type.
Edge effect	The modified environmental (climatic/abiotic or biological) conditions along the margins, or edges, of patches of one habitat type (often forest) surrounded partially or entirely by other habitat type (often cleared lands).
Effluent	An outflowing of water from a natural body of water, or from a man-made structure.

Electrofishing	A “live” fishing capture technique in which negative (anode) and positive (cathode) electrodes are placed in the water and an electrical current is passed between the electrodes. Fishes are attracted (galvano - taxis) to the anode and become stunned (galvano - narcosis) by the current, allowing the fish to be collected, measured and released.
Electrowinning	The electrodeposition of metals from their ores that have been put in solution or liquefied. Also called electrorefining or electroextraction.
Emergency	An event, or imminent event, outside the scope of normal operations that requires prompt coordination of resources to protect the health, safety, or welfare of people, or to limit damage to property and the environment.
Emergency preparedness	Activities, programs, and systems for response, recovery and mitigation in anticipated emergencies.
Endangered	Based on World Conservation Union (IUCN) criteria, a taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered and it is therefore considered to be facing a very high risk of extinction in the wild.
Endangered species	A species facing imminent extinction or extirpation (no longer occurring in the country or region).
Endemic	Native or confined to a certain region.
Endemic species	Species which are restricted to a particular region and occur nowhere else.
Endemism	Being native to, and confined within the local region.
Endorheic	In geography, an endorheic basin is a watershed from which there is no outflow of water (either on the surface as rivers, or underground by flow or diffusion through rock or permeable material). Any rain (or other precipitation) that falls inside an endorheic basin remains there permanently, leaving the system only by evaporation. Endorheic basins are also called "internal drainage systems".

Entrainment	To carry suspended particles (for example) along in a current. In meteorology, the mixing of environmental air into a pre-existing organized air current so that the environmental air becomes part of the current.
Enviro bund	A dedicated constructed berm to limit access by humans and domestic animals to open pits.
Ephemeral	Lasting or living for a very short time. Having a very short life cycle.
Epicenter	The point on the Earth's surface immediately above where an earthquake was generated.
Equator Principles	A voluntary set of guidelines for managing environmental and social issues in project finance lending. The Equator Principles refer to guidelines developed by leading financial institutions such as the International Finance Corporation (IFC) and the World Bank.
Erodibility	A measure of the susceptibility of a soil to detachment by flowing water.
Erosion	The breaking down and subsequent removal of either rock or surface material by wind, rain, wave action, freezing and thawing, and other processes.
Erosivity	The capacity of falling or flowing water to erode land surfaces. Rainfall erosivity is defined by the computation of the values of rain erosivity factors based on the analysis of rainfall events.
ESMS	Environmental and social management system designed to manage mitigation and monitoring requirements for a project.
Esteva attenuation law	A law explaining how seismic activity is propagated or attenuated from a source to a site through the ground.
Eutrophic	The nutrient-rich status (amount of nitrogen, phosphorus and potassium) of an ecosystem.
Evapotranspiration	Loss of water from the soil both by evaporation from the soil surface and by transpiration from the leaves of the plants growing on it.
Ex situ	Growth of a species in a place not previously one of its native habitats.

Exchange acidity	The titratable hydrogen and aluminum that can be replaced from the adsorption complex by a neutral salt solution.
Exchangeable cations	A cation such as calcium that is adsorbed onto a surface, usually clay or humus, and is capable of being easily replaced by another cation such as potassium. Exchangeable cations are readily available to plants.
Expansion bolts	Bolts used to attach fixtures into concrete walls.
Exposure	The state of being exposed to something harmful.
Exposure pathways	The physical route by which a contaminant moves from a source to a biological receptor. A pathway may involve exchange among multiple media and may include transformation of the contaminant.
Extinct	A taxon (plant or animal) that is no longer alive or in existence.
Extirpation	The act of removing all members of a species from an area; as, the extirpation of weeds from land.
Fallow	Land left unseeded during a growing season. The act of plowing land and leaving it unseeded.
Fecal coliform	Bacteria that do not require but can use oxygen. Their presence in the water supply indicates recent contamination by human or animal feces.
Ferrasols	A group of soils in the United Nations Food and Agriculture Organization (FAO) soil classification system. They are very similar to Oxisols (United States Department of Agriculture [USDA] classification) in that they have at least one horizon with an almost complete decomposition of primary weatherable minerals and a clay fraction which is dominated by kaolinite and/or sesquioxides.
Ferricrete	A conglomerate consisting of superficial sand and gravel cemented into a hard mass by iron oxide derived from the oxidation of percolating solutions of iron salts.

Filterable residue	Materials in water that pass through a standard-size filter (often 0.45 microns). This is a measure of the "total dissolved solids" (TDS), that is chemicals that are dissolved in the water or that are in a particulate form smaller than the filter size. These chemicals are usually salts, such as sodium ions and potassium ions.
First order stream	A stream that has no tributaries emptying into it and normally originates from springs and/or seeps.
Fishery	The occupation devoted to the catching, processing, or selling of fish, shellfish, or other aquatic animals or a workplace where fish are caught and processed and sold.
Fly rock	Rock, mud or debris traveling in the air or along the ground as a result of a blast.
Focal depth	The depth from the earth's surface to the point of origin of an earthquake.
Foot-slope	Bottom of a slope.
Forbs	Broad-leaved herb, as distinguished from grasses.
Fossorial species	Burrowing or digging species.
FRAGSTATS	A spatial pattern analysis software program used to quantify the areal extent and spatial configuration of patches within a landscape. The analysis is done using categorical spatial data (e.g., plant communities).
Frequency	How often an effect occurs.
Fuelwood	A general term used to identify any woody biomass used as a fuel. It includes firewood, pellets and wood used for fuel in industry (e.g. wood chips, sawdust, shavings).
Fugitive emissions	Substances emitted from any source except those from stacks and vents. Typical sources include gaseous leakage from valves, flanges, drains, volatilization from ponds and lagoons, and open doors and windows. Typical particulate sources include bulk storage areas, open conveyors, construction areas or plant roads.
Funerary objects	Objects related to deaths, burials or funerals.
Gabions	Metal containers filled with stones, used in the construction of underwater foundations.

Gallery forest	A forest growing along a watercourse sometimes in an otherwise treeless region. Gallery forest often forms a corridor along a river system. A type of riparian forest.
Gamma diversity	A measure of the overall diversity within a large region.
Gauge plates	A steel plate that resembles a large ruler. It has graduated markings. The gauge plate is fixed into the river bed and the water levels are read off the gauge plate.
Gauging weir	A concrete structure built in the river bed to obstruct the flow of water. Water will flow over the weir in a desired location, where the depth of this flow is measured. Simple hydraulic calculations are used to convert this depth into a flow.
Genetic drift	Random changes to the genetic material in isolated populations.
Geographic extent	Area affected by the impact.
Geomembrane	A product, often made of polyvinyl chloride (PVC) or high density polyethylene (HDPE) that is used to limit seepage from or rainfall into a pond or other disposal facility.
Geomorphology	Scientific discipline concerned with the description and classification of the earth's topographic features.
Geotechnical	Refering to the use of scientific methods and engineering principles to acquire, interpret, and apply knowledge of earth materials for solving engineering problems.
Germination	The first stage in the development of a plant from a mature seed characterized by the emergence of a stem and root.
Glides	A calm stretch of shallow water flowing smoothly.
Graminoid	Grasses and grasslike plants such as sedges and rushes.
Gravity units	Units of acceleration, usually in meter per second squared.

Green manuring	Green manuring is the plowing under or soil incorporation of any green manure crops while they are green or soon after they flower. Green manure is forage or leguminous crops that are grown for their leafy materials needed for soil conservation. It is an effective way of increasing the humus content of the soil.
Greenhouse gases	Gaseous components of the atmosphere that contribute to the greenhouse effect. The major natural greenhouse gases (GHG) are water vapor, which causes about 36 to 70 percent of the greenhouse effect on Earth (not including clouds); carbon dioxide, which causes between 9 to 26 percent; and ozone, which causes between 3 to 7 percent. Minor greenhouse gases include, but are not limited to: methane, nitrous oxide, sulfur hexafluoride, and chlorofluorocarbons.
Ground-truthing	Visiting sites to confirm the accuracy of remotely sensed information.
Groundwater	Water that occurs below the surface of the Earth, where it occupies spaces in soils or geologic strata.
H:h	A waste disposal site with a low to medium hazard rating.
H:V	The ratio of horizontal length (H) to vertical length (V) for a specific slope.
Habitat	An area with generally uniform environmental conditions for a species.
Habitat insularity	Degree of isolation of a habitat patch from other similar habitat patches.
Hardness	Measure of the sum of calcium and magnesium concentrations, expressed as milligrams per liter (mg/L) equivalent of calcium carbonate ($CaCO_3$. Hardness scale consists of very soft (low) (0–30 mg/L $CaCO_3$), soft (31-60 mg/L $CaCO_3$), moderately soft (61-120 mg/L $CaCO_3$), hard (121-180 mg/L $CaCO_3$) and very hard (>180 mg/L $CaCO_3$) waters.
Hazard	A situation with a potential for harm to persons, property or the environment.
Hazard identification	The process of recognizing that a hazard exists and defining its characteristics.

Hazardous materials	Materials released in quantities that may harm persons, property or the environment.
Headwater	The source of a stream or river.
Herpetofauna	Reptiles and amphibians.
HIV	Human immunodeficiency virus; a retrovirus which causes acquired immune deficiency syndrome (AIDS).
Holoendemics	A living organism which has a specialized habitat and therefore has a distribution restricted to a small area.
Holotype	A single specimen designated the type specimen by the original author at the time of publication of the original description.
Homogenous	When the composition of a material is uniform or constant from one point to another.
Horizon	A specific layer of soil or subsoil in a vertical cross section of land. In ABC soil, the uppermost zone of soil, containing humus; topsoil.
Hydraulic units	The concept of the hydraulic (flow) unit was developed to integrate geological and hydrologic data. Hydraulic unit is defined as a group of reservoir rocks with similar properties that affect flowing fluids like water.
Hydromorphic	Relating to soil in a wet environment; relating to or typical of a soil that has built up in the presence of excess water.
Hydrophilic grasses	Grasses requiring large amounts of water.
Hydrophytic plants	A plant adapted for growth in waterlogged soils or areas with regular water source.
Hypereutrophic	One of the four trophic state categories, the hypereutrophic state is defined as having the highest level of biological productivity. The prefix "hyper" means over abundant. Hypereutrophic waterbodies are among the most biologically productive in the world.

Hypolimnion	The lower and colder layer in a lake. The hypolimnion is the bottom and most dense layer of water in a thermally-stratified lake. It is the layer that lies below the thermocline. Typically, it is non-circulatory and remains cold throughout the year.
Iconography	The study of images.
Igneous activity	Activity relating to rocks solidified from molten magma at or above the surface of the earth.
Impervious	Incapable of being penetrated, for example by water.
In situ	In place; the original location; in the natural environment.
Inbreeding depression	Reduced fitness in a given population as a result of breeding of related individuals.
Incipient speciation	The beginning of the formation of a new species.
Infiltration	Movement of water from the land surface into the soil.
Ingestion	To take (food or drink) into the body by swallowing or absorbing it.
Inhalation	To breathe in (air, gas, smoke, etc.).
Inselberg	An isolated rocky hill rising abruptly from a flat plain.
Instream	The amount of water passing a particular point in a stream or river, usually expressed in cubic meters per second (m^3/s).
Insularity	Isolation of a species.
Iron Age	The stage in the development of any people where the use of iron implements as tools and weapons is prominent. In Africa the Iron Age began about 1,400 BC.
Kaolisols	A soil type in the old Zaire soil classification. There is a close similarity of Kaolisols with Ferrisols (United Nations Food and Agriculture Organization [FAO] Classification) or Oxisols (United States Department of Agriculture [USDA] Classification).
Kapita	Chief of a hamlet, of a lower grade than a village chief or a land chief.

K_d	The distribution coefficient or partition coefficient, which is a measure of the affinity of a chemical to partition between the dissolved and particulate phase.
Key indicator species	Biological indicator species are unique environmental indicators as they offer a signal of the biological condition in an ecosystem. Using those bioindicators as an early warning of pollution or degradation in an ecosystem can help sustain critical resources. Key indicator species are actually groups or types of biological resources that can be used to assess environmental condition.
Key question	A specific question defined to assess an issue of specific concern to stakeholders. Used to focus the ESIA and ensure that it clearly addresses the issues of concern.
Kimbalama	Second (mid-rainy season) crop, usually beans.
Kinkurimba	A mutual assistance system in which there is a rotational system of sharing agriculture labor.
Kinyanga	Marshland crops (cultures maraíchéres).
Koppie	A small isolated hill within the African veld.
Landscape character	The individual elements that make up the landscape, including prominent or eye-catching features such as hills, valleys, savannah, trees, waterbodies, buildings and roads. They are generally quantifiable and can be easily described.
Landscape quality	Quality of landscape based on its aesthetic appeal, including topographic ruggedness and relief, water forms, color in the landscape, diverse patterns of grasslands and trees, scarcity of landscape, naturalness of landscape and land use.
Landscape effect (impact)	Landscape effects derive from changes in the physical landscape, which may give rise to changes in its character and how this is experienced.
Laterites	A group of minerals derived from weathering of an ultrabasic type of rock. Encompasses the entire geologic profile from surface to bedrock.
Latrines	A receptacle (as a pit in the earth) for use as a toilet or a communal toilet of a type often used in a camp or barracks.

L_d	The daytime equivalent sound level L_{eq} noise level detected from 7:00 a.m. to 10:00 p.m.
L_{dn}	The noise level detected for a reference period during daytime and nighttime hours. The day/night sound level is a fraction of the day versus nighttime hours to get one value.
Leaching	A chemical process for the extraction of valuable minerals from ore; also, a natural process by which ground waters dissolve minerals, thus leaving the rock with a smaller proportion of some of the minerals than it contained originally.
Legume	A member of the pea family (Fabaceae); a dry dehiscent fruit derived from a single carpel and usually splitting along two lines.
L_{eq}	Equivalent sound level. A sound level that, if constant over a referenced time period, would contain the same amount of sound energy as the actual sound which varied in level within that time.
Life form	An individual form of life, such as a plant, animal, bacterium, protist, or fungus; a body made up of organs, organelles, or other parts that work together to carry on the various processes of life.
Limnology	The study of bodies of fresh water with reference to their plant and animal life, physical properties, geographical features, etc.
Linkage diagram	A diagram linking project activities, environmental changes, key questions and other discipline areas to assist specialists in their work and to enable readers to understand what has (and has not) been included in the impact analysis.
Listed species	Species (plants or animals) listed by international organizations as having special status due to their rarity. See ‘endangered’.
Lithology	The study of the mineral content, grain size, texture and color of rocks.
L_{max}	The highest noise level detected over a referenced period of time.

L_{min}	The lowest noise level detected over a referenced period of time.
L_n	The nighttime equivalent sound level L_{eq} noise level detected from 10:00 p.m. to 7:00 a.m.
Logistic	The science of planning and implementing the acquisition and use of the resources necessary to sustain the operation of a system.
Lotic ecosystems	Natural communities living in rapidly moving water.
Lower risk	Based on World Conservation Union (IUCN) criteria, a taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories.
L_{peak}	The peak noise level detected over a referenced period of time.
Macroinvertebrate	An invertebrate animal (animal without a backbone) large enough to be seen without magnification.
Magnitude	Degree of change to analysis endpoint.
Malachite	A green copper carbonate mineral.
Mannings equation	A standard hydraulic equation to calculate flows and flow depths.
Mantle	The outer soil layers that covers the terrain.
MAP (Mean annual precipitation)	The average amount of precipitation that is recorded in a year. Precipitation is recorded as a depth and is usually expressed in millimeters. Precipitation includes rainfall, snowfall, hail, mist, dew and fog. Snow does not normally occur in the concession area.
Mbile	A mutual assistance system in which people are invited to help with agriculture labor in exchange for food and drinks.

MDL (Method detection limit)	The lowest concentration at which individual measurement results for a specific analyzed are statistically different from a blank (that may be zero) with a specified confidence level for a given method and representative matrix.
Meka	Standard measure for cereals, beans and other agriculture products. Weighs approximately 2.6 to 2.8 kilograms.
Mensuration	The act or process of measuring.
Meq/100 g	Milliequivalents of exchangeable ions retained by 100 grams of soil. Cation exchange capacity is sometimes expressed in terms of meq/100 g of soil. The unit meq/100 g is equal to cmol kg^{-1}.
Mesotrophic	A moderate nutrient-rich status.
Metallicolous ecosystems	A singular ecological system that functions upon terrain (rocks or soil) that has high metals content.
Metalliferous soil	Soil with high concentrations of heavy metals with very restrictive habitats for plants and are limited in size and geography.
Metallophytes	Species that only occur on metal-rich soils.
Meteorology	The study or science of the atmospheric character of a region.
Microevolution	Minor change in a small group of organisms or species.
Miombo	A vernacular word that has been adopted by ecologists to describe those woodland ecosystems dominated by trees in the genera *Brachystegia*, *Julbernardia* and *Isoberlinia* of the family *Fabacea.*
Miombo woodland	A type of deciduous woodland which covers a vast area of southern Africa.
Mitigation	All actions aimed at reducing the extent or likelihood of pollution or environmental impacts, as well as actions aimed at reducing their negative effects. To cause to become less harsh or hostile.
Mitigation measures	All actions aimed at reducing the extent or likelihood of pollution or environmental impacts, as well as actions aimed at reducing their negative effects.

Monera	Unicellular and colonial including the true bacteria (eubacteria) and cyanobacteria (blue-green algae).
Mulch/Mulching	A protective covering, usually of organic matter such as leaves, straw, or peat, placed around plants to prevent the evaporation of moisture, the freezing of roots, and the growth of weeds. Mulching is covering or surrounding with mulch.
Mutual Aid Agreement	An agreement among two or more public or private organizations or operations to provide emergency-related assistance to each other.
Mutualism	Two species living together in a relationship in which both benefit from the association.
Mycorrhizal fungi	A type of fungus, which is often applied to the roots of a vine at planting. The mycorrhizae forms a mutually beneficial relationship with the plant's roots. As such it acts as an extension of the root system, increasing the roots' ability to absorb nutrients and water. Some research indicates that the co-dependent symbiotic relationship between the fungi and the vine helps the vine to survive stress, absorb more water and nutrients, and increase its resistance to soilborne diseases.
Neoendemics	A species with a restricted distribution as a result of more recent events (recent on a geological time scale) and which has not had time to colonize several sites.
Noise	"Noise" or "noise levels" refers to the levels that can be heard or measured at a receiver.
Noise level	Noise levels and sound emissions also have a "frequency". The human ear does not respond to all frequencies in the same way. Mid-range frequencies are most readily detected by the human ear, while low and high frequencies are harder to hear. Environmental noise levels are usually presented as "A-weighted" decibels (or dBA), which incorporates the frequency response of the human ear. While low-frequency noise may not be "heard", it can often be felt.
Noise receiver	A noise "receiver" is a location where measurements or predictions of noise levels are made.
Non-timber forest products	Goods derived from forests of both plant and animal origin other than timber and firewood.

Nutrients	Environmental substances (elements or compounds) such as nitrogen or phosphorus, which are necessary for the growth and development of plants and animals.
OHSA	Occupational Health and Safety Assessment Series (ISO 18,000) which define an Occupational Health and Safety Management System.
Oligotrophic	Trophic state classification for lakes characterized by low productivity and low nutrient inputs (particularly total phosphorus).
Open cast (open pit) mining	A method of extracting rock or minerals from the earth by their removal from an open pit or borrows. The term is used to differentiate this form of mining from extractive methods that require tunneling into the earth.
Open pit	A mine that is entirely on surface. Also referred to as open-cut or open-cast mine.
Operation	A process, including but not limited to, transportation, manufacturing, storage, distribution, use, or disposal.
Ore	A mixture of ore minerals and gangue (valueless and undesireable material, such as quartz in small quantities, in an ore) from which at least one of the ore minerals can be extracted at a profit or that is economically feasible for mining.
Ore body	A natural concentration of a valuable mineral or minerals that can be extracted and sold at a profit.
Organic carbon	The most abundant element found in all organisms. In aquatic environments, organic carbon is produced by plant photosynthesis and bacterial growth. Leaching of humic substances and decomposition of plants and animals are also natural sources of organic carbon to surface waters.
Organic matter	Compounds containing carbon often derived from living organisms. As well, the part of the soil that includes the decomposing remains of plants and animals, as well as the product of complete decomposition, known as humus.

Organic nitrogen	Any nitrogen compound produced by natural (that is, living things) rather than synthetic (or man-made) processes. It is the nitrogen combined in organic molecules such as proteins, amines, and amino acids and other organic nitrogen substances produced by organisms in the soil.
Outdoor Noise	Usually expressed as an "equivalent noise level" (L_{eq}), which is a logarithmic average of the measured or predicted noise levels over a given period of time. This type of average takes into account the natural variability of sound.
Overburden	Rock or soil overlying a mineral deposit.
Overtopping	The flow of water over the top of a dam or embankment. Also, the vegetation higher than the favoured species, as in brush or deciduous species that are shading and suppressing more desirable coniferous trees.
Oxisols	A United States Department of Agriculture (USDA) soil type consisting of soils with a B horizon in which most weatherable materials have been removed leaving oxides of iron and aluminum and some quartz.
Palaeoendemics	A species with restricted distribution which may have had a large distribution at one time (not recent on a geological time scale) but presently exists only in a few places or in one place.
Palaeractic	Biogeographic region that includes Europe, the northwest coast of Africa and northern Asia.
Pan evaporation	Evaporation measured using a pan of water, where water evaporates from the water surface.
Pan wetland/pans	Seasonally saturated wetlands.
Partition coefficients	Describes the partitioning of a chemical between sorbing material such as surface water, suspended solids and sediments.
Pedogenesis	The formation of soils through the natural process of soil erosion and leaching.
Pedon	The smallest volume (soil body) which displays the normal range of variation in properties in soil.

Periphyton	Organisms (as some algae) that live attached to underwater surfaces.
Permeability	Capacity of a soil or other surface to be penetrated by water sinking into the ground under the force of gravity. It thus expresses the rate of percolation. Also, the ability of a material to allow the passage of a liquid, such as water through rocks. Permeable materials, such as gravel and sand, allow water to move quickly through them, whereas unpermeable materials, such as clay, do not allow water to flow freely.
pH	The negative logarithm of the hydrogen ion activity, pH is an indication of the acidic or basic, i.e., alkaline, nature of water. Neutral water has a pH of seven. The potential hydrogen scale, measuring the acidity or alkalinity of a solution, from zero (highly acidic) to 14 (highly alkaline).
Phenology	The study of how plants species are influenced by environmental factors such as climate.
Phosphorus	The key nutrient influencing plant growth in lakes; total phosphorus includes the amount of phosphorus in solution (reactive) and in particulate form.
Physiognomic	The description of the number and cover types of plant formations among different strata.
Physiognomy	The outward physical appearance of a species. A person's facial features or expression, especially when regarded as indicative of character or ethnic origin.
Phytogeochemistry	The study of metabolic and chemical processes in plants.
Phytogeographic	The location or biogeography of a plant species.
Phytoremediation	The use of plants to remove contaminants or chemicals in the soil by the accumulation of the contaminant by the plant.
Phytosociology	The study of the organization, development, geographical distribution and classification of plant communities.
Phytotoxic	Toxic or poisonous to plants.
Phytotoxicity	The level of toxicity to a substance in a plant.

Piche evaporation	Evaporation measured using an anemometer, where water evaporates from a filter paper at the open end of a water-filled glass tube.
Piedmont	An area of land formed or lying at the foot of a mountain or mountain range.
Pisolites	Soils containing gravel-like concretions.
Pit lake	Artificial lakes made deliberately by digging, or by flooding an open-pit mine.
Plume	Visible or measurable discharge of a contaminant from a given point of origin; it can be visible or thermal in water or visible in the air as, for example, a plume of smoke.
PLUMES	Mathematical model for dilution modeling.
PM_{10}	Airborne particulate matter with mean diameter less than 10 µm (microns) in diameter.
$PM_{2.5}$	Airborne particulate matter with mean diameter less than 2.5 µm (microns) in diameter.
PMR (Plant Micro-Reserve)	Small plots of land of peak value in terms of plant species richness, endemism (locally on regionally occurring) or rarity, given over to long-term monitoring and conservation of plant species and vegetation types. PMRs are designed to conserve vegetation and to develop or test active conservation methods that bring together ex situ and in situ actions.
Potable	Refers to drinkable. Water that is potable is clean and free from harmful chemicals and disease-carrying microbes.
Potential evaporation	The amount of water that will be evaporated if this water is available. Evaporation is usually recorded as a depth and expressed in millimeters.
Prevention	Activities and programs designed to eliminate hazards before they can become emergencies.
Process water	Water that serves in any level of the manufacturing process of certain products or the water used in the scheduled depuration process.
Profanation	The act of depriving something of its sacred character.

Propagation	The act of multiplication by a plant or animal by any process of natural reproduction from the parent stock. It is a method of increasing the number of plants by dividing roots, layering or start from cuttings.
Protista	Unicellular protozoans and unicellular and multicellular (macroscopic) algae.
Protohistoric	The transition period between oral tradition and written history in a society. This also refers to the period during which a society of primarily oral tradition begins to feel the influence of a contact with a society of writing. In Africa, the protohistoric period is regarded as the leading into the Iron Age between 1,400 B.C. and A.D. 200. In some areas, Protohistoric also refers to the time of initial contact before European colonization.
QA/QC (Quality Assurance/Quality Control)	A set of practices that ensure the quality of a product or a result. For example, "Good Laboratory Practice" is part of QA/QC in analytical laboratories and involves such things as proper instrument calibration, meticulous glassware cleaning and an accurate sample information system.
Ramsar site	Wetlands of recognized international importance, which have been designated for protection and "wise use" under the Ramsar convention of 1971 based on their significance in terms of ecology, botany, zoology, limnology or hydrology.
Rare	Not frequent; seldom occurring or scarce.
Rating curve	A relationship between flow and water depth for a particular section of river.
Reach (Stream)	A reach in geography is an expanse, or widening, of a stream or river channel. This commonly occurs after the river or stream is dammed.
Receptor	A point or location where the existing activity may be adversely affected when noise levels exceed predefined thresholds of acceptability or when levels increase by predefined thresholds of change.
Recharge	Addition of water (percolation) that reaches the zone of saturation (groundwater). Also used to refer to the volume of water reaching the zone of saturation.

Reclamation	The restoration of a site after mining or exploration activity is completed.
Red-listed	Species on the World Conservation Union/International Union for the Conservation of Nature (IUCN) Red List due to some level of threat.
Reserve	That part of a mineral resource that can be mined profitably.
Resources	In emergencies,resources are the personnel, equipment, and information required to respond effectively to an emergency.
Response	Activities designed to address the immediate and short-term effects of an emergency.
Reversibility	Effect on the resource (or resource capability) can or cannot be reversed.
Riffles	A reach of stream that is characterized by shallow, fast-moving water broken by the presence of rocks and boulders.
Riparian	Relating to or living or located on the bank of a natural watercourse (as a river) or sometimes of a lake or a tidewater. Refers to terrain, vegetation or simply a position next to or associated with a stream, flood plain, or standing waterbody.
Riparian forest	Forest that occurs within a riparian zone, along watercourses or waterbodies. See also gallery forest.
Risk	A measure of the likelihood and the consequence severity with a hazard occurring.
River reaches	A comparatively short length of river, stream channel or shore within which habitat conditions are similar.
Royalty	An amount of money paid at regular intervals by the lessee or operator of a mining property to a lender or the owner of the ground. Generally based on a certain amount per tonne or a percentage of the total production or profits.

Runoff	The water from rain, snowmelt or irrigation that flows over the land surface and is not absorbed into the ground, instead flowing into streams or other surface waters or land depressions.
Rupicolous	Thriving or living among small rocks.
Sacred character	The quality of being holy; devoted to a deity or spirit. Having some religious ceremonial use or supernatural function in ritual.
SAG Mill	Semi-autogenous grinding mill. A SAG mill is used for crushing ore. It rotates, tumbling its contents violently, causing a breaking action. The mill is lined with wear-resistant steel liners. Fresh ore is continually conveyed into the mill feed chute and is crushed by means of steel balls until small enough to pass though the openings in the discharge grates.
Savanna	Flat grassland of tropical or subtropical regions.
Saxicolous	Growing on, or living among, rocks.
Sclerophyll	Woody plant with leathery leaves: any woody plant of arid areas with thick leathery evergreen foliage that retains water.
Seasonal wetlands	Wetland area that is only wet seasonally.
Secchi disk	A circular plate, generally about 10-12 inches (25.4-30.5 centimeters) in diameter, divided into black and white quarters, used to measure the transparency or clarity of water by noting the greatest depth at which it can be visually detected. Its primary use is in the study of lakes.
Second order stream	A stream in which many first order streams join to make a second order stream.
Sedimentation	Deposition of organic or inorganic material (sediment) that is transported and deposited by wind and water.
Seismic	An interpretation of geologic strata through measurement and recording of sound wave transmission below the surface produced by earthquakes, seaquakes, volcanoes and tectonic plates or by equipment or methods used to create Earth vibrations, such as exploding dynamite in oil exploration.

Sense of place	The unique value that is allocated to a specific place or area through the cognitive experience of the user or viewer.
Sensitive areas	Environments or ecosystems considered sensitive under Democratic Republic of the Congo (DRC) regulations (Annex XII). These include marshes, lakes, areas were threatened plant or animal species live, areas subject to erosion, and sources of potable water.
Sensitive receptors	Visual receptors (viewers) potentially sensitive to the proposed development.
Serpentine	A rock mineral group with the general formula $(MgFe)_3Si_2O_5(OH)_4$.
Silt	Fine particles of sand or rock that can be picked up by the air or water and deposited as sediment.
Soil aggregate	A unit of soil structure consisting of primary soil particles held together by cohesive forces or by secondary soil materials such as iron oxides, silica or organic matter.
Sound	“Sound” or “sound emissions” refers to the acoustic energy generated by natural or man-made sources, including the project activities.
Sound Volume	The “volume” of a sound or noise is expressed on a logarithmic scale, in units called decibels (dB). Since the scale is logarithmic, a sound or noise that is twice as loud as another will only be three decibels (3 dB) higher. A sound or noise with double the number of decibels is much more than twice as loud. A change of three decibels is also the general threshold at which a person can notice a change in sound volume.
Speciation	The formation of a new species.
Species area curve	A graph that shows the cumulative number of plant species encountered as the area surveyed increases.
Species of concern	An informal term for a plant or animal with declining populations and believed in need of concentrated conservation actions such as research, monitoring, or removal of threats, and given legal classification as threatened or endangered.

SRDT (Solar radiation/delta-T)	Method to measure solar radiation from the United States Environmental Protection Agency (US EPA).
Steppic plant communities	Steppe is an open vegetation unit (the grass layer does not cover 100 percent of the surface) with the dominance of two biological types namely cespitose (tuffed) herbs (mainly grasses and sedges) but also geofrutex (= Magnoliopsida = dicotyledons plants with a woody underground organ).
Stockpile	Broken ore heaped on the surface, pending treatment or shipment.
Stoloniferous	Producing stolons, a horizontal branch from the base of a plant, trailing over the soil surface and rooting at the apex or the nodes.
Stone Age	The stage in the development of any people where the use of stone implements as tools and weapons is prominent. In Africa, the Stone Age begins about 2 million years ago and extends to about 3,000 B.C. when the use of naturally occurring metals, such as copper, begins.
Storativity	The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer, per unit change in head. It is equal to the product of specific storage and aquifer thickness. In an unconfined aquifer, the storativity is equal to the specific yield.
Storm water	Precipitation that accumulates in natural and/or constructed storage and stormwater systems during and immediately following a storm event and that is often routed into drain systems in order to prevent flooding.
Stressors	Pressure or tension exerted on a material object.
Strip	To remove the overburden or waste rock overlying an ore body in preparation for mining by open-pit methods.
Strip mining	A process that uses machines to scrape soils or rock away from mineral deposits just under the earths's surface.
Stripping ratio	The ratio of tonnes removed as waste to the number of tonnes of ore removed from an open-pit mine.
Subsistence fishery	A fishery in which the fish caught are consumed directly by the families of the fishers rather than being bought by middle-men and sold at the next larger market.

Supernatant	The liquid, containing soluble compounds, which is left behind after a mixture is centrifuged or precipitated. The liquid lying above a solid residue after crystallization, centrifugation, or other process.
Surface miner	A track-mounted machine with a large rotating drum with hardened steel picks used to break up ore in situ.
Surface water	Water standing on the top of ground or soil, waiting either to soak down into the soil or to evaporate. Is also used to characterize water that collects and stands or is stored in lakes, ponds, rivers, bayous, streams, canals and reservoirs, either natural or man-made.
Suspended sediments	Particles of matter suspended in the water. Measured as the oven dry weight of the solids, in milligrams per liter (mg/L), after filtration through a standard filter paper. Less than 25 mg/L would be considered clean water, while an extremely muddy river might have 200 mg/L of suspended sediments.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Swidden agriculture	Agricultural technique whereby forest vegetation is cut down, let dry and burned to prepare fields for crops and fields that are not cultivated continuously.
Syncline	Basin or trough-shaped fold in the rock in which rock layers are downwardly convex. The youngest rock form the core of the fold and outward from the core progressively older rocks occur.
Tailings	Material rejected from a mill after most of the recoverable valuable minerals have been extracted. Also, residues separated in the preparation of various products (as grain or ores).
Tailings pond	A depression used to confine tailings.
Tainting	A contaminating influence or effect with a bad or undesirable quality.
Taxa	Groupings of organisms based on their formal taxonomic names such as species, genus or family groups.

TDS (Total dissolved solids)	The total concentration of all dissolved compounds solids found in a water sample.
Tectonic activity	Movements of the Earth's crust such as earthquakes, folds and faults.
Temporal	Of or relating to or limited by time as temporal processing, temporal dimensions and temporal and spacial boundaries.
Termitaria	Nests built by colonies of termites.
Third order stream	A third order stream has only first and second order tributaries.
Tilth	The physical condition of the soil as related to its ease of tillage, fitness as a seedbed, and impedence to seedling emergence and root penetration. Good tilth is a sign of healthy soil organisms. While digesting organic material, bacteria secrete gum and slime-like matter in the soil. This works like glue, binding soil particles and humus together to form aggregates.
Ton	2,000 pounds.
Tonne	Metric ton, 1,000 kilograms.
Total soil nitrogen	Sum of organic and inorganic nitrogen in a defined soil sample.
Toxicity	A measure of the quality or state of being poisonous.
Trabeco	Tranverses en Béton du Congo: a concrete railways sleepers factory that was formerly based in Fungurume.
Transhumance migration	The seasonal migration of farmers to suitable farming lands.
Transhumance agriculture	The practice of living in one area for part of the year and farming and living in another area for the other part of the year.
Translocation	Movement of nutrients or other substances within an organism. As well, it is the movement of native or introduced species to habitats outside their natural or previous distribution; endangered species are now translocated by humans in efforts to preserve them from extinction.

Transmissivity	The rate at which groundwater can flow through an aquifer section of unit width under a unit hydraulic gradient. It is the average permeability of a section of the entire aquifer at a given location multiplied by the thickness of the formation.
Transplantation	To uproot and replant a growing plant to a new location.
TRV (Toxicity reference value)	A quantitative expression that benchmarks the potency of each substance.
TSP (Total suspended particulates)	Particles which includes airborne particulates nominally smaller than 30 microns (µm) in aerodynamic diameter.
TSS (Total suspended solids)	Solids, found in wastewater or in a stream, which can be removed by filtration. The origin of suspended matter may be artificial or anthropogenic (man-made) wastes or natural sources such as silt.
Tufa	A soft porous rock consisting of calcium carbonate deposited from springs or creeks rich in lime.
Turbidity	Turbidity is cloudiness or opacity in the appearance of a liquid caused by solids, particles and other pollutants. Turbidity measurement provides an indication of the clarity of water and water quality.
Understorey	Those trees or other vegetation in a forest stand below the main canopy level.
Uplands	Areas where the soil is not saturated for extended periods as indicated by vegetation and soils.
Vegetation unit	A patch, grouping or zone of plants evident in overall plant cover, which appears distinct from other such units because of the vegetation's structure and floristic composition; a given unit is typically topographically distinct and typically has a rather uniform soil.
Viewshed	The two-dimensional spatial pattern created by an analysis that defines areas, which contain all possible observation sites from which an object would be visible. Area of land seen from a single viewpoint or from a series of viewpoints such as along a highway or waterway.
Visibility	The area/points where project components are potentially visible.

Visual aesthetics	The quality of the visible environment.
Visual effects (impact)	Visual effects relate to the changes that arise in the composition of available views as a result of changes to the landscape, to people's responses to the changes, and to the overall effects with respect to visual amenity.
Visual exposure	Visibility and visual intrusion qualified with a distance rating to indicate the degree of intrusion.
Visual intrusion	The nature of intrusion of an object on the visual quality of the environment resulting in its compatibility (absorbed into the landscape elements) or discord (contrasts with the landscape elements) with the landscape and surrounding land uses.
Visual receptors	Visual receptors (viewers) potentially sensitive to the proposed development.
Visual resource	Aesthetic value or scenic beauty is the rating given to a particular landscape. It is the emotional response derived from the experience of the environment with its particular natural and cultural attributes. The response can be either to visual or non-visual elements and can embrace sound, smell and any other factor having a strong impact on human thoughts, feelings and attitudes. Thus aesthetic value encompasses more than the seen view, visual quality or scenery, and includes atmosphere, landscape character and sense of place and is collectively described as the visual resource.
Vleis	Seasonal wetlands.
VOC (Volatile organic compounds)	Gaseous hydrocarbons that exclude methane, and tend to contribute to chemical reactions in the atmosphere.
Vulnerable	A species is vulnerable by World Conservation Union/International Union for Conservation of Nature (IUCN) definition when the best available evidence indicates that it faces a high risk of extinction in the wild.
Waste	Unmineralized, or sometimes mineralized, rock that is not mineable at a profit.
Watershed	The specific land area that drains water into a river system or to a particular point along a stream. Each stream has its own watershed.

Wetland	An area that is regularly saturated by surface water or groundwater and is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions (e.g., swamps bogs, fens, marshes, and estuaries).
Windrose	A type of figure often used to illustrate the frequency of wind direction and the magnitude of the wind velocity. The lengths of the bars on the windrose indicate the frequency and speed of wind. The direction from which the wind blows is illustrated by the orientation of the bar in one of 16 cardinal directions.
Worked stones	Stones that have been shaped or modified by a human to form a tool or other object.
Zone of potential influence	The area defined as the radius about an object beyond which the visual impact of its most visible features fade into the background and become insignificant in the greater landscape scene.

ACRONYMS AND ABBREVIATIONS

SAWMS-1998	1998 South African Waste Management Series
OSHA	US Occupational Safety and Health Administration
EHS Guidelines	Environmental, Health and Safety Guidelines
%	Percent
<	Less than
>	More than
°C	Temperature in degrees Celsius
µeq/L	Microequivalent per liter
µg/Kg	Microgram per kilogram
µg/L	Microgram per liter
µL	Microliter
µm	Micron
µPa	Micro Pascal
µS	Micro Siemens
µS/cm^2	Micro Siemens per square centimeter
µS/h	Micro Siemens per hour
AA	Atomic absorption
ABA	Acid-base accounting
ACRU	Agricultural Catchments Research Unit
ADFL	Alliance of Democratic Forces for the Liberation of Congo-Zaire
Ag	Silver
AGC	Australian Groundwater Consultants
AGP	Acid generating potential
AIDS	Acquired immune deficiency syndrome
Al	Aluminum
Al_2O_3	Aluminum oxide
ALBA	Association Laique pour les Bambins d'Afrique (Secular Association for The African Children)
AM	Audio monitoring
ANC	Acid neutralizing capacity
ANFO	Ammonium nitrate / fuel oil

ANP	Acid neutralizing potential
ANR	Agence National de Renseignement
ANSI	American National Standards Institute
AP	Acid generation potential
ARD	Acid rock drainage
ARMC	Amended and restated mining convention
Art.	Article
As	Arsenic
ASME	American Society of Mechanical Engineers
atm	Atmospheres
Au	Gold
B	Boron
Ba	Barium
BBC	British Broadcasting Corporation
BCF	Bioconcentration factors
BDD	Bureau Diocesan Pour le Development (Diocesan Bureau for the Development)
Bi	Bismuth
BID	Background information document
BMP	Best management practices
BOD	Biological oxygen demand
BOD_5	Biochemical oxygen demand
BPF	Barely perceptible flow
BPIP	Building Profile Input Program
Bq	Becquerel
Br	Bromide
BR	Belgian National Botanic Garden at Meise
BRGM	Bureau des Recherchés Géologiques et Minières (Geological and Mining Surveys Agency)
BRLU	Laboratoire de Botanique systématique of the Brussels Free University
C	Carbon
ca	Circa
Ca	Calcium

$CaCl_2$	Calcium chloride
$CaCO_3$	Calcium carbonate
CadnaA	Computer aided noise abatement model
$CaMgHCO_3$	Calcium magnesium bicarbonate
CAMP	Conservation assessment and management planning
CaNP	Carbonate neutralization potential
CARPE	Central African Program for the Environment
CBD	Convention on Biological Biodiversity
CCC	Criterion continuous concentration
CCD	Countercurrent decantation
CCISR	Center of Catchment and In-Stream Research
CCME	Canadian Council of Ministers of the Environment
Cd	Cadmium
CD	Chart Datum
CDA	Canadian Dam Association
CDAP	Community development action plan
CDC	Community Development Committee
CdG	Chef de Groupement, Chief of Groups
CDH	Human Rights Center
CdT	Chef de Terre, Land Chief
CEA	Cumulative effects assessment
CEC	Cation exchange capacity
CEMI	Canadian Environment Metallurgic Inc.
CFU	Colony forming units
CFU/100 ml	Colony Forming Units per 100 milliliters
CH	Cultural heritage
CI	Conservation International
CIA	Central Intelligence Agency
CITES	Convention on International Trade in Endangered Species
Cl	Chlorine
CLE	Critical level
CLO	Community liaison officer
cm	Centimeter

CM	Corrective maintenance
CMC	Criteria maximum concentration
CMN	Calcaire a mineral noir (siliceous dolomite and graphitic shale)
cmol	Centimole – charge of saturating ion per kilogram
Co	Cobalt
CO	Carbon monoxide
CO_2	Carbon dioxide
COC	Chemical (or constituent) of concern
COMIFAC	Central African Forests Commission
COPC	Chemicals of potential concern
CPC	Center of Plant Conservation
CPESC	Certified professional in erosion and sediment control
CPR	Cardiopulmonary resuscitation
CPUE	Catch per unit of effort
CPWCC	Canadian Pipeline Water Crossing Committee
Cr	Chromium
CSIR	Center for Scientific and Industrial Research of South Africa
CTB	Coopération Technique Belge (Belgian Technical Cooperation)
CTE	Technical evaluation committee
Cu	Copper
CVAA	Cold vapor atomic adsorption
CVDNN	Coefficient of variation in distance to nearest neighbor
CZMW	Central Zambezian Miombo Woodland
d	Day
dBA	A-weighted decibels
DBH	Diameter at breast height
dBL	Linear decibels
DCA	Direct concession area (Initial planned project footprint)
DEM	Digital elevation model
DFID	UK Department for International Development
DFO	Department of Fisheries and Oceans (Canada)

DL	Detection limit
DO	Dissolved oxygen
DOE	Department of environment
DRC	Democratic Republic of the Congo
DSHA	Deterministic seismic hazard assessment
DW	Dry weight
E	East
E. coli	Escherichia coli
e.g.	For example
EA	Environmental assessment
EC	Electrical conductivity
EC_{20}	Effects Concentration (EC) is the concentration that results in a decrease of 20 percent of the measured variables
EC_{50}	Effects Concentration (EC) is the concentration that results in a decrease of 50 percent of the measured variables
ECI	Environmentally conservative isotherms
ECRP	Emergency and contingency response plan
EDS	Environmental design standard
EEM	Environmental effects monitoring
EFMA	European Fertilizer Manufacturers Association
Eh	Redox potential
EIA	Environmental impact assessment
EIE	Environmental impact effect
EIFAC	European Inland Fisheries Advisory Commission
EMNN	Euclidean mean distance to nearest neighbor
EMP	Environmental management plan
EMS	Environmental management system
ENSO	El Nino southern oscillation
EOP	Emergency operation plan
EP	Equator principles
EPC	Engineering procurement and construction
ERP	Emergency response plan
ERT	Emergency response team

ESA	European Sulfuric Acid Association
ESIA	Environmental and social impact assessment
ESMS	Environmental and social management system
et al	And others
EU	European Union
EV	Extreme value
F	Fluorine
FAM	Fe-Al-Mn (Iron, aluminum and manganese)
FAO	United Nations Food and Agriculture Organization
Fc	Franc congolais, Congolese francs
Fe	Iron
Fe/Al/Mn	Iron / aluminum / manganese (see FAM)
FeOOH	Iron oxide-hydroxide
FIDIC	International Federation of Consulting Engineers
FS	Feasibility study
FY	Fiscal year
g	Gram
g/L	Gallon per liter
GC	Geochemical controls
GDP	Gross domestic product
GDRC	Government of the Democratic Republic of the Congo
Gécamines	La Générale des Carriéres et des Mines
GEPFE	Groupe d'Études des Populations Forestières Équatoriales
GHG	Greenhouse gases
GIS	Geographic information system
Golder	Golder Associates Ltd.
GP	Good practice
GPS	Global positioning system
GRI	Global reporting initiative
H&S	Health and safety
ha	Hectare
Hazen	Hazen Research Inc.
HAZID	Hazard identification study

HCO_3	Bicarbonate
HDPE	High-density polyethylene
Hg	Mercury
HG	High grade
HG PLS	High-grade pregnant leach solution
HIV	Human immunodeficiency virus
H_{max}	Maximum wave height
hr	Hour
HRDP	Human resource development plan
HSMS	Health and safety management system
HSP	Health and safety plan
Hz	Hertz (Unit of frequency)
I&APs	Interested and affected parties
i.e.	That is
ICCN	Institut Congolais pour la Conservation de la Nature (Congolese Institute for the Natural Conservancy)
ICOLD	International Commission on Large Dams
ICP	Inductively coupled plasma
ICP-MS	Inductively coupled plasma mass spectrometry
IDF	Inflow design flood
IDFC	Intensity-duration-frequency curve
IFC	International Finance Corporation
IFESH	International Foundation for Education and Self-help
IHIA	Intermediate habitat integrity assessment
ILCR	Incremental lifetime cancer risk
INDVAL	Indicator value method
IP	Internal paging
IPPC	Integrated pollution prevention and control directive
Ir	Iridium
ISCST3	Industrial Source Complex Short-term Model
ISO	International Organization for Standardization
ISQG	Interim sediment quality guideline
ISRIC	International Soil Reference Information Center

ITN	Insecticide treated nets
IUCN	International Union for the Conservation of Nature and Natural Resources (Also known as World Conservation Union)
K	Potassium
KCl	Potassium chloride
kg	Kilogram
Kg/ha	Kilogram per hectare
Kg/t	Kilogram per ton
Km	Kilometer
km/h	Kilometers per hour
Km^2	Square kilometers
KRBC	Kew Royal Botanic Gardens
Kt/yr	Kilotonnes per year
L	Liter
L/s	Liter per second
L_{Aeq}	Equivalent sound level
LC	Lethal concentration
LEV	Log extreme value
LG	Low Grade
LGIM	Large mining investment act
LHL	Lundin Holdings Ltd.
LMS	Low magnesium saprolite
LN	Log normal
LNTPB	Laboratoire National des Travaux Publics et du Bâtiment (Public Works and Building National Laboratory)
LOI	Loss in ignition
LOTOTO	Lock/Tag/Try
LSA	Local study area
Ltd.	Limited
LWD	Large woody debris
M	Million
m	Meter
m^2	Square meter

m^3/h	Cubic meters per hectare
m^3/s	Cubic meters per second
MAB	Man and Biosphere Program (UNESCO)
MAC	Mining Association of Canada
mamsl	Meters above mean sea level
MAP	Mean annual precipitation
MAR	Mean annual runoff
masl	Meters above sea level
MB	Mass balance
mbcl	Meters below collard level
MBG	Missouri Botanical Gardens
mbgl	Meters below ground level
MCE	Maximum credible earthquake
MCL	Maximum contaminant level
MDL	Method detection limit
MDNN	Mean distance to nearest neighbor
meq	Milliequivalent
MEW	Mass of evaporated water
MFI	Microfinance institution
Mg	Magnesium
mg	Milligram
mg/kg/d	Milligram per kilogram per day
mg/L	Milligram per liter
mg/m^2	Milligram per square meter
mg/m^3	Milligram per cubic meter
MGW	Mass of groundwater
mL	Milliliter
ML	Metal leaching
mL/yr	Milliliter per year
mm	Millimeter
mm/month	Millimeters per month
mm/s	Millimeters per second
Mn	Manganese

MNOL	Maximum normal operating level
Mo	Molybdenum
MONUC	Mission Observation of United Nations for Congo
MOU	Memorandum of understanding
MPW	Mass of pit lake water
MRD	Maximum daily rate of deposition
MS	Magnitude scale
mS/cm	Millisiemens per centimeter
MSDS	Material safety data sheet
Msed	Mass of bottom sediments
MSF	Médecins sans frontiéres
MSS	Mass of all suspended particle matter
MSW	Mass of surface water
Mt	Metric tons
mtpa	Million tonnes per annum
mv	Mass/volume
mV	Millivolts
MVCLA	Market value chain livelihoods analysis
MWe	Megawatt electrical
n	Number
N	Nitrogen
n/a	Not applicable
na	Not analyzed
Na	Sodium
NAG	Net acid generation
Nb	Niobium
NCDC	National climatic data center
ND	No data
n-day	Number of days
NECSA	Nuclear Energy Corporation of South Africa
NGO	Non-governmental organization
NH_3	Ammonia
Ni	Nickel

nm	Nanometer
NMC	New Mine Code
NNP	Net neutralization potential
NO	Nitrogen monoxide
NO_2	Nitrite / nitrogen dioxide (gas)
NO_3	Nitrate
NOAA	United States National Oceanic and Atmospheric Administration
NO_x	Nitric and nitrous oxides
NP	National park
NPR	Neutralization potential ratio
NRC	National Research Council
NSD	Not sufficient data
NTFP	Non-timber forest products
NTU	Nephelometric turbidity units
O/F	Over flow
OBE	Operating basis earthquake
OECD	Organization for Economic Cooperation and Development
OHSP	Occupational health and safety plan
OJ	Official journal
OMS	World Health Organization (Congo)
ONE	Office National pour l'Environnement (Environmental National Office)
OP	Operational policy
Os	Osmium
P	Phosphorus
PAH	Polycyclic aromatic hydrocarbons
Pb	Lead
PCA	Principal component analysis
pCi	Picocurie
pCi/L	Picocuries per liter
PCOC	Potential chemicals of concern
Pd	Palladium

PD	Phelps Dodge Corporation
PEL	Probable effect level
PGA	Peak horizontal ground acceleration
PLS	Pregnant leach solution
PM_{10}	Airborne particulate matter with mean diameter less than 10 µm (microns) in diameter
$PM_{2.5}$	Airborne particulate matter with mean diameter less than 2.5 µm (microns) in diameter
PMF	Probable maximum flood
PMP	Probable maximum precipitation
PMR	Plant micro-reserve
PN	Parc national (National park)
PO_4	Phosphate
PPAH	Pollution prevention and abatement handbook
ppb	Parts per billion
PPE	Personal protective equipment
ppm	Parts per million
PRA	Participatory rural appraisal
PS-1	Pump station 1
PSHA	Probabilistic Seismic Hazard Association
Pt	Platinum
Q&A	Questions and answer session
QA/QC	Quality Assurance/Quality Control
QESF	Qualité de l'Eau de Surface (Surface Water Quality)
RAIS	Risk assessment information system
Ramsar	Convention on wetlands of international importance especially as waterfowl habitat
RAP	Resettlement action plan
RAT	Roche argilleuse talquese (argillic talcose rocks)
RATG	Roche Argilotalesqueuse (brecciated dolomitic and sandy shale)
RDC	Regional development committee
RDP	Regional development plan
REGIDESO	Régie de production et Distribution d'Eau et d'Électricité

RF	Resettlement framework
Rfd	Reference dose
RGS	Sandy dolomite and feldspathic sandstone
Rh	Rhodium
RIAP	Resettlement interim action plan
RN	Route national
RNI	Reserve naturelle integrale (Nature Integral Reserve)
ROM	Run of mine
RS	Reserve speciale (Special Reserve)
RSA	Regional study area
RSB	Roberts, Synder Baumgartnew. Refer to the RSB model in PLUMES software for dilution modeling
RSC	Roche siliceuse cellulaire (coarse-grained siliceous shale)
RSF	Laminated dolomitic shale
Ru	Ruthenium
RWD	Return water dam
S	South
S	Sulfur
S.A.R.L	Société à responsabilité limitée
s.u.	Standard unit
SADWAF	South African Department of Water Affairs and Forestry
SAGE	Service d'Appui à la Gestion de l'environnement (Support Service for Environmental Management)
SAP	Social action plan
SASS5	South Africa Scoring System Version 5
Sb	Antimony
SC	Soil concentration
SCADA	Supervisory control and data acquisition
SCUBA	Self-contained underwater breathing apparatus
SD	Shale dolomitique (Dolomite and dolomitic shale)
SDP	Social development plan
Se	Selenium
SE	Socio-economic (as in SE survey)

SEASSCAM	Organization of Informal Miners, Kolwezi
SEBR	Socio-economic baseline report
SF	Slope factor
SHEQ	Safety, health and environment quality
Si	Silicon
SiO_2	Silicon dioxide
SLO	Social license to operate
SME	Small and medium enterprise
SMP	Social management plan
SMTF	Société minière de Tenke Fungurume
Sn	Tin
SNCC	Societé Nationale des Chemins de fer du Congo
SO_2	Sulfur dioxide
SO_3	Sulfite
SO_4	Sulfate
SOP	Standard operating procedure
SPCC	Spill prevention, control and counter measure
SPL	Sound pressure level
SPLP	Synthetic precipitation leaching procedure
SPSS	Statistical Package for the Social Sciences
SRDT	Solar Radiation/Delta-T method from the United States Environmental Protection Agency (US EPA)
SRK	Steffen, Robertson and Kirsten Ltd. (UK)
SRR	Spill and release response
STD	Sexually transmitted diseases
STI	Sexually transmitted infections
SVOC	Semivolatile organic compound
SWD	Small woody debris
SWQ	Surface water quality
SX/EW	Solving extraction/electrowinning
t	Tonnes
t/a	Tonnes per annum (same as tonnes per year)
t/d	Tonnes per day

t/h	Tonnes per hour
t/ha	Tonnes per hectare
t/yr	Tonnes per year
Ta	Tantalum
TA-1	Tailings area 1
TBC	To be confirmed
TCU	True color unit
TDS	Total dissolved solids
TEL	Threshold effect level
TFHL	TF Holding Ltd.
TFM	Tenke Fungurume Mining
TFSDP	Tenke Fungurume Social Development Program
Th	Thorium
TIC	Total inorganic carbon
TKN	Total Kjeldahl nitrogen
TLV - TWA	Threshold Limit Values - Time-Weighted Average
TMC	Tenke Mining Corporation (Canada)
TN	Tailings neutralization
ton	Metric ton (1,000 kilograms)
ToR	Terms of reference
tpd	Tonnes per day
TPH	Total petroleum hydrocarbons
tpy	Tonnes per year
Trabeco	Tranverses en Béton du Congo: A concrete railway sleeper factory formerly in Fungurume
TRV	Toxicity reference value
TSF	Tailings storage facility
TSP	Total suspended particulate
TSS	Total suspended solids
TT	Treatment technology
TU	Toxicity Unit
TWA-TLV	Time-Weighted Average - Threshold Limit Values
TWM	Toxic waste management

UBC	United States Uniform Building Code
UET	Upper effect threshold
UHF	Ultra high frequency
UK	United Kingdom
UMCOR	United Methodist Committee of Relief
UMHK	Union Miniére de Haut Katanga
UN	United nations
UN OCHA	United Nations Office for Coordination of Humanitarian Affairs
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
US EPA	United States Environmental Protection Agency
US FDA	United States Food and Drug Administration
USAID	United States Agency for International Development
USD	United States dollars
USDA	United States Department of Agriculture
USGS	United States Geological Services
UTM	Universal transverse mercator
V	Vanadium
VES	Visual encounter surveys
VOC	Volatile organic compounds
VOS	Voluntary observing ships recording
W	Tungsten
Watt/m^2	Watt per meter squared
WBG	World Bank Group
WCMC	World Conservation Monitoring Center
WCPA	World Commission on Protected Areas
WCS	Wildlife Conservation Society
WET	Whole effluent toxicity

WGS	Working groups
WHO	World Health Organization
WMO	World Meteorological Organization
WQ	Water quality
WRC	Water Research Commission, Republic of South Africa
wt	Weight
wt %	Weight percent
WW	Wet weight
WWF	World Wildlife Fund for Nature, or World Wildlife Fund in the United States and Canada
XRD	X-Ray diffraction
XRF	X-Ray fluorescence
yr	year
Zn	Zinc
Zr	Zirconium

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APPENDIX A-I

TABLE OF CONFORMANCE TO TFM TERMS OF REFERENCE

Terms of Reference	ESIA Section
Topography/Geomorphology	
describe the topography and geomorphology of the local study area using topographic maps, other existing maps, aerial photos, and site visits	B2.1
determine the presence of any unique topographic features	B2.1
evaluate changes to topography and geomorphology as a result of the project	C2.1
Geology/Geochemistry	
ascertain the volume (quantity) and quality of the seepage from waste rock facilities under the revised mine plan	B2.3
use existing data and some test work to characterize the waste rock and tailings material (both the transitional and sulfide ores will be tested if they will be exposed during mining)	B2.3
model the quality of various water mixing scenarios such as seepage into surface water streams, spillages due to entrainment by storm water and effluent discharges (in and off specification)	B2.3
provide modeling results as input to the hydrogeological, hydrological, and water quality disciplines for impact analyses	B2.3
Soils	
determine soils type and distribution within the study areas	B2.4
determine capability of soils for agriculture and other uses	B2.4
determine the sensitivity of soil types to acidifying emissions for those study areas where such emissions are expected, their sensitivity/buffering capacity and predicted deposition patterns	B2.4
conduct an assessment of soil types for reclamation suitability	B2.4, D3.1.1
determine the potential for soil erosion and measures to minimize the effects of any such erosion	B2.4, D3.1.1
determine the availability of soils suitable for reclamation activities	B2.4
determine any constraints or limitations to achieving vegetation restoration based on anticipated soil conditions	B2.4
assess the effect of the project on soil quantity and capability	C2.4
Visual Aesthetics	
determine the nearest habitations or frequented viewpoints of concern for the study area (e.g., highway or hill top viewpoints)	B2.5
assess potential effects to viewpoints from the project	C2.5
Natural Risks	
describe the natural risks (e.g., earthquakes, landslides, flooding) that may occur within the study areas	B2.6
evaluate the potential risk for the project to be affected by these risks (e.g., tailings dam failure), and any consequent environmental or social impacts	C2.6
Air Quality	
analyze the general climatology and local meteorology	B2.7
characterize the current air quality in the air study area	B2.7
identify, quantify and evaluate the potential air quality impacts anticipated due to the mining operations and processing facility	C2.8
describe the health risk criteria applicable to the pollutants expected from the proposed operations	C2.8

Terms of Reference	ESIA Section
overview the legislation and regulatory context as it pertains to the regulation of atmospheric emissions and air pollutant concentrations, (i.e., air pollution compliance criteria)	A2.7
identify all potentially significant emission sources	C2.8
quantify significant air emissions, including gaseous and particulate, from well-defined (e.g., stacks) and fugitive sources	C2.8
quantify greenhouse gas emissions	C2.8
set up an appropriate atmospheric dispersion model to simulate the transport and dilution of air emissions from the proposed project	C2.8
predict air concentrations and deposition rates expected to result from the proposed operations	C2.8
assess the predicted incremental air pollution levels (air concentration and deposition) with respect to local and international regulatory requirements (as applicable)	C2.8
identify significant information gaps, if applicable	C2.8
provide recommendations regarding measures which could be implemented to reduce the impact of the proposed development on the receiving environment (where applicable)	C2.8, D3.1.3
Noise and Vibration	
identify noise and vibration sensitive locations in the concession	B2.9
characterize the baseline noise levels within the study areas	B2.9
quantify noise emissions and vibrations from the project	C2.9
calculate probable increases in noise or vibration levels at sensitive locations as a result of the project	C2.9
evaluate the significance of changes in noise or vibration levels due to the project	C2.9
evaluate the effectiveness of mitigation measures	C2.9, D3.1.4
Hydrogeology	
describe and map the groundwater regimes for the study areas for both the wet and the dry season, including data from monitoring wells, local wells for humans or livestock, springs and seeps	B2.10
prepare an inventory of water users; identify water use conflicts and proposed resolutions	B2.10
include measurement for levels/flow and quality	B2.10
develop a conceptual groundwater flow model followed by a numerical model	C2.10
assess the potential of the project to cause changes in groundwater and surface water levels and flows for both the wet and dry seasons	C2.10
assess the effects of groundwater withdrawal under prolonged drought conditions	C2.10
assess the effects of changes in groundwater regime on other resources such as vegetation, wetlands, fish and wildlife	C3.1, C3.2, C3.3
describe a groundwater monitoring program for water levels and flows and the early detection of potential contamination	D3.1.6
describe groundwater mitigation options to be considered for implementation should adverse effects be detected	C2.10
describe predicted groundwater effects following closure	C2.10
demonstrate water availability for the life of mine	C2.10

Terms of Reference	ESIA Section
Surface Water Hydrology	
take daily readings of water levels at baseline stream monitoring stations equipped with staff gauges in the study areas for the wet season; continue monitoring after ESIA completion to capture dry season data	B2.11
carry out discharge measurements to develop rating curves at baseline stream monitoring stations in study areas at changes of flow	B2.11
describe the annual and seasonal climatic regimes (mean annual precipitation, mean monthly precipitation, intensity-duration-frequency of extreme precipitation events, mean annual temperature, mean monthly temperature, annual evaporation and evapotranspiration, monthly evaporation and evapotranspiration) for the study areas based on regional and local climatic data	B2.11, C2.11
describe the annual and seasonal surface water regimes (mean annual runoff, mean monthly flows, flood flows, low flows) for the study areas based on regional and local hydrologic data	B2.11
describe the response of catchments in the study areas to short-duration rainfall events	B2.11
describe the water balance of catchments in the study areas	B2.11
prepare an inventory of all water users based on survey data administered by the social assessment team	B4.1
assess the potential impacts of the project on drainage patterns in the study areas (stream lengths, diversions, re-alignment of streams, etc.)	C2.11
assess the potential impacts of the project on surface water flows (low flows, flood flows, water balance) for both the wet and dry seasons	C2.11
assess the effects of anticipated water withdrawal for the project's use on stream flows under normal and prolonged drought conditions	C2.11
identify potential water use conflicts and propose resolutions	C4.1
provide flow data to the water quality and geochemistry studies to assess the potential impacts of treated effluent discharges, spills and seeps from the mining operations on the receiving stream water quality	C2.11, C2.12
describe a surface water monitoring program for water levels and flows	D3.1.5
describe surface water mitigation options to be considered for implementation should adverse effects be detected	C2.11, D3.1.5
design, where possible, for naturally sustaining watercourses at closure	C2.12, D5
describe predicted hydrological impacts following closure	C2.11, C2.12, C3.1, C3.2, C3.3, C4.1
Water Quality	
describe the baseline water quality of watercourses in the study areas; the description of water quality will consider all appropriate water quality parameters, their seasonal variations and relationships to flow and other controlling factors	B2.12
identify components within each phase of the project that may influence or affect surface water quality	C2.12
assess (using qualitative or quantitative methods) the potential impacts of the project on surface water quality within the study areas; compare the results of the water quality assessment with relevant national (DRC) and international (e.g., world health organization) water quality guidelines	C2.12
describe the proposed mitigation measures to be considered, during the construction, operation and reclamation phases of the project, to maintain surface water quality	C2.12

Terms of Reference	ESIA Section
describe the monitoring program that will be used to identify and monitor project impacts on water quality, justify the selection of monitoring locations, and the integration of these sites into an overall aquatic assessment and monitoring program	D3.1.5
Traffic	
determine existing traffic levels and types of traffic on local roads and railways by means of traffic counts and/or existing data	B2.13
predict changes in traffic as a result of the project	C2.13
assess effects of increased traffic and vibrations on nearby residences	C4.1, C2.9
assess effects of increased traffic on human and livestock safety	C4.1
Flora	
select an appropriate local study area for the flora assessment that includes the footprint of the mine and infrastructure as well as an appropriate buffer	B1, C1
select a suitable RSA for the flora assessment, to allow for an assessment of project-related impacts, within a regional context	B1, C1
map and describe the baseline flora of the study areas in terms of their vegetation communities, including a consideration of structure and species composition	B3.1
inventory each community during the wet season to determine species richness, diversity and relative abundance	B3.1
inventory timber to document commercial value of trees to be affected by the project	B3.1
inventory offsite areas of similar community types that may have similar species assemblages	B3.1
determine the presence of endemic or listed species by study area and community type	B3.1
describe the local use of flora for commercial, traditional and medicinal purposes	B3.1, B4.1
select key indicator species to focus the assessment; provide the selection criteria and rationale for the choice of key species or higher indicator taxa (e.g., orchids)	C3.1
quantitatively assess the adequacy of baseline sampling	B3.1
assess potential impacts to flora through mine activities including site clearing, air and water effects and potential changes in land use due to induced development	C3.1
provide details on any planned mitigation or compensation	C3.1, D3.1.13
contribute revegetation and monitoring components to the reclamation and closure plan	D5
assess residual impacts to vegetation, given the application of mitigation activities	C3.1
prepare vegetation conservation/management plans for the life cycle of the project	D3.1.13
describe and assess floral conditions for the eventual post-closure landscape	C3.1, D5
Fauna	
map vegetation types for the study areas and describe the baseline fauna (including at least birds, mammals, reptiles, amphibians) associated with each vegetation type	B3.2
inventory each vegetation type during the wet season to determine species richness, diversity and relative abundance	B3.2
inventory offsite areas (outside of the proposed mining footprints) of similar community types that may have similar species assemblages	B3.2
determine the presence of endemic or listed species by study area and community type	B3.2
quantitatively assess the adequacy of baseline sampling	B3.2
determine key habitats and movement corridors if possible	B3.2
estimate the nature and extent of the local use of fauna for commercial, traditional and medicinal purposes	B3.2, B4.1

Terms of Reference	ESIA Section
select key indicator species/taxa to focus the assessment; provide the selection criteria and rationale for the choice of key species/taxa	C3.2
assess potential impacts to fauna through mine activities including site clearing, air and water effects and potential changes in land use due to induced development	C3.2
provide details on any planned mitigation or compensation	C3.2, D3.1.14
describe and assess fauna conditions for the eventual post-closure landscape	C3.2, D5
Fish and Aquatic Habitats	
inventory each study area stream reach during the wet season to determine fish species composition (species richness, diversity), relative abundance, distribution, movements, and general life history parameters in those water bodies	B3.3
determine key habitats (critical or sensitive areas such as spawning, rearing, migration corridors)	B3.3
complete an assessment of baseline tissue residue contaminant concentrations (e.g., heavy metals) in fish that reside in the water bodies within the zone of impact of the proposed mine and ancillary infrastructure	B3.3
inventory aquatic resources in addition to fish, including macro-invertebrates and periphyton	B3.3
inventory a regional area (drainages) of similar aquatic community types that may have similar biota for purposes of reference, control or future monitoring	B3.3
determine the presence of endemic or listed species by study area and community type	B3.3
describe the local use of fish resources for subsistence and traditional purposes	B3.3, B4.1
select key indicator species to focus the impact assessment; provide the selection criteria and rationale for the choice of key species	C3.3
assess potential impacts to aquatic resources, including fish and fish habitat, invertebrates, riparian areas, and consumptive fish use, from mining or other related infrastructure activities including site clearing, changes in hydrology, air and water effects and potential changes in land use	C3.3
describe how stream channel alterations, changes to substrate conditions and quality, stream flow alterations, groundwater changes, and water quality alterations may affect fish and fish habitat in the study areas	C3.3
assess potential acute and chronic effects on fish health	C3.3
identify the mechanism, existing source of any tissue contaminants (if present), and provide projections on potential cumulative contamination impacts with key fish species	C3.3
discuss how the project impacts could affect local and regional aquatic biodiversity	C3.3, C3.4
outline mitigation measures to prevent or minimize adverse effects during project construction, operations and closure	C3.3, D3.1.15
identify activities that cannot be mitigated and develop a compensation plan to offset the loss of productive fish habitat	C3.3
describe and assess fish and fish habitat conditions for the eventual post-closure landscape	C3.3, D5
make recommendations regarding any required wet season work	C3.3
identify any aquatic environmental effects monitoring programs that will be initiated by the proponent to identify and manage the effects of the project on aquatic resources and confirm the performance of mitigation measures	C3.3
Natural Habitats and Biodiversity	
describe the current level of disturbance and biodiversity of each natural terrestrial and aquatic vegetation type within the local study area	B3.4

Terms of Reference	ESIA Section
describe each vegetation type's sensitivity to disturbance and ability to be restored	B3.4
determine the status (distribution, abundance, conversion rates) of each vegetation type	B3.4, B3.1
describe landscape characteristics such as habitat connectivity and fragmentation	B3.4
discuss the mitigative and compensatory mechanisms to be used to reduce/offset losses to natural vegetation types	C3.4
discuss if the project has the potential to enhance biodiversity	C3.4
assess residual impacts for both the operations and post-closure phases of the project to natural vegetation types and biodiversity	C3.4
provide details on natural habitat and biodiversity monitoring and management that includes participation of local residents	D3.1.16
Protected Areas	
describe and map project study areas relative to the nearest protected areas such as national parks and reserves, and any proposed protected or special management areas	B3.5
develop mitigation measures if required	C3.5
determine the potential impact of the project on the ecological integrity and economic sustainability (e.g., tourism) of the protected areas	C3.5
Cultural Resources	
describe and map archaeological, historical, religious and natural unique sites within the study areas	B4.2
plan avoidance, recovery or preservation of sites as necessary	C4.2, D4.2
Socio-economics	
review literature and available national, regional and district secondary data to characterize the economic and social context for the project	B4.1
describe the socio-economic status of the directly affected population, including demography, education, economic activities, natural resource use (including land and water), social services and infrastructure, public health, political and social organization, and perceptions of the project	B4.1
describe the socio-economic status of people to be resettled, if needed, including the detail of livelihoods, assets and social organization that will be affected by resettlement, prepare a resettlement action plan to IFC standards	B4.1
use data collection methods appropriate to the required level of detail, including review of existing documentation, stakeholder consultations, key informant interviews, focus group discussions and house to house surveys	B4.1
identify potential negative impacts and benefits to the economy of the DRC, to the directly affected population, and to people to be resettled	C4.1
develop social and economic mitigation and benefit enhancement measures, to be more fully described in the social action plan	C4.1, D2, D4.4, D4.1
assess residual impacts	C4.1
Land Use	
describe and map land use	B4.1
develop mitigation measures and assess residual impacts to land use	C4.1, D4.4
Action Plans	
develop integrated environmental and social management plans addressing interventions to enhance the benefits of the project and mitigate against damage to the biophysical and social environments	D1 to D4

Terms of Reference	ESIA Section
document intervention required during the pre-construction, construction, operations and closure phases of the mine to meet environmental, social and economic and other issue-specific management objectives	D
ensure the safety of the site during and after the mining or quarrying operation	D7
reduce the adverse effects of the mining or quarrying operation on the atmosphere, on water sources and watercourses to an acceptable level	D3.1.3, D3.1.5
harmonize the mine or quarry and the infrastructures with the landscape through appropriate development to protection wildlife and vegetation	D3.1.2, D3.1.13, D3.1.14
reduce erosion, leakage of water or chemicals and irregularities in the landscape resulting from the mining or quarrying operation, as well as its adverse effects on the habitat of wildlife species and local flora	D3.1.1, D3.1.13, D3.1.14
improve the well-being of local populations by implementing economic and social development programs and by providing for compensation of the populations in the event of the displacement of their home	D2, D4.4, D4.1
reduce adverse effects of the mining or quarrying operation such as shock, noise, dust, etc., on the activities of the human and animal populations that live in the surrounding area	D3.13, D3.14
Reclamation and Closure Plan	
develop a conceptual reclamation and mine closure plan as follows: – describe the mine site, regulatory and other requirements and company policy and goals from a closure perspective – develop closure objectives and conceptual reclamation and closure approaches, and indicate the typical measures that TFM must implement during the operational, decommissioning and post-closure periods of mining to achieve its post-closure objectives – guide the progressive development of the closure plan over time – estimate the costs of progressive and final closure – make recommendations for a possible walk-away situation for the mining proponent – formulate and describe the required control and monitoring mechanisms	D5

APPENDIX A-II

TABLE OF CONFORMANCE TO INTERNATIONAL FINANCE CORPORATION (IFC) PERFORMANCE STANDARDS

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006)

Performance Standard	Section of ESIA
1) Social and Environmental Assessment and Management Systems	
1A) The client will establish and maintain a Social and Environmental Management System appropriate to the nature and scale of the project and commensurate with the level of social and environmental risks and impacts. The Management System will incorporate the following elements: (i) Social and Environmental Assessment; (ii) management program; (iii) organizational capacity; (iv) training; (v) community engagement; (vi) monitoring; and (vii) reporting.	environmental and social action plans (D3 and D4)
1B) The client will conduct a process of Social and Environmental Assessment that will consider in an integrated manner the potential social and environmental (including labor, health, and safety) risks and impacts of the project. The Assessment process will be based on current information, including an accurate project description, and appropriate social and environmental baseline data. The Assessment will consider all relevant social and environmental risks and impacts of the project, including the issues identified in Performance Standards 2 through 8, and those who will be affected by such risks and impacts. Applicable laws and regulations of the jurisdictions in which the project operates that pertain to social and environmental matters, including those laws implementing host country obligations under international law, will also be taken into account.	introduction and project description (Volume A), baseline reports (Volume B), social and environmental assessment (Volume C)
1C) Risks and impacts will be analyzed in the context of the project's area of influence. This area of influence encompasses, as appropriate: (i) the primary project site(s) and related facilities that the client (including its contractors) develops or controls , such as power transmission corridors, pipelines, canals, tunnels, relocation and access roads, borrow and disposal areas, construction camps; (ii) associated facilities that are not funded as part of the project (funding may be provided separately by the client or by third parties including the government), and whose viability and existence depend exclusively on the project and whose goods or services are essential for the successful operation of the project; (iii) areas potentially impacted by cumulative impacts from further planned development of the project, any existing project or condition, and other project-related developments that are realistically defined at the time the Social and Environmental Assessment is undertaken; and (iv) areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location. The area of influence does not include potential impacts that would occur without the project or independently of the project.	areas of influence defined in section C1; social and environmental assessment including cumulative impacts assessment in Volume C
1D) Risks and impacts will also be analyzed for the key stages of the project cycle, including preconstruction, construction, operations, and decommissioning or closure. Where relevant, the Assessment will also consider the role and capacity of third parties (such as local and national governments, contractors and suppliers), to the extent that they pose a risk to the project, recognizing that the client should address these risks and impacts commensurate to the client's control and influence over the third party actions. The impacts associated with supply chains will be considered where the resource utilized by the project is ecologically sensitive, or in cases where low labor cost is a factor in the competitiveness of the item supplied. The Assessment will also consider potential transboundary effects, such as pollution of air, or use or pollution of international waterways, as well as global impacts, such as the emission of greenhouse gasses.	social and environmental assessment (Volume C) including major hazards assessment (C2.6), air assessment (C2.8) and water quality assessment (C2.12)
1E) The Assessment will be an adequate, accurate, and objective evaluation and presentation of the issues, prepared by qualified and experienced persons. In projects with significant adverse impacts or where technically complex issues are involved, clients may be required to retain external experts to assist in the Assessment process.	ESIA as a whole; preparer credentials provided in E1

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
1F) Depending on the type of project and the nature and magnitude of its risks and impacts, the Assessment may comprise a full-scale social and environmental impact assessment, a limited or focused environmental or social assessment, or straightforward application of environmental siting, pollution standards, design criteria, or construction standards. When the project involves existing business activities, social and/or environmental audits may need to be performed to determine any areas of concern. The types of issues, risks and impacts to be assessed, and the scope of the community engagement (see rows 1G through 1K below) can also vary considerably, depending on the nature of the project, and its size, location, and stage of development.	full-scale social and environmental assessment is presented (document as a whole)
1G) Projects with potential significant adverse impacts that are diverse, irreversible, or unprecedented will have comprehensive social and environmental impact assessments. This assessment will include an examination of technically and financially feasible alternatives to the source of such impacts, and documentation of the rationale for selecting the particular course of action proposed. In exceptional circumstances, a regional, sectoral or strategic assessment may be required.	project has potential significant adverse impacts; full-scale social and environmental assessment is presented (document as a whole); analysis of alternatives in A3
1H) Narrower scopes of Assessments may be conducted for projects with limited impacts that are few in number, generally site-specific, largely reversible, and readily addressed through mitigation measures.	n/a
1I) Projects with minimal or no adverse impacts will not be subject to further assessment beyond their identification as such.	n/a
1J) As part of the Assessment, the client will identify individuals and groups that may be differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status. Where groups are identified as disadvantaged or vulnerable, the client will propose and implement differentiated measures so that adverse impacts do not fall disproportionately on them and they are not disadvantaged in sharing development benefits and opportunities.	B4.1 and C4.1
1K) Taking into account the relevant findings of the Social and Environmental Assessment and the result of consultation with affected communities, the client will establish and manage a program of mitigation and performance improvement measures and actions that address the identified social and environmental risks and impacts (the management program).	mitigation presented for each component in Volume C and as a unified management program in Volume D

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
1L) Management programs consist of a combination of operational policies, procedures and practices. The program may apply broadly across the client's organization, or to specific sites, facilities, or activities. The measures and actions to address identified impacts and risks will favor the avoidance and prevention of impacts over minimization, mitigation, or compensation, wherever technically and financially feasible. Where risks and impacts cannot be avoided or prevented, mitigation measures and actions will be identified so that the project operates in compliance with applicable laws and regulations, and meets the requirements of Performance Standards 1 through 8 (see row 1N below). The level of detail and complexity of this program and the priority of the identified measures and actions will be commensurate with the project's risks and impacts.	analysis of alternatives to avoid impacts presented in A3; mitigation presented for each component in Volume C and as a unified management program in Volume D
1M) The program will define desired outcomes as measurable events to the extent possible, with elements such as performance indicators, targets, or acceptance criteria that can be tracked over defined time periods, and with estimates of the resources and responsibilities for implementation. Recognizing the dynamic nature of the project development and implementation process, the program will be responsive to changes in project circumstances, unforeseen events, and the results of monitoring (see row 1V below).	indicators defined for impact assessment and monitoring for each discipline in Volume C
1N) Where the client identifies specific mitigation measures and actions necessary for the project to comply with applicable laws and regulations and to meet the requirements of Performance Standards 1 through 8, the client will prepare an Action Plan. These measures and actions will reflect the outcomes of consultation on social and environmental risks and adverse impacts and the proposed measures and actions to address these, consistent with the requirements under row 1S. The Action Plan may range from a brief description of routine mitigation measures to a series of specific plans. The Action Plan will: (i) describe the actions necessary to implement the various sets of mitigation measures or corrective actions to be undertaken; (ii) prioritize these actions; (iii) include the time-line for their implementation; (iv) be disclosed to the affected communities (see row 1X); and (v) describe the schedule and mechanism for external reporting on the client's implementation of the Action Plan.	environmental and social action plans (D3 and D4)
1O) The client will establish, maintain, and strengthen as necessary an organizational structure that defines roles, responsibilities, and authority to implement the management program, including the Action Plan. Specific personnel, including management representative(s), with clear lines of responsibility and authority should be designated. Key social and environmental responsibilities should be well defined and communicated to the relevant personnel and to the rest of the organization. Sufficient management sponsorship and human and financial resources will be provided on an ongoing basis to achieve effective and continuous social and environmental performance.	workforce described in A4.13; organizational structures and roles defined in D3
1P) The client will train employees and contractors with direct responsibility for activities relevant to the project's social and environmental performance so that they have the knowledge and skills necessary to perform their work, including current knowledge of the host country's regulatory requirements and the applicable requirements of Performance Standards 1 through 8. Training will also address the specific measures and actions required under the management program, including the Action Plan, and the methods required to perform the action items in a competent and efficient manner.	training plans described in D3.15

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
1Q) Community engagement is an on-going process involving the client's disclosure of information. When local communities may be affected by risks or adverse impacts from a project, the engagement process will include consultation with them. The purpose of community engagement is to build and maintain over time a constructive relationship with these communities. The nature and frequency of community engagement will reflect the project's risks to and adverse impacts on the affected communities. Community engagement will be free of external manipulation, interference, or coercion, and intimidation, and conducted on the basis of timely, relevant, understandable and accessible information.	A2.4, A2.5, A6, E2 to E7
1R) Disclosure of relevant project information helps affected communities understand the risks, impacts and opportunities of the project. Where the client has undertaken a process of Social and Environmental Assessment, the client will publicly disclose the Assessment document. If communities may be affected by risks or adverse impacts from the project, the client will provide such communities with access to information on the purpose, nature and scale of the project, the duration of proposed project activities, and any risks to and potential impacts on such communities. For projects with adverse social or environmental impacts, disclosure should occur early in the Social and Environmental Assessment process and in any event before the project construction commences, and on an ongoing basis (see row 1X below).	A2.4, A2.5, A6, E2 to E7
1S) If affected communities may be subject to risks or adverse impacts from a project, the client will undertake a process of consultation in a manner that provides the affected communities with opportunities to express their views on project risks, impacts, and mitigation measures, and allows the client to consider and respond to them. Effective consultation: (i) should be based on the prior disclosure of relevant and adequate information, including draft documents and plans; (ii) should begin early in the Social and Environmental Assessment process; (iii) will focus on the social and environmental risks and adverse impacts, and the proposed measures and actions to address these; and (iv) will be carried out on an ongoing basis as risks and impacts arise. The consultation process will be undertaken in a manner that is inclusive and culturally appropriate. The client will tailor its consultation process to the language preferences of the affected communities, their decision-making process, and the needs of disadvantaged or vulnerable groups.	A4.14.3, A2.4 and A6, E2 to E7
1T) For projects with significant adverse impacts on affected communities, the consultation process will ensure their free, prior and informed consultation and facilitate their informed participation. Informed participation involves organized and iterative consultation, leading to the client's incorporating into their decision-making process the views of the affected communities on matters that affect them directly, such as proposed mitigation measures, the sharing of development benefits and opportunities, and implementation issues. The client will document the process, in particular the measures taken to avoid or minimize risks to and adverse impacts on the affected communities.	A2.4 and A6, E2 to E7

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
1U) The client will respond to communities' concerns related to the project. If the client anticipates ongoing risks to or adverse impacts on affected communities, the client will establish a grievance mechanism to receive and facilitate resolution of the affected communities' concerns and grievances about the client's environmental and social performance. The grievance mechanism should be scaled to the risks and adverse impacts of the project. It should address concerns promptly, using an understandable and transparent process that is culturally appropriate and readily accessible to all segments of the affected communities, and at no cost and without retribution. The mechanism should not impede access to judicial or administrative remedies. The client will inform the affected communities about the mechanism in the course of its community engagement process.	A2.4 and A6; grievance mechanism described in D3.18
1V) As an element of its Management System, the client will establish procedures to monitor and measure the effectiveness of the management program. In addition to recording information to track performance and establishing relevant operational controls, the client should use dynamic mechanisms, such as inspections and audits, where relevant, to verify compliance and progress toward the desired outcomes. For projects with significant impacts that are diverse, irreversible, or unprecedented, the client will retain qualified and experienced external experts to verify its monitoring information. The extent of monitoring should be commensurate with the project's risks and impacts and with the project's compliance requirements. Monitoring should be adjusted according to performance experience and feedback. The client will document monitoring results, and identify and reflect the necessary corrective and preventive actions in the amended management program. The client will implement these corrective and preventive actions, and follow up on these actions to ensure their effectiveness.	environmental and social management system (Volume D)
1W) Senior management in the client organization will receive periodic assessments of the effectiveness of the management program, based on systematic data collection and analysis. The scope and frequency of such reporting will depend upon the nature and scope of the activities identified and undertaken in accordance with the client's management program and other applicable project requirements.	environmental and social management system (Volume D)
1X) The client will disclose the Action Plan to the affected communities. In addition, the client will provide periodic reports that describe progress with implementation of the Action Plan on issues that involve ongoing risk to or impacts on affected communities, and on issues that the consultation process or grievance mechanism has identified as of concern to those communities. If the management program results in material changes in, or additions to, the mitigation measures or actions described in the Action Plan on issues of concern to the affected communities, the updated mitigation measures or actions will also be disclosed. These reports will be in a format accessible to the affected communities. The frequency of these reports will be proportionate to the concerns of affected communities but not less than annually.	environmental and social management system (Volume D)
2) Labor and Working Conditions	
2A) The client will adopt a human resources policy appropriate to its size and workforce that sets out its approach to managing employees consistent with the requirements of this Performance Standard. Under the policy, the client will provide employees with information regarding their rights under national labor and employment law, including their rights related to wages and benefits. This policy will be clear and understandable to employees and will be explained or made accessible to each employee upon taking employment.	employee/labor policy referenced in A2.3

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
2B) The client will document and communicate to all employees and workers directly contracted by the client their working conditions and terms of employment, including their entitlement to wages and any benefits.	employee/labor policy referenced in A2.3
2C) Where the client is 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) the client will provide reasonable working conditions and terms of employment that, at a minimum, comply with national law.	employee/labor policy referenced in A2.3
2D) In countries where national law recognizes workers rights to form and to join workers organizations of their choosing without interference and to bargain collectively, the client will comply with national law. Where national law substantially restricts workers organizations, the client will enable alternative means for workers to express their grievances and protect their rights regarding working conditions and terms of employment.	employee/labor policy referenced in A2.3
2E) In either case described in row 2D, and where national law is silent, the client will not discourage workers from forming or joining workers' organizations of their choosing or from bargaining collectively, and will not discriminate or retaliate against workers who participate, or seek to participate, in such organizations and bargain collectively. Clients will engage with such worker representatives. Worker organizations are expected to fairly represent the workers in the workforce.	employee/labor policy referenced in A2.3
2F) The client will not make employment decisions on the basis of personal characteristics unrelated to inherent job requirements. The client will base the employment relationship 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 (including wages and benefits), working conditions and terms of employment, access to training, promotion, termination of employment or retirement, and discipline. In countries where national law provides for nondiscrimination in employment, the client will comply with national law. When national laws are silent on non-discrimination in employment, the client will meet this Performance Standard. 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.	employee/labor policy referenced in A2.3
2G) The client 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 the client's consultation with employees, their organizations and, where appropriate, the government.	C4.1 and D4
2H) The client will provide a grievance mechanism for workers (and their organizations, where they exist) to raise reasonable workplace concerns. The client will inform the workers of the grievance mechanism at the time of hire, and make it easily accessible to them. The mechanism should 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 should 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.	employee/labor policy referenced in A2.3

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
2I) The client will not employ children in a manner that is economically exploitative, or is likely to be hazardous or to interfere with the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development. Where national laws have provisions for the employment of minors, the client will follow those laws applicable to the client. Children below the age of 18 years will not be employed in dangerous work.	employee/labor policy referenced in A2.3
2J) The client will not employ forced labor, 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 labor, such as indentured labor, bonded labor or similar labor-contracting arrangements.	employee/labor policy referenced in A2.3
2K) The client will provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular sector and specific classes of hazards in the client's work areas, including physical, chemical, biological, and radiological hazards. The client 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, the client 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.	safety, health and environment policy referenced in A2.3
2L) For purpose of this Performance Standard, "non-employee workers" refers to workers who are: (i) directly contracted by the client, or contracted through contractors or other intermediaries; and (ii) performing work directly related to core functions essential to the client's products or services for a substantial duration. When the client contracts non-employee workers directly, the client will use commercially reasonable efforts to apply the requirements of this Performance Standard, except for rows 2A, 2G, and 2H. With respect to contractors or other intermediaries procuring non-employee workers, the client will use commercially reasonable efforts to: (i) ascertain that these contractors or intermediaries are reputable and legitimate enterprises; and (ii) require that these contractors or intermediaries apply the requirements of this Performance Standard, except for rows 2A, 2G, and 2H.	contractor management, D3.16
2M) The adverse impacts associated with supply chains will be considered where low labor cost is a factor in the competitiveness of the item supplied. The client will inquire about and address child labor and forced labor in its supply chain, consistent with rows 2I and 2J above.	employee/labor policy referenced in A2.3
3) Pollution Prevention and Abatement	
3A) During the design, construction, operation and decommissioning of the project (the project lifecycle) the client will consider ambient conditions and apply pollution prevention and control technologies and practices (techniques) that are best suited to avoid or, where avoidance is not feasible, minimize or reduce adverse impacts on human health and the environment while remaining technically and financially feasible and cost-effective. The project-specific pollution prevention and control techniques applied during the project life-cycle will be tailored to the hazards and risks associated with project emissions and consistent with good international industry practice, as reflected in various internationally recognized sources, including IFC's Environmental, Health and Safety Guidelines (the EHS Guidelines).	analysis of alternatives, A3; air quality, C2.8; water quality, C2.12; major hazards, A2.6

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
3B) The client will avoid the release of pollutants or, when avoidance is not feasible, minimize or control the intensity or load of their release. This applies to the release of pollutants due to routine, non-routine or accidental circumstances with the potential for local, regional, and transboundary impacts .In addition, the client should examine and incorporate in its operations resource conservation and energy efficiency measures, consistent with the principles of cleaner production.	analysis of alternatives, A3; air quality, C2.8; water quality, C2.12
3C) The client will avoid or minimize the generation of hazardous and non-hazardous waste materials as far as practicable. Where waste generation cannot be avoided but has been minimized, the client will recover and reuse waste; where waste can not be recovered or reused, the client will treat, destroy, and dispose of it in an environmentally sound manner. If the generated waste is considered hazardous, the client will explore commercially reasonable alternatives for its environmentally sound disposal considering the limitations applicable to its transboundary movement. When waste disposal is conducted by third parties, the client will use contractors that are reputable and legitimate enterprises licensed by the relevant regulatory agencies.	D3.8 and D3.9
3D) The client will avoid or, when avoidance is not feasible, minimize or control the release of hazardous materials resulting from their production, transportation, handling, storage and use for project activities. The client will avoid the manufacture, trade, and use of chemicals and hazardous materials subject to international bans or phase-outs due to their high toxicity to living organisms, environmental persistence, potential for bioaccumulation, or potential for depletion of the ozone layer, and consider the use of less hazardous substitutes for such chemicals and materials.	analysis of alternatives, A3; air quality, C2.8; water quality, C2.12; major hazards, A2.6
3E) The client will be prepared to respond to process upset, accidental, and emergency situations in a manner appropriate to the operational risks and the need to prevent their potential negative consequences. This preparation will include a plan that addresses the training, resources, responsibilities, communication, procedures, and other aspects required to effectively respond to emergencies associated with project hazards. Additional requirements on emergency preparedness and response are found in Performance Standard 4.	D7
3F) The client will refer to the current version of the EHS Guidelines when evaluating and selecting pollution prevention and control techniques for the project. These Guidelines contain the performance levels and measures that are normally acceptable and applicable to projects. When host country regulations differ from the levels and measures presented in the EHS Guidelines, clients will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the client will provide full and detailed justification for any proposed alternatives. This justification will demonstrate that the choice for any alternate performance levels is consistent with the overall requirements of this Performance Standard.	air quality, C2.8; water quality, C2.12
3G) To address adverse project impacts on existing ambient conditions, the client will: (i) consider a number of factors, including the finite assimilative capacity of the environment, existing and future land use, existing ambient conditions, the project's proximity to ecologically sensitive or protected areas, and the potential for cumulative impacts with uncertain and irreversible consequences; and (ii) promote strategies that avoid or, where avoidance is not feasible, minimize or reduce the release of pollutants, including strategies that contribute to the improvement of ambient conditions when the project has the potential to constitute a significant source of emissions in an already degraded area. These strategies include, but are not limited to, evaluation of project location alternatives and emissions offsets.	land use, C4.1; protected areas, C3.5; air quality, C2.8; water quality, C2.12; cumulative effects assessment for all disciplines in Volume C

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
3H) The client will promote the reduction of project-related greenhouse gas (GHG) emissions in a manner appropriate to the nature and scale of project operations and impacts.	air quality, C2.8
3I) During the development or operation of projects that are expected to or currently produce significant quantities of GHGs,10 the client will quantify direct emissions from the facilities owned or controlled within the physical project boundary and indirect emissions associated with the off-site production of power used by the project. Quantification and monitoring of GHG emissions will be conducted annually in accordance with internationally recognized methodologies. In addition, the client will evaluate technically and financially feasible and cost-effective options to reduce or offset project-related GHG emissions during the design and operation of the project. These options may include, but are not limited to, carbon financing, energy efficiency improvement, the use of renewable energy sources, alterations of project design, emissions offsets, and the adoption of other mitigation measures such as the reduction of fugitive emissions and the reduction of gas flaring.	air quality, C2.8
3J) The client will formulate and implement an integrated pest management (IPM) and/or integrated vector management (IVM) approach for pest management activities. The client's IPM and IVM program will entail coordinated use of pest and environmental information along with available pest control methods, including cultural practices, biological, genetic and, as a last resort, chemical means to prevent unacceptable levels of pest damage.	D4.4
3K) When pest management activities include the use of pesticides, the client will select pesticides that are low in human toxicity, known to be effective against the target species, and have minimal effects on non-target species and the environment. When the client selects pesticides, the selection will be based on whether the pesticides are packaged in safe containers, are clearly labeled for safe and proper use, and have been manufactured by an entity currently licensed by relevant regulatory agencies.	D4.4
3L) The client will design its pesticide application regime to minimize damage to natural enemies and prevent the development of resistance in pests. In addition, pesticides will be handled, stored, applied, and disposed of in accordance with the Food and Agriculture Organization's International Code of Conduct on the Distribution and Use of Pesticides or other good international industry practice.	D4.4
3M) The client will not use products that fall in World Health Organization Recommended Classification of Pesticides by Hazard Classes Ia (extremely hazardous) and Ib (highly hazardous); or Class II (moderately hazardous), if the project host country lacks restrictions on distribution and use of these chemicals, or if they are likely to be accessible to personnel without proper training, equipment, and facilities to handle, store, apply, and dispose of these products properly.	D4.4
4) Community Health, Safety and Security	
4A) The client will evaluate the risks and impacts to the health and safety of the affected community during the design, construction, operation, and decommissioning of the project and will establish preventive measures to address them in a manner commensurate with the identified risks and impacts. These measures will favor the prevention or avoidance of risks and impacts over minimization and reduction.	C2.6, major hazards and C4.1, socio-economics

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
4B) Where the project poses risks to or adverse impacts on the health and safety of affected communities, the client will disclose the Action Plan and any other relevant project-related information to enable the affected communities and relevant government agencies to understand these risks and impacts, and will engage the affected communities and agencies on an ongoing basis consistent with the requirements of Performance Standard 1.	environmental and social action plans (D3 and D4) will be disclosed; periodic updates to be provided
4C) The client will design, construct, and operate and decommission the structural elements or components of the project in accordance with good international industry practice, and will give particular consideration to potential exposure to natural hazards, especially where the structural elements are accessible to members of the affected community or where their failure could result in injury to the community. Structural elements will be designed and constructed by qualified and experienced professionals, and certified or approved by competent authorities or professionals. When structural elements or components, such as dams, tailings dams, or ash ponds, are situated in high-risk locations, and their failure or malfunction may threaten the safety of communities, the client will engage one or more qualified experts with relevant and recognized experience in similar projects, separate from those responsible for the design and construction, to conduct a review as early as possible in project development and throughout the stages of project design, construction, and commissioning. For projects that operate moving equipment on public roads and other forms of infrastructure, the client will seek to prevent the occurrence of incidents and accidents associated with the operation of such equipment.	C2.6, major hazards and C2.13, traffic
4D) The client will prevent or minimize the potential for community exposure to hazardous materials that may be released by the project. Where there is a potential for the community (including workers and their families) to be exposed to hazards, particularly those that may be life-threatening, the client will exercise special care to avoid or minimize their exposure by modifying, substituting or eliminating the condition or substance causing the hazards. Where hazardous materials are part of existing project infrastructure or components, the client will exercise special care when conducting decommissioning activities in order to prevent exposure to the community. In addition, the client will exercise commercially reasonable efforts to control the safety of deliveries of raw materials and of transportation and disposal of wastes, and will implement measures to avoid or control community exposure to pesticides in accordance with the requirements outlined in Performance Standard 3.	C2.6, major hazards; D3.10, materials management, safety, health and environment, section A2.3
4E) The client will avoid or minimize the exacerbation of impacts caused by natural hazards, such as landslides or floods that could arise from land use changes due to project activities.	C2.6, major hazards
4F) The client will also avoid or minimize adverse impacts due to project activities on soil, water, and other natural resources in use by the affected communities .	C2.4 soil; C2.10 hydrogeology; C2.11 hydrology; C2.12 water quality; C3.1 flora; C3.2 fauna; C3.3 fish and aquatic habitat

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
4G) The client will prevent or minimize the potential for community exposure to water-borne, water based, water-related, vector-borne disease, and other communicable diseases that could result from project activities. Where specific diseases are endemic in communities in the project area of influence, the client is encouraged to explore opportunities during the project life cycle to improve environmental conditions that could help reduce their incidence.	C4.1 socio-economics
4H) The client will assess the potential risks and impacts from project activities and inform affected communities of significant potential hazards in a culturally appropriate manner. The client will also assist and collaborate with the community and the local government agencies in their preparations to respond effectively to emergency situations, especially when their participation and collaboration are necessary to respond to such emergency situations. If local government agencies have little or no capacity to respond effectively, the client will play an active role in preparing for and responding to emergencies associated with the project. The client will document its emergency preparedness and response activities, resources, and responsibilities, and will disclose appropriate information in the Action Plan or other relevant document to affected communities and relevant government agencies.	C2.6, major hazards; D7, emergency response plan
4I) When the client directly retains employees or contractors to provide security to safeguard its personnel and property, it will assess risks to those within and outside the project site posed by its security arrangements. In making such arrangements, the client will be guided by the principles of proportionality, good international practices in terms of hiring, rules of conduct, training, equipping and monitoring of such personnel, and applicable law. The client will make reasonable inquiries to satisfy itself that those providing security are not implicated in past abuses , will train them adequately in the use of force (and where applicable, firearms) and appropriate conduct toward workers and the local community, and require them to act within the applicable law. The client will not sanction any use of force except when used for preventive and defensive purposes in proportion to the nature and extent of the threat. A grievance mechanism should allow the affected community to express concerns about the security arrangements and acts of security personnel.	TFM policies, A2.3
4J) If government security personnel are deployed to provide security services for the client, the client will assess risks arising from such use, communicate its intent that the security personnel act in a manner consistent with paragraph 13 above, and encourage the relevant public authorities to disclose the security arrangements for the client's facilities to the public, subject to overriding security concerns.	community and social issues (A4.14)
4K) The client will investigate any credible allegations of unlawful or abusive acts of security personnel, take action (or urge appropriate parties to take action) to prevent recurrence, and report unlawful and abusive acts to public authorities when appropriate.	community and social issues (A4.14)
5) Land Acquisition and Involuntary Resettlement	
5A) The client will consider feasible alternative project designs to avoid or at least minimize physical or economic displacement, while balancing environmental, social, and financial costs and benefits.	analysis of alternatives (A3)

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
5B) When displacement cannot be avoided, the client will offer displaced persons and communities' compensation for loss of assets at full replacement cost and other assistance to help them improve or at least restore their standards of living or livelihoods, as provided in this Performance Standard. Standards for compensation will be transparent and consistent within the project. Where livelihoods of displaced persons are land-based, or where land is collectively owned, the client will offer land based compensation, where feasible. The client will provide opportunities to displaced persons and communities to derive appropriate development benefits from the project.	resettlement plan (D4.3)
5C) Following disclosure of all relevant information, the client will consult with and facilitate the informed participation of affected persons and communities, including host communities, in decision making processes related to resettlement. Consultation will continue during the implementation, monitoring, and evaluation of compensation payment and resettlement to achieve outcomes that are consistent with the objectives of this Performance Standard.	resettlement plan (D4.3)
5D) The client will establish a grievance mechanism consistent with Performance Standard 1 to receive and address specific concerns about compensation and relocation that are raised by displaced persons or members of host communities, including a recourse mechanism designed to resolve disputes in an impartial manner.	D3.18
5E) Where involuntary resettlement is unavoidable, the client will carry out a census with appropriate socio-economic baseline data to identify the persons who will be displaced by the project, to determine who will be eligible for compensation and assistance, and to discourage inflow of people who are ineligible for these benefits. In the absence of host government procedures, the client will establish a cut-off date for eligibility. Information regarding the cut-off date will be well documented and disseminated throughout the project area.	resettlement plan (D4.3)
5F) In the case of Type I transactions (acquisition of land rights through the exercise of eminent domain) or Type II transactions (negotiated settlements) that involve the physical displacement of people, the client will develop a resettlement action plan or a resettlement framework based on a Social and Environmental Assessment that covers, at a minimum, the applicable requirements of this Performance Standard regardless of the number of people affected. The plan or framework will be designed to mitigate the negative impacts of displacement, identify development opportunities, and establish the entitlements of all categories of affected persons (including host communities), with particular attention paid to the needs of the poor and the vulnerable (see Performance Standard 1). The client will document all transactions to acquire land rights, as well as compensation measures and relocation activities. The client will also establish procedures to monitor and evaluate the implementation of resettlement plans and take corrective action as necessary. A resettlement will be considered complete when the adverse impacts of resettlement have been addressed in a manner that is consistent with the objectives stated in the resettlement plan or framework as well as the objectives of this Performance Standard.	resettlement plan (D4.3)

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
5G) In the case of Type II transactions (negotiated settlements) involving economic (but not physical) displacement of people, the client will develop procedures to offer to the affected persons and communities compensation and other assistance that meet the objectives of this Performance Standard. The procedures will establish the entitlements of affected persons or communities and will ensure that these are provided in a transparent, consistent, and equitable manner. The implementation of the procedures will be considered complete when affected persons or communities have received compensation and other assistance according to the requirements of this Performance Standard. In cases where affected persons reject compensation offers that meet the requirements of this Performance Standard and, as a result, expropriation or other legal procedures are initiated, the client will explore opportunities to collaborate with the responsible government agency, and if permitted by the agency, play an active role in the resettlement planning, implementation, and monitoring.	resettlement plan (D4.3)
5H) Displaced persons may be classified as persons: (i) who have formal legal rights to the land they occupy; (ii) who do not have formal legal rights to land, but have a claim to land that is recognized or recognizable under the national laws; or (iii) who have no recognizable legal right or claim to the land they occupy. The census will establish the status of the displaced persons.	socio-economic baseline B4.1, resettlement plan D4.3
5I) Land acquisition for the project may result in the physical displacement of people as well as their economic displacement. As a result, requirements for both physical displacement and economic displacement may apply.	resettlement plan (D4.3)
5J) If people living in the project area must move to another location, the client will: (i) offer displaced persons choices among feasible resettlement options, including adequate replacement housing or cash compensation where appropriate; and (ii) provide relocation assistance suited to the needs of each group of displaced persons, with particular attention paid to the needs of the poor and the vulnerable. Alternative housing and/or cash compensation will be made available prior to relocation. New resettlement sites built for displaced persons will offer improved living conditions.	resettlement plan (D4.3)
5K) In the case of physically displaced persons under row 5H (i) or (ii), the client will offer the choice of replacement property of equal or higher value, equivalent or better characteristics and advantages of location, or cash compensation at full replacement value where appropriate.	resettlement plan (D4.3)
5L) In the case of physically displaced persons under row 5H (iii), the client will offer them a choice of options for adequate housing with security of tenure so that they can resettle legally without having to face the risk of forced eviction. Where these displaced persons own and occupy structures, the client will compensate them for the loss of assets other than land, such as dwellings and other improvements to the land, at full replacement cost, provided that these people occupy the project area prior to the cut-off date for eligibility. Compensation in kind will be offered in lieu of cash compensation where feasible. Based on consultation with such displaced persons, the client will provide relocation assistance sufficient for them to restore their standards of living at an adequate alternative site. The client is not required to compensate or assist those who encroach on the project area after the cut-off date.	resettlement plan (D4.3)
5M) Where communities of Indigenous Peoples are to be physically displaced from their communally held traditional or customary lands under use, the client will meet the applicable requirements of this Performance Standard, as well as those of Performance Standard 7.	resettlement plan (D4.3)

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
5N) If land acquisition for the project causes loss of income or livelihood, regardless of whether or not the affected people are physically displaced, the client will meet the following requirements: -Promptly compensate economically displaced persons for loss of assets or access to assets at full replacement cost. -In cases where land acquisition affects commercial structures, compensate the affected business owner for the cost of reestablishing commercial activities elsewhere, for lost net income during the period of transition, and for the costs of the transfer and reinstallation of the plant, machinery or other equipment. -Provide replacement property (e.g., agricultural or commercial sites) of equal or greater value, or cash compensation at full replacement cost where appropriate, to persons with legal rights or claims to land which are recognized or recognizable under the national laws (see row 5H (i) and (ii)). -Compensate economically displaced persons who are without legally recognizable claims to land (see row 5H (iii)) for lost assets (such as crops, irrigation infrastructure and other improvements made to the land) other than land, at full replacement cost. The client is not required to compensate or assist opportunistic settlers who encroach on the project area after the cut-off date. -Provide additional targeted assistance (e.g., credit facilities, training, or job opportunities) and opportunities to improve or at least restore their income-earning capacity, production levels, and standards of living to economically displaced persons whose livelihoods or income levels are adversely affected. -Provide transitional support to economically displaced persons, as necessary, based on a reasonable estimate of the time required to restore their income earning capacity, production levels, and standards of living.	resettlement plan (D4.3)
5O) Where communities of Indigenous Peoples are economically displaced (but not relocated) as a result of project-related land acquisition, the client will meet the applicable requirements of this Performance Standard, as well as those of Performance Standard 7.	resettlement plan (D4.3)
5P) Where land acquisition and resettlement are the responsibility of the host government, the client will collaborate with the responsible government agency, to the extent permitted by the agency, to achieve outcomes that are consistent with the objectives of this Performance Standard. In addition, where government capacity is limited, the client will play an active role during resettlement planning, implementation and monitoring, as described below in rows 5Q through 5S.	n/a
5Q) In the case of Type I transactions (acquisition of land rights through expropriation or other legal procedures) involving physical or economic displacement, and Type II transactions (negotiated settlements) involving physical displacement, the client will prepare a plan (or a framework) that, together with the documents prepared by the responsible government agency, will address the relevant requirements of this Performance Standard (the General Requirements, except for row 5G, and requirements for Physical Displacement and Economic Displacement above). The client may need to include in its plan: (i) a description of the entitlements of displaced persons provided under applicable laws and regulations; (ii) the measures proposed to bridge any gaps between such entitlements and the requirements of this Performance Standard; and (iii) the financial and implementation responsibilities of the government agency and/or the client.	resettlement plan (D4.3)

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
5R) In the case of Type II transactions (negotiated settlements) involving economic (but not physical) displacement, the client will identify and describe the procedures that the responsible government agency plans to use to compensate affected persons and communities. If these procedures do not meet the relevant requirements of this Performance Standard (the General Requirements, except for row 5H, and requirements for Economic Displacement above), the client will develop its own procedures to supplement government action.	resettlement plan (D4.3)
5S) If permitted by the responsible government agency, the client will, in collaboration with such agency: (i) implement its plan or procedures established in accordance with rows 5Q or 5R above; and (ii) monitor resettlement activity that is undertaken by the government agency until such activity has been completed.	n/a
6) Biodiversity Conservation and Sustainable Natural Resource Management	
6A) In order to avoid or minimize adverse impacts to biodiversity in the project's area of influence (see Performance Standard 1), the client will assess the significance of project impacts on all levels of biodiversity as an integral part of the Social and Environmental Assessment process. The Assessment will take into account the differing values attached to biodiversity by specific stakeholders, as well as identify impacts on ecosystem services. The Assessment will focus on the major threats to biodiversity, which include habitat destruction and invasive alien species. When requirements of rows 6F, G and H apply, the client will retain qualified and experienced external experts to assist in conducting the Assessment.	B3 (biological baseline) and C3 (biological impact assessment), especially B3.4, C3.4 and D3 address impacts on biodiversity Appendices D3.1-I and D3.1II
6B) Habitat destruction is recognized as the major threat to the maintenance of biodiversity. Habitats can be divided into natural habitats (which are land and water areas where the biological communities are formed largely by native plant and animal species, and where human activity has not essentially modified the area's primary ecological functions) and modified habitats (where there has been apparent alteration of the natural habitat, often with the introduction of alien species of plants and animals, such as agricultural areas). Both types of habitat can support important biodiversity at all levels, including endemic or threatened species.	C3
6C) In areas of modified habitat, the client will exercise care to minimize any conversion or degradation of such habitat, and will, depending on the nature and scale of the project, identify opportunities to enhance habitat and protect and conserve biodiversity as part of their operations.	C3
6D) In areas of natural habitat, the client will not significantly convert or degrade such habitat, unless the following conditions are met: -There are no technically and financially feasible alternatives. -The overall benefits of the project outweigh the costs, including those to the environment and biodiversity. -Any conversion or degradation is appropriately mitigated.	A3 (analysis of alternatives) and C3 (biological impact assessment)

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
6E) Mitigation measures will be designed to achieve no net loss of biodiversity where feasible, and may include a combination of actions, such as: -Post-operation restoration of habitats. -Offset of losses through the creation of ecologically comparable area(s) that is managed for biodiversity. -Compensation to direct users of biodiversity.	C3.4 (biodiversity impact assessment) and C4.1 (assessment for direct users of biodiversity)
6F) Critical habitat is a subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic or cultural importance to local communities.	C3 (biological impact assessment), especially C3.4, C3.5, D3 and Appendices D3.1-I and D3.1-II
6G) In areas of critical habitat, the client will not implement any project activities unless the following requirements are met: -There are no measurable adverse impacts on the ability of the critical habitat to support the established population of species described in row 6F or the functions of the critical habitat described in row 6F. -There is no reduction in the population of any recognized critically endangered or endangered species. -Any lesser impacts are mitigated in accordance with row 6E.	C3.1 (flora) and C3.2 (fauna) Appendices D3.1-I and D3.1-II
6H) In circumstances where a proposed project is located within a legally protected area, the client, in addition to the applicable requirements of row 6G above, will meet the following requirements : -Act in a manner consistent with defined protected area management plans. -Consult protected area sponsors and managers, local communities, and other key stakeholders on the proposed project. -Implement additional programs, as appropriate, to promote and enhance the conservation aims of the protected area.	n/a (refer to section C3.5, protected areas)
6I) Intentional or accidental introduction of alien, or non-native, species of flora and fauna into areas where they are not normally found can be a significant threat to biodiversity, since some alien species can become invasive, spreading rapidly and out-competing native species.	C3.1 (flora) and C3.2 (fauna)
6J) The client will not intentionally introduce any new alien species (not currently established in the country or region of the project) unless this is carried out in accordance with the existing regulatory framework for such introduction, if such framework is present, or is subject to a risk assessment (as part of the client's Social and Environmental Assessment) to determine the potential for invasive behavior. The client will not deliberately introduce any alien species with a high risk of invasive behavior or any known invasive species, and will exercise diligence to prevent accidental or unintended introductions.	C3.1 (flora), C3.2 (fauna), and D5 (reclamation and closure plan)

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
6K) The client will manage renewable natural resources in a sustainable manner. Where possible, the client will demonstrate the sustainable management of the resources through an appropriate system of independent certification.	n/a
6L) In particular, forests and aquatic systems are principal providers of natural resources, and need to be managed as specified below.	C3.1 (flora) and C3.3 (aquatic habitats)
6M) Clients involved in natural forest harvesting or plantation development will not cause any conversion or degradation of critical habitat. Where feasible, the client will locate plantation projects on unforested land or land already converted (excluding land that is converted in anticipation of the project). In addition, the client will ensure that all natural forests and plantations over which they have management control are independently certified as meeting performance standards compatible with internationally accepted principles and criteria for sustainable forest management. Where a pre-assessment determines that the operation does not yet meet the requirements of such an independent forest certification system, the client will develop and adhere to a time-bound, phased action plan for achieving such certification.	C3.1 in relation to agroforestry program
6N) Clients involved in the production and harvesting of fish populations or other aquatic species must demonstrate that their activities are being undertaken in a sustainable manner, through application of an internationally accepted system of independent certification, if available, or through appropriate studies carried out in conjunction with the Social and Environmental Assessment process.	n/a
7) Indigenous Peoples	
7A) No indigenous peoples are present in the concession.	
8) Cultural Heritage	
8A) In addition to complying with relevant national law on the protection of cultural heritage, including national law implementing the host country's obligations under the Convention Concerning the Protection of the World Cultural and Natural Heritage and other relevant international law, the client will protect and support cultural heritage by undertaking internationally recognized practices for the protection, field-based study, and documentation of cultural heritage. If the requirements of row 8D, E, F, G, or H apply, the client will retain qualified and experienced experts to assist in the Assessment.	C4.2, D4.2
8B) The client is responsible for siting and designing a project to avoid significant damage to cultural heritage. When the proposed location of a project is in areas where cultural heritage is expected to be found, either during construction or operations, the client will implement chance find procedures established through the Social and Environmental Assessment. The client will not disturb any chance finds further until an Assessment by a competent specialist is made and actions consistent with the requirements of this Performance Standard are identified.	C4.2, D4.2

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
8C) Where a project may affect cultural heritage, the client will consult with affected communities within the host country who use, or have used within living memory, the cultural heritage for longstanding cultural purposes to identify cultural heritage of importance, and to incorporate into the client's decision-making process the views of the affected communities on such cultural heritage. Consultation will also involve the relevant national or local regulatory agencies that are entrusted with the protection of cultural heritage.	C4.2, D4.2
8D) Most cultural heritage is best protected by preservation in its place, since removal is likely to result in irreparable damage or destruction of the cultural heritage. The client will not remove any cultural heritage, unless the following conditions are met: -There are no technically or financially feasible alternatives to removal. -The overall benefits of the project outweigh the anticipated cultural heritage loss from removal. -Any removal of cultural heritage is conducted by the best available technique.	C4.2, D4.2
8E) Critical cultural heritage consists of (i) the internationally recognized heritage of communities who use, or have used within living memory the cultural heritage for long-standing cultural purposes; and (ii) legally protected cultural heritage areas, including those proposed by host governments for such designation.	C4.2, D4.2
8F) The client will not significantly alter, damage, or remove any critical cultural heritage. In exceptional circumstances , where a project may significantly damage critical cultural heritage, and its damage or loss may endanger the cultural or economic survival of communities within the host country who use the cultural heritage for long-standing cultural purposes , the client will: (i) meet the requirements of Paragraph 6 above; and (ii) conduct a good faith negotiation with and document the informed participation of the affected communities and the successful outcome of the negotiation. In addition, any other impacts on critical cultural heritage must be appropriately mitigated with the informed participation of the affected communities.	C4.2, D4.2
8G) Legally protected cultural heritage areas are important for the protection and conservation of cultural heritage, and additional measures are needed for any projects that would be permitted under the applicable national laws in these areas. In circumstances where a proposed project is located within a legally protected area or a legally defined buffer zone, the client, in addition to the requirements for critical cultural heritage cited above in row 8F, will meet the following requirements : -Comply with defined national or local cultural heritage regulations or the protected area management plans. -Consult the protected area sponsors and managers, local communities and other key stakeholders on the proposed project. -Implement additional programs, as appropriate, to promote and enhance the conservation aims of the protected area.	n/a (see C3.5)

Table 1 Tenke Fungurume Mine Project Conformity Table for IFC Performance Standards (2006) (continued)

Performance Standard	Section of ESIA
8H) Where a project proposes to use the cultural resources, knowledge, innovations, or practices of local communities embodying traditional lifestyles for commercial purposes, the client will inform these communities of: (i) their rights under national law; (ii) the scope and nature of the proposed commercial development; and (iii) the potential consequences of such development. The client will not proceed with such commercialization unless it: (i) enters into a good faith negotiation with the affected local communities embodying traditional lifestyles; (ii) documents their informed participation and the successful outcome of the negotiation; and (iii) provides for fair and equitable sharing of benefits from commercialization of such knowledge, innovation, or practice, consistent with their customs and traditions.	n/a

APPENDIX A-III

AIR QUALITY GUIDELINE TABLES

Table 1 Air Quality Guideline References

Sulfur Dioxide	[µg/m^3]	Reference
24-hr	125	World Health Organization Regional Office for Europe, Copenhagen – "Air Quality Guidelines for Europe Second Edition, 2000", Chapter 3, Table 2: Guideline values for individual substances based on effects other than cancer or odour/annoyance.
	365	The Code of Federal Regulations (CFR) Title 40, Protection of Environment, Sec. 50.4 National primary ambient air quality standards for sulfur oxides (sulfur dioxide). – U.S Environmental Protection Agency (EPA) (http://www.epa.gov/air/criteria.html).
	500	"World Bank Environment, Health and Safety Guidelines, Mining and Milling – Open Pit, August 11, 1995" DRC. 2003. Mining Regulations, Annex IX, Table 3.
annual	50	World Health Organization Regional Office for Europe, Copenhagen – "Air Quality Guidelines for Europe Second Edition, 2000", Chapter 3, Table2: Guideline values for individual substances based on effects other than cancer or odour/annoyance.
	100	"World Bank Environment, Health and Safety Guidelines, Mining and Milling – Open Pit, August 11, 1995" DRC. 2003. Mining Regulations, Annex IX, Table 3.
Nitrogen Dioxide	**[µg/m^3]**	**Reference**
24-hr	40	World Health Organization Regional Office for Europe, Copenhagen – "Air Quality Guidelines for Europe Second Edition, 2000", Chapter 3, Table2: Guideline values for individual substances based on effects other than cancer or odour/annoyance.
	100	"World Bank Environment, Health and Safety Guidelines, Mining and Milling – Open Pit, August 11, 1995" DRC. 2003. Mining Regulations, Annex IX, Table 3. The Code of Federal Regulations (CFR) Title 40, Protection of Environment, Sec. 50.11 National primary and secondary ambient air quality standards for nitrogen dioxide – U.S Environmental Protection Agency (EPA) (http://www.epa.gov/air/criteria.html).
	200	"World Bank Environment, Health and Safety Guidelines, Mining and Milling – Open Pit, August 11, 1995" DRC. 2003 Mining Regulations, Annex IX, Table 3.
annual	100	"World Bank Environment, Health and Safety Guidelines, Mining and Milling – Open Pit, August 11, 1995" DRC. 2003b. Mining Regulations, Annex IX, Table 3. The Code of Federal Regulations (CFR) Title 40, Protection of Environment, Sec. 50.11 National primary and secondary ambient air quality standards for nitrogen dioxide – U.S Environmental Protection Agency (EPA) (http://www.epa.gov/air/criteria.html).

Table 1 Air Quality Guideline References (continued)

PM10	[μg/m³]	Reference
24-hr	150	The Code of Federal Regulations (CFR) Title 40, Protection of Environment, Sec. 50.6 National primary and secondary ambient air quality standards for PM10. – U.S Environmental Protection Agency (EPA) (http://www.epa.gov/air/criteria.html).
	500	"World Bank Environment, Health and Safety Guidelines, Mining and Milling – Open Pit, August 11, 1995" DRC. 2003. Mining Regulations, Annex IX, Table 3.
annual	50	The Code of Federal Regulations (CFR) Title 40, Protection of Environment, Sec. 50.6 National primary and secondary ambient air quality standards for PM10. – U.S Environmental Protection Agency (EPA) (http://www.epa.gov/air/criteria.html).
	100	"World Bank Environment, Health and Safety Guidelines, Mining and Milling – Open Pit, August 11, 1995" DRC. 2003. Mining Regulations, Annex IX, Table 3.
Carbon Monoxide	**[μg/m³]**	**Reference**
1-hr	40,000	The Code of Federal Regulations (CFR) Title 40, Protection of Environment, Sec. 50.8 National primary ambient air quality standards for carbon monoxide. – U.S Environmental Protection Agency (EPA) (http://www.epa.gov/air/criteria.html).
8-hr	10,000	The Code of Federal Regulations (CFR) Title 40, Protection of Environment, Sec. 50.8 National primary ambient air quality standards for carbon monoxide. – U.S Environmental Protection Agency (EPA) (http://www.epa.gov/air/criteria.html).
Lead	**[μg/m³]**	**Reference**
quarterly average period	1.5	The Code of Federal Regulations (CFR) Title 40, Protection of Environment, Sec. 50.12 National primary and secondary ambient air quality standards for lead. – U.S Environmental Protection Agency (EPA) (http://www.epa.gov/air/criteria.html).
annual	0.5	World Health Organization Regional Office for Europe, Copenhagen – "Air Quality Guidelines for Europe Second Edition, 2000", Chapter 3, Table2: Guideline values for individual substances based on effects other than cancer or odour/annoyance.

APPENDIX A-IV

ANALYSIS OF ALTERNATIVES DATA TABLES

Table 1 Scoring for the Alternative Operational Configurations

1.3-1 Operations Configuration Analysis				28-Jun-06	1- Fungurume-Fungurume							2 - Kwatebala-Fungurume							3-Kwatebala-Kwatebala						
		Weighting			Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)		Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)		Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)	
Issue	Description	Total Weight	Weight	Notes on Weight	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score
ENVIRONMENTAL		33						26.0		27.6					26.0		27.6					26.0		27.6	
Noise	noise and vibrations		10	Noise and vibrations can affect residents. Vibrations noted as a concern during consultation	10	Short Haul road length but road and plant site close to Fungurume	100		78.8		83.6	3	Long haul road length	30		23.6		25.1	7	Long access road length but traffic would not include ore trucks	70		55.2		58.5
Air Quality	emissions and dust		10	Dust from road traffic can be a nuisance to residents, but it can be mitigated	10	Short Haul road length but road and plant site close to Fungurume	100		78.8		83.6	3	Long haul road length	30		23.6		25.1	7	Long access road length but traffic would not include ore trucks	70		55.2		58.5
			0		0		0		0.0		0.0	0		0		0.0		0.0	0		0		0.0		0.0
Surface water quality	potential for spills, and dust, at creek crossings		3	Potential for spills is low; dust can be mitigated for.	10	Short Haul road length, fewer crossings	30		23.6		25.1	6	Long haul road length, more crossings	18		14.2		15.1	6	Long haul road length, more crossings	18		14.2		15.1
Natural habitats	Minimize clearing of woodland and copper-cobalt flora, wetlands		6	Loss of natural habitats is not a large concern given the degraded nature of the concession	10	Small footprint; short road and most of plant area already disturbed	60		47.3		50.2	3	Greatest footprint; long road and area of mine in less disturbed Kwatebala area	18		14.2		15.1	3	Greatest footprint; long road and area of mine in less disturbed Kwatebala area	18		14.2		15.1
Biodiversity	Fragmentation effects. Better to use existing roads.		4	Fragmentation not a large concern due to current and potential future (even without project) land clearing.	10	Small footprint; short road and most of plant area already disturbed	40		31.5		33.5	3	Greatest footprint; long road and area of mine in less disturbed Kwatebala area	12		9.5		10.0	3	Greatest footprint; long road and area of mine in less disturbed Kwatebala area	12		9.5		10.0
SOCIAL		31						26.0		27.6					26.0		27.6					26.0		27.6	
Land use	effects to agricultural lands		10	Loss of farmland is a concern to local residents	7	Impacts about 1,033 ha agricultural land	70		58.7		62.3	5	Impacts about 1,240 ha agricultural land	50		41.9		44.5	10	Affects least agricultural land	100		83.9		89.0
Relocation	relocation of houses		10	Relocation may be necessary to widen road and to replace farmland	5	Relocates most residences (740)	50		41.9		44.5	10	Relocates 390 residences	100		83.9		89.0	10	Relocates 390 residences	100		83.9		89.0
Public safety	avoid towns and built up areas		10	Human-vehicle collisions are likely in built up areas. Assumes bike trail built to parallel whatever road route is selected.	10	Shorter haul road but road close to Fungurume	100		83.9		89.0	4	Longest haul route	40		33.5		35.6	10	Long access road length but traffic would not include ore trucks	100		83.9		89.0
Cultural Resources	loss of cultural resources		1	Cultural resources are primarily in valley bottoms and can be mitigated for.	10	Low anticipated effects	10		8.4		8.9	10	Low anticipated effects	10		8.4		8.9	10	Low anticipated effects	10		8.4		8.9
TECHNICAL		14						26.0		18.4					26.0		18.4					26.0		18.4	
Cost	Development cost relates to feasibility of project		10	Construction and transport cost over the life of the mine is important	2	Highest cost estimated for construction and mitigation	20		37.1		26.3	4	Midrange to high cost estimated for construction and mitigation	40		74.3		52.6	10	Lowest cost estimated for construction and mitigation	100		185.7		131.4
Terrain	Terrain can influence cost of construction and erodibility of road surface		4	Terrain may require more road maintenance, which can be costly	10	Plant/Road in good areas but include valley bottoms, some side slopes	40		74.3		52.6	6	Longest road - potential for more terrain issues	24		44.6		31.5	4	Longest road - potential for more terrain issues. Land at plant area slopes to north and west.	16		29.7		21.0
SUSTAINABILITY		14								18.4							18.4							18.4	
Length of associated road	Emissions related to total length		4	Emissions a concern but not overriding	10	short road	40		n/a		52.6	5	longest road	20		n/a		26.3	5	longest road	20		n/a		26.3
Conversion to uses post closure	Usefulness for local communities post-closure		10	Use of roads at closure would benefit local communities	6	Road upgrades will be of benefit to some local residents	60		n/a		78.9	10	Longer road has potential to benefit more people in long term	100		n/a		131.4	10	Longer road has potential to benefit more people in long term	100		n/a		131.4
Total							720		564.3		691.1			492		371.7		510.2			734		623.5		743.4

Notes: Env. = Environment
Sust. = Sustainability
Soc. = Social
Tec. = Technical
n/a = Not applicable

Table 2 Scoring for the Alternative Waste Rock Facility Locations

Waste Rock Facility					Option 1							Option 2							Option 3						
Issue	Description	Weighting		Notes on Weight	Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)		Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)		Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)	
		Total Weight	Weight		Option 1	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score
ENVIRONMENTAL		39						37.0		39.9					37.0		39.9					37.0		39.9	
air quality	effects of dust (from traffic on haul roads) on nearby receptor communities (Koboko, Ndela 1)		10	air effects considered to be a major issue due to proximity to villages; DRC and International Finance Corporation (IFC) standards may not be met	5	intermediate haul road distance; intermediate distance to nearby communtiies	50		47.4		51.2	10	least total haul road distance; furthest from communities	100		94.9		102.3	1	most haul road distance; closer to more communties than options 1 or 2	10		9.5		10.2
noise	effects of noise (mainly from haul trucks) on nearby receptor communities (Koboko, Ndela 1)		10	noise effects considered to be a major issue due to proximity to villages; DRC and IFC standards may not be met	5	intermediate haul road distance; intermediate distance to nearby communtiies	50		47.4		51.2	10	least total haul road distance; furthest from communities	100		94.9		102.3	1	most haul road distance; closer to more communties than options 1 or 2	10		9.5		10.2
surface disturbance	effect on total footpriint		7	keep footprint to a minimum	4	footprint (399 ha) much greater than Option 2 but somewhat less than Option 3	28		26.6		28.6	10	least total footprint at 232 ha	70		66.4		71.6	1	greatest total footprint at 445 ha	7		6.6		7.2
surface water quantity	effect on surface water quantity (flows)		5	related to number and type of existing drainages within footprint	7	overlaps with a couple more drainages than Option 2	35		33.2		35.8	10	overlaps with least number of drainages	50		47.4		51.2	1	overlaps with the most number of drainages	5		4.7		5.1
surface water quality	downstream effects (e.g., of dust) on surface water quality		3	dust can be mitigated for	9	affects more drainages than Option 2 but not as many as Option 3. Intermediate haul road distances. Would affect same downstream communities as Option 2.	27		25.6		27.6	10	affects least number of drainages. Least total haul road distance. Mwanga Muteba is about 1.5 km downstream	30		28.5		30.7	1	affects most number of drainages. Greatest haul road distances. Greatest number of downstream communities, including Mwanga Muteba and others further away on different drainages	3		2.8		3.1
natural habitats	loss or alteration of sensitive habitats (Miombo, riparian, wetland, Copper-cobalt flora)		2	not a large concern given the already degraded nature of the concession	8	would affect slightly more miombo woodland than Option 2 but much less than Option 3 (29.2 ha)	16		15.2		16.4	10	would affect least amount of miombo woodland (25.2 ha)	20		19.0		20.5	1	would affect greatest amount of miombo woodland (70.5 ha)	2		1.9		2.0
biodiversity	loss of terrestrial or aquatic biodiversity		2	not a large concern	7	would affect slightly more miombo woodland than Option 2 (29.2 ha) and intermediate amount of riparian areas.	14		13.3		14.3	10	would affect least amount of miombo woodland (25.2 ha) and least number of riparian areas	20		19.0		20.5	1	would affect greatest amount of miombo woodland (70.5 ha) and the most riparian areas	2		1.9		2.0
SOCIAL		36						37.0		39.9					37.0		39.9					37.0		39.9	
land use	loss of agricultural lands		10	farmland in region is important to local residents; soil capability similar among all options	3	would affect much more agricultural area (370 ha) than Option 1 and almost as much as Option 3	30		30.8		33.3	10	would affect the least amount of agricultural area (207 ha)	100		102.8		110.8	1	would affect the most agricultural area (375 ha)	10		10.3		11.1
relocation	requirement to resettle people due to air or noise emissions or loss of agricultural land		10	relocation should only be considered as a last resort	1	requires relocation of Mulumbu residents	10		10.3		11.1	1	requires relocation of Mulumbu residents	10		10.3		11.1	1	requires relocation of Mulumbu, may require relocation of Kiboko and/or Ndela 1 residents	10		10.3		11.1
public safety	traffic - human interaction		10	traffic-related human mortality/injury can be high	5	intermediate haul road distance; intermediate distance from communities	50		51.4		55.4	10	requires least haul road distance; furthest from nearby communities	100		102.8		110.8	1	greatest haul road distances; close to more communities than options 1 or 2	10		10.3		11.1
cultural resources	loss of archaeological resources, cultural sites		2	sites in the Kwatebala/Goma area are few; can be mitigated	4	less footprint than Option 3 but much more than Option 2; intermediate no. of streams/rivers affected	8		8.2		8.9	10	least footprint area and least number of streams/rivers affected	20		20.6		22.2	1	greatest footprint area, and overlaps with most rivers/streams, which can have high cultural potential	2		2.1		2.2
visual impact	visual impact on the landscape		4	visual impact is important to some people	5	overall intermediate footprint; intermediate distance to communities; therefore intermediate visual impact	20		20.6		22.2	10	overall least visual impact because least footprint, although waste rock would be stacked higher, it is further from nearby communties than Option 1	40		41.1		44.3	1	overall greatest visual impact because total of 3 sites affected (most footprint), and closer to more communties	4		4.1		4.4
TECHNICAL		36						37.0		26.6					37.0		26.6					37.0		26.6	
ore condemnation	potential for growth center to overlie mineable ore		10	mineable ore should be used.	10	site not underlain by mineable ore (outside of central zone which is underlain by high grade copper ore)	100		102.8		73.9	10	site not underlain by mineable ore (outside of central zone which is underlain by high grade copper ore)	100		102.8		73.9	1	approximately 50% of eastern dump area is within Central Zone (underlain by high-grade copper ore)	10		10.3		7.4
area of slopes	amount of outside edges or slopes affects erosion potential, reclamation costs, etc.		10	less slope area preferred	10	least amount of out slopes	100		102.8		73.9	1	has significantly more out slopes than Options 1 or 3	10		10.3		7.4	7	slopes as Option 1, but more area involved.	70		71.9		51.7
horizontal haulage requirements	haul road distances related to fuel costs, truck hours, etc.		8	less haul road length preferred; related to cost	6	intermediate horizontal hauling distance, but closer to Option 2 than to Option 3	48		49.3		35.5	10	least amount of horizontal hauling distance	80		82.2		59.1	1	greatest horizontal hauling distances	8		8.2		5.9
vertical hauling requirements	height of waste rock facility related to fuel costs, truck hours etc.		8	prefer less vertical haul distances; related to cost	5	intermediate vertical hauling distance; north dump would still be stacked, but not as high as Option 2	40		41.1		29.6	1	greatest vertical hauling distance; north dump would be stacked highest of the 3 options	8		8.2		5.9	10	least vertical hauling distance; north dump would not be stacked as high as Options 1 or 2	80		82.2		59.1
SUSTAINABILITY		22								26.6							26.6							26.6	
relative energy use	fuel use related to haulage distances		7	shorter distances preferred	8	intermediate horizontal hauling distance; vertical hauling distance similar to Option 3	56		n/a		67.7	1	greatest vertical hauling distance and most amount of out slopes would result in greatest energy use	7		n/a		8.5	5	greatest horizontal hauling distances; vertical hauling distance similar to Option 1	35		n/a		42.3
conversion to agriculture use	potential for use for agriculture after closure		10	large broad areas more suitable than side slopes	7	provides intermediate area	70		n/a		84.6	1	provides less area for future agricultural site	10		n/a		12.1	10	provides largest, broadest area	100		n/a		120.9
post-closure uses	potential for local communities to use waste rock (e.g., for gravel needs, etc.)		5	some communities have expressed interest in use of waste rock	5	intermediate between Options 2 and 3	25		n/a		30.2	1	waste rock is further from communities than options 1 and 3	5		n/a		6.0	10	more communities near areas of waste rock	50		n/a		60.5
Total							777		626.0		751.2			880		851.0		871.2			428		246.7		427.6

Notes:
Env. = Environment
Sust. = Sustainability
Soc. = Social
Tec. = Technical
n/a = Not applicable
ha = Hectares

Table 3 Scoring for the Alternative Processing Plant Locations

Plant Alternatives					3 - northeast							2 - southwest							1 - northwest						
		Weighting			Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)		Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)		Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)	
Issue	Description	Total Weight	Weight	Notes on Weight	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score
ENVIRONMENTAL		38						37.3		35.1					37.3		35.1					37.3		35.1	
Air Quality	Effect of emissions and particulates on receptors at Mulumbu, Salabwe or Tenke		10	air effects considered to be a major issue due to proximity to villages; DRC and IFC standards may not be met	1	emission exceedences at Mulumbu (population = 1238); not easily mitigable	10		9.8		9.2	10	likely no effect at Tenke	100		98.2		92.4	2	likely effect at Salabwe (population = 243); not easily mitigable	20		19.6		18.5
Noise	Effect of noise on receptors at Mulumbu, Salabwe or Tenke		10	noise effects considered to be a major issue due to proximity to villages; DRC and IFC standards may not be met	1	noise exceedences at Mulumbu; not easily mitigable	10		9.8		9.2	10	likely no effect at Tenke	100		98.2		92.4	2	likely noise exceedances at Salabwe (population = 243); not easily mitigable	20		19.6		18.5
Groundwater quality	Effects due to spills		4	Mitigation can prevent deleterious effects	5	many agricultural fields near plant but ground water relatively deep	20		19.6		18.5	5	lowest number of fields and wells near site but groundwater more shallow	20		19.6		18.5	7	intermediate number of fields and wells, gw likley an intermediate depth	28		27.5		25.9
Surface water quantity	Diversion of streams to build plant site		5	Ore bodies are in the upper parts of watersheds	10	least stream diversion as at top of drainage	50		49.1		46.2	3	most stream diversions required	15		14.7		13.9	7	intermediate number of streams	35		34.4		32.3
Surface water quality	Proximity to surface water in the event of spills/discharges		5	Effluent can be mitigated; effluent outfall location can be changed	8	at top of drainage, and further from major surface waters	40		39.3		36.9	1	very close to Dipeta River	5		4.9		4.6	3	Close to Mofya River	15		14.7		13.9
Natural habitats	Loss or alteration of sensitive habitats (Miombo, riparian, wetland, copper flora)		2	Remaining natural habitats need protection. No plant sites on copper flora.	9	woodland occupies 8% of site	18		17.7		16.6	5	woodland occupies 95% of site, but has been partially cleared	10		9.8		9.2	10	woodland occupies 3% of site	20		19.6		18.5
Biodiversity	Loss of terrestrial or aquatic biodiversity		2	Loss of terrestrial or aquatic diversity	9	low amount of biodiversity	18		17.7		16.6	3	woodland and streams on site	6		5.9		5.5	10	low biodivesity due to agriculture	20		19.6		18.5
SOCIAL		32						37.3		35.1					37.3		35.1					37.3		35.1	
Land use	Loss of agricultural lands		10	Farmland in region is important to local residents; soil capability is equivalent at all 3 sites	4	agricultural fields 91.5% of site	40		46.7		43.9	10	only 5% of area is cultivated	100		116.7		109.7	1	agricultural fields 97% of site	10		11.7		11.0
Relocation	Requirement to resettle people due to air or noise emissions or loss of land		10	Relocation should only be considered as a last resort	1	Mulumbu, Amoni and Kiboko would probably have to be resettled	10		11.7		11.0	10	least resettlement required	100		116.7		109.7	2	may have to resettle Salabwe	20		23.3		21.9
Public safety	traffic - human interaction		10	Traffic-related human mortality/injury can be high	7	least preferred location, but effects can be mitigated	70		81.7		76.8	10	lowest potential for traffic - human interaction	100		116.7		109.7	9	little pedestrian traffic in area	90		105.0		98.7
Cultural Resources	Loss of archaeological resources, cultural sites		2	Sites in the Kwatebala/Goma area are few; can be mitigated	10	site is furthest from valley bottoms where most artifacts found	20		23.3		21.9	3	closer to Dipeta River valley	6		7.0		6.6	7	intermediate in distance to valleys	14		16.3		15.4
TECHNICAL		42						37.3		23.4					37.3		23.4					37.3		23.4	
Ore condemnation	Potential for plant site to overlie mineable ore		10	Mineable ore should be utilized. Plant could be moved at a later date to mine ore beneath it.	10	site is not underlain by mineable ore	100		88.9		55.7	3	site probably underlain by ore, but at depth	30		26.7		16.7	10	assume site is not underlain by mineable ore	100		88.9		55.7
Haulage	Haulage distance/elevation, considering mining at both Kwatebala and Goma		5	Costs associated with haulage	5	location closest to Kwatebala, but further from Goma	25		22.2		13.9	10	most central to the two pits	50		44.4		27.9	1	furthest from pits	5		4.4		2.8
Fly rock	Risk of fly rock affecting plant site or tailings liner		4	Fly rock can be a hazard to workers at the plant and tailings facility	1	closest to Kwatebala pit	4		3.6		2.2	5	intermediate distance to both pits	20		17.8		11.1	10	furthest from pits	40		35.6		22.3
Space requirements	Requirements for all facilities, including potential expansion		4	Room for future expansion of plant	8	expansion would take more agricultural lands but relatively flat additional area exists	32		28.4		17.8	3	may have to relocate rail line, limited by Dipeta River, steep topography and underlying ore zones	12		10.7		6.7	10	most available space	40		35.6		22.3
Transport in/out	New road/rail requirements, and distance/elevation of transport		4	Costs associated with new construction and transport	10	requires new rail spur on hill, but existing road is close	40		35.6		22.3	4	closest to rail line, but longer road access	16		14.2		8.9	2	furthest from pits and developed road or rail	8		7.1		4.5
Levelling site	cut and fill requirements		3	costs associated with cut and fill to level site	10	site is relatively flat	30		26.7		16.7	2	topography requires extensive levelling	6		5.3		3.3	6	intermediate in levelling requirements	18		16.0		10.0
Diversion of water	Preferred not to have to divert water		2	Costs associated with diversions	10	least amount of stream diversion	20		17.8		11.1	3	most stream diversions required	6		5.3		3.3	7	some diversion required	14		12.4		7.8
Drainage of site	Good drainage required		2	Costs associated with improving drainage	8	a small wet area needs to be drained	16		14.2		8.9	5	drainage is reasonable, but stream diversions required	10		8.9		5.6	10	well drained site	20		17.8		11.1
Pumping tailings	Distance/elevation to pump tailings		8	Costs associated with pumping tailings	10	gravity flow of tailings from plant to tailings facility; short distance	80		71.1		44.6	1	need to pump tailings over ridge to tailings facility	8		7.1		4.5	5	intermediate in elevation and distance to pump tailings	40		35.6		22.3
SUSTAINABILITY		5								23.4							23.4							23.4	
Relative energy use	Haulage, transport fuel use		3	Shorter distances and lower elevation changes preferred	9	not as close to rail as site 2	27		n/a		126.4	10	closest to rail line; between Goma and Kwatebala pits	30		n/a		140.4	1	furthest from rail, and ore	3		n/a		14.0
Conversion to other use at closure	If plant can be used for other uses post-closure it will be a benefit to local communities		2	Differences are proximity to Tenke and ease of maintaining future access	9	relatively close to Tenke and on a reliable road access	18		n/a		84.2	5	closest to Tenke but costs of road maintenance may be high	10		n/a		46.8	5	furthest from Tenke, intermediate road maintenance requirements	10		n/a		46.8
Total							698		634.9		710.8			760		749.0		847.3			590		564.9		512.5

Notes: Env. = Environment
Sust. = Sustainability
Soc. = Social
Tec. = Technical
n/a = Not applicable
ha = Hectares

Table 4 Scoring for the Alternative Construction Camp/Permanent Village Locations

Construction Camp/Permanent Village: Issue	Description	Weighting: Total Weight	Weighting: Weight	Notes on Weight
ENVIRONMENTAL		40		
air quality	camp is a receptor. Ambient concentration at site due to emissions from other project facilities, urban centers.		7	poor air quality could impact worker's health or reduce quality of life
noise	camp is a receptor. Noise and vibrations from other project facilities and urban centers.		7	important for workers and worker's families to get adequate rest and have improved quality of life
groundwater quantity	adequate supply required		10	adequate groundwater supply essential. Groundwater supply to be confirmed later.
groundwater quality	effects due to urban pollution and use		9	groundwater quality at camp site influenced by nearby land uses. Costs associated with treatment.
surface water quality	effects due to release of wastewater		3	effects can be mitigated
natural habitats	loss or alteration of sensitive habitats (miombo woodland, riparian, wetland, copper flora)		2	no camp sites on copper flora, riparian or wetland areas.
biodiversity	loss of terrestrial or aquatic biodiversity		2	loss of terrestrial or aquatic biodiversity
SOCIAL		56		
land use	loss of agricultural land		10	farmland is important to local residents
relocation	relocation of households directly impacted		9	relocation would be considered as a last resort
public safety	disease vectors		6	concentration of workers near urban areas may promote spread of disease/illness
visual impact	visual effect on landscape		4	visual impact important to some people
cultural resources	relocation of archaeoogical sites		2	sites in the Kwatebala/Goma area are few and can be mitigated
induced development impacts	control influx of people to concession area		10	has been raised as an issue by non-governmental organizations (NGOs), academics, locals
economic impact	benefits to local communities		10	benefits should flow to as many communities as possible
proximity to urban areas	increased social pressures with proximity to urban areas		5	potential for negative influence on workers
TECHNICAL		28		
ore condemnation	potential for camp site to overlie mineable ore		10	mineable ore should be used. Confirmation later in 2006
distance to work sites	daily travel distances for workers between camp and work sites should be as short as possible		7	greater costs associated with greater travel distance to work site
transport in/out	minimize new road requirements		5	associated costs
leveling site	cut and fill requirements		3	costs associated with cut and fill to level site
drainage of site	good drainage required		2	costs associated with improving drainage
diversion of water	preferred not to have to divert water		1	costs associated with water diversion
SUSTAINABILITY		13		
relative energy use	cost of transporting materials, supplies, etc.; fuel use		3	shorter distances preferred from supply centers
conversion to other use at closure	if construction camp can be used for other uses post-closure it will be a benefit to local communities		10	closer to communities is better, but all areas close to agriculture have post-closure use potential
Total				

A - Kiboko

Issue	Simple: Score	Simple: Notes on Score	Simple: Weighted Score	Normalized (Env .33, Soc .33, Tec .33): Total Normalized Weight	Normalized (Env .33, Soc .33, Tec .33): Normalized Score	Normalized (Env .3, Soc .3, Tec .2, Sust .2): Total Normalized Weight	Normalized (Env .3, Soc .3, Tec .2, Sust .2): Normalized Score
ENVIRONMENTAL				41.3		41.1	
air quality	6	2nd closest to plant site; intermediate distance to Tenke and Fungurume (3 km from plant site; 11 km from Fungurume; 11 km from Tenke)	42		43.4		43.2
noise	6	2nd closest to plant site; intermediate distance to Tenke and Fungurume (3 km from plant site; 11 km from Fungurume; 11 km from Tenke)	42		43.4		43.2
groundwater quantity	8	site probably has adequate groundwater supply but needs to be confirmed	80		82.7		82.2
groundwater quality	8	further from larger centers than B or C, but close to small village	72		74.4		74.0
surface water quality	8	close to Kanzana River	24		24.8		24.7
natural habitats	3	area is about 50% closed woodland,	6		6.2		6.2
biodiversity	4	area has the most biodiversity: agricultural + closed woodland	8		8.3		8.2
SOCIAL				41.3		41.1	
land use	5	area is about 50% agricultural	50		36.9		36.7
relocation	9	low present use for housing	81		59.8		59.4
public safety	6	close to several smaller settlements	36		26.6		26.4
visual impact	2	highest visual effect; located in a more rural area with several nearby villages	8		5.9		5.9
cultural resources	7	intermediate distance from valley bottoms, where most artifacts are found	14		10.3		10.3
induced development impacts	2	located close to proposed mining area. Would be costly to establish services. Impact of uncontrolled growth hard to mitigate	20		14.8		14.7
economic impact	3	benefits would go to fewer people due to small community size	30		22.1		22.0
proximity to urban areas	7	far from large centers but close to several small villages	35		25.8		25.7
TECHNICAL				41.3		27.4	
ore condemnation	5	located in Buffer Zone (moderate to high possibiity of copper ore)	50		73.8		48.9
distance to work sites	8	second closest to pits and plant site	56		82.7		54.8
transport in/out	10	no new road required, upgrades already planned	50		73.8		48.9
leveling site	10	assume site is relatively flat (don't have site specific info)	30		44.3		29.4
drainage of site	10	assume good drainage (no site specific info)	20		29.5		19.6
diversion of water	10	no stream diversions expected	10		14.8		9.8
SUSTAINABILITY						27.4	
relative energy use	2	furthest from a main supply center	6		n/a		12.6
conversion to other use at closure	5	intermediate distance from urban centers, except smaller villages	50		n/a		105.4
Total			**820**		**804.2**		**812.0**

B - In or Near Fungurume

Issue	Simple: Score	Simple: Notes on Score	Simple: Weighted Score	Normalized (Env .33, Soc .33, Tec .33): Total Normalized Weight	Normalized (Env .33, Soc .33, Tec .33): Normalized Score	Normalized (Env .3, Soc .3, Tec .2, Sust .2): Total Normalized Weight	Normalized (Env .3, Soc .3, Tec .2, Sust .2): Normalized Score
ENVIRONMENTAL				41.3		41.1	
air quality	6	closest to Fungurume; farthest from Tenke; farthest from plant site (17 km from plant site; 3 km from Fungurume; 24 km from Tenke)	42		43.4		43.2
noise	4	closest to Fungurume; farthest from Tenke; farthest from plant site (17 km from plant site; 3 km from Fungurume; 24 km from Tenke)	28		28.9		28.8
groundwater quantity	10	existing well P3 will initially be used, which has a tested, adeqate water supply	100		103.3		102.8
groundwater quality	10	close to largest urban area, but Well P-3 not impacted. It would be the water supply.	90		93.0		92.5
surface water quality	8	close to river	24		24.8		24.7
natural habitats	9	area is 2% open woodland	18		18.6		18.5
biodiversity	9	low biodiversity due to mainly agricultural use	18		18.6		18.5
SOCIAL				41.3		41.1	
land use	6	area is predomintantly agricultural; but less productive than Kiboko area	60		44.3		44.0
relocation	9	low present use for housing	81		59.8		59.4
public safety	2	close to largest urban center	12		8.9		8.8
visual impact	8	low visual effect; near large urban/agricultural area	32		23.6		23.5
cultural resources	10	site is far from valley bottoms where most artifacts found	20		14.8		14.7
induced development impacts	10	far from mining area and located near major urban area/growth area	100		73.8		73.4
economic impact	8	mainly benefits Fungurume	80		59.0		58.7
proximity to urban areas	3	close to largest urban center of Fungurume	15		11.1		11.0
TECHNICAL				41.3		27.4	
ore condemnation	8	located in Outer Zone (low to moderate possibility of copper ore)	80		118.1		78.3
distance to work sites	1	furthest distance from pits and plant site	7		10.3		6.9
transport in/out	5	bypass road construction would be desired, but most upgrading already planned.	25		36.9		24.5
leveling site	10	assume site is relatively flat (don't have site-specific info)	30		44.3		29.4
drainage of site	10	assume good drainage (no site-specific info)	20		29.5		19.6
diversion of water	10	no stream diversions expected	10		14.8		9.8
SUSTAINABILITY						27.4	
relative energy use	10	close to Fungurume, a main supply center	30		n/a		63.2
conversion to other use at closure	10	close to Fungurume	100		n/a		210.8
Total			**1,022.0**		**879.8**		**1,064.7**

C - In or Near Tenke

Issue	Simple: Score	Simple: Notes on Score	Simple: Weighted Score	Normalized (Env .33, Soc .33, Tec .33): Total Normalized Weight	Normalized (Env .33, Soc .33, Tec .33): Normalized Score	Normalized (Env .3, Soc .3, Tec .2, Sust .2): Total Normalized Weight	Normalized (Env .3, Soc .3, Tec .2, Sust .2): Normalized Score
ENVIRONMENTAL				41.3		41.1	
air quality	4	closest to Tenke; intermediate distance to plant site; farthest from Fungurume (6 km from plant site; 19 km from Fungurume; <1 km from Tenke)	28		28.9		28.8
noise	2	closest to Tenke; intermediate distance to plant site; farthest from Fungurume (6 km from plant site; 19 km from Fungurume; < 1 km from Tenke). Also adjacent to rail line	14		14.5		14.4
groundwater quantity	8	assume site has adequate groundwater supply but needs to be confirmed	80		82.7		82.2
groundwater quality	6	close to smaller urban center of Tenke	54		55.8		55.5
surface water quality	5	no nearby rivers; surrounded by agricultural land; further to pipe effluent if necessary	15		15.5		15.4
natural habitats	5	area is 30% open woodland and 17% closed woodland	10		10.3		10.3
biodiversity	6	higher biodiversity than agricultural area, but lower than closed woodland	12		12.4		12.3
SOCIAL				41.3		41.1	
land use	5	area is about 50% agricultural	50		36.9		36.7
relocation	9	low present use for housing	81		59.8		59.4
public safety	3	very close to smaller urban center	18		13.3		13.2
visual impact	8	low visual effect; near urban area	32		23.6		23.5
cultural resources	5	closer to valley bottoms	10		7.4		7.3
induced development impacts	7	close to mining area but near small existing urban area/potential growth areas	70		51.7		51.4
economic impact	6	mainly benefits Tenke	60		44.3		44.0
proximity to urban areas	5	close to small urban center	25		18.5		18.3
TECHNICAL				41.3		27.4	
ore condemnation	5	located in Buffer Zone (moderate to high possibility of copper ore)	50		73.8		48.9
distance to work sites	5	intermediate distance to pits and plant site	35		51.7		34.3
transport in/out	2	significant road upgrading required. This route not already planned for upgrading	10		14.8		9.8
leveling site	10	assume site is relatively flat (don't have site specific info)	30		44.3		29.4
drainage of site	10	assume good drainage (no site specific info)	20		29.5		19.6
diversion of water	10	no stream diversions expected	10		14.8		9.8
SUSTAINABILITY						27.4	
relative energy use	8	close to Tenke, a smaller supply center	24		n/a		50.6
conversion to other use at closure	9	close to Tenke	90		n/a		189.7
Total			**828**		**704.3**		**864.8**

Notes:
Env. = Environment
Sust. = Sustainability
Soc. = Social
Tec. = Technical
n/a = Not applicable
ha = Hectares

Table 5 Scoring for the Alternative Growth Center Locations

Growth Center					A - Kiboko						
Issue	Description	Weighting		Notes on Weight	Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)	
		Total Weight	Weight		Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score
ENVIRONMENTAL		40						43.3		45.6	
air quality	growth center is a receptor. Ambient concentration at site due to emissions from other project facilities, urban centers.		7	poor air quality could impact worker's/resident's health	10	furthest from larger urban centers and from plant site	70		75.8		79.8
noise	growth center is a receptor. Noise and vibrations from other project facilities and urban centers.		7	important for workers to get adequate rest	10	furthest from larger urban centers and from plant site and pits	70		75.8		79.8
groundwater quantity	adequate supply required		10	adequate groundwater supply essential. Groundwater supply to be confirmed later.	10	assume site has adequate groundwater supply	100		108.3		114.0
groundwater quality	effects due to urban pollution and use		9	groundwater quality at growth center site influenced by nearby land uses. Costs associated with treatment.	10	further from larger centers than B or C; baseline water quality probably best	90		97.5		102.6
surface water quality	effects due to release of wastewater		3	effects can be mitigated	10	near headwaters of Kanzana River	30		32.5		34.2
natural habitats	loss or alteration of sensitive habitats (miombo woodland, riparian, wetland, copper flora)		2	no growth center sites on Copper-cobalt flora, riparian or wetland areas.	3	area has greatest proportion of closed woodland	6		6.5		6.8
biodiversity	loss of terrestrial or aquatic biodiversity		2	loss of terrestrial or aquatic biodiversity	4	area has the most biodiversity: agricultural + woodland	8		8.7		9.1
SOCIAL		71						43.3		45.6	
land use	loss of agricultural land		10	farmland is important to local residents	3	area is about 50% agricultural; soil is most productive	30		18.3		19.3
relocation	relocation of households directly impacted		9	relocation would be considered as a last resort	10	lowest present use for housing	90		54.9		57.8
public safety	disease vectors		6	concentration of workers near urban areas may promote spread of disease/illness	10	least; away from larger urban areas	60		36.6		38.5
visual impact	visual effect on landscape		4	visual impact important to some people	2	most visual effect; located in a more rural area	8		4.9		5.1
cultural resources	relocation of archaeoogical sites		2	sites in the Kwatebala/Goma area are few and can be mitigated	7	intermediate distance	14		8.5		9.0
induced development impacts	influx of people to concession area		10	more desirable to keep people from settling near ore body locations; consider cost of providing services	1	located away from concession area but would be costly to establish services	10		6.1		6.4
mitigating foreseeable induced development impact	induced development will occur in areas near the facilities. managed development better than unmanaged		10	more desirable to provide tools to manage induced development, where it can be predicted	2	not a prime target for induced devepment	20		12.2		12.8
social equity	manage the stated community concerns about equity		10	Fungurume is perceived to be getting the benefits, while other areas get the impacts	5	avoids Fungurume and Tenke, but does not provide benefits to either	50		30.5		32.1
economic impact	benefits to local communities		10	benefits should flow to as many communities as possible	1	benefits would overwhelm smaller communties	10		6.1		6.4
TECHNICAL		19						43.3		30.4	
ore condemnation	potential for growth center to overlie mineable ore		10	mineable ore should be used. Confirmation later in 2006	5	located in buffer zone (moderate to high probability of copper ore)	50		114.0		80.0
distance to work sites	daily travel distances for operations workers between camp/growth center and work sites should be as short as possible		4	greater costs associated with greater travel distance to work site, but only affects workers and not other residents	8	second closest to pits and plant site	32		73.0		51.2
transport in/out	minimize new road requirements		5	associated costs	10	minor new road construction needed	50		114.0		80.0
SUSTAINABILITY		22								30.4	
relative energy use	cost of transporting materials, supplies, etc.; fuel use		3	shorter distances preferred from supply centers	2	furthest from a main supply center	6		n/a		8.3
potential for small business development	establishment of market gardens, small vendors		9	proximity to agricultural areas with good soil productivity	5	highest utilization; soils are most productive in this area, however, fewer total purchasers	45		n/a		62.2
ability to meet long-term housing/commercial needs	proximity to existing urban centers		10	desirable to be close to existing urban areas	2	furthest from urban centers, except smaller villages	20		n/a		27.6
Total							869		884.4		923.2

Growth Center	B - Fungurume						
Issue	Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)	
	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score
ENVIRONMENTAL				43.3		45.6	
air quality	7	close to largest urban area, but furthest from plant	49		53.1		55.9
noise	7	close to largest urban area, but furthest from plant and pits	49		53.1		55.9
groundwater quantity	10	assume site has adequate groundwater supply	100		108.3		114.0
groundwater quality	4	4 km east of largest urban area (Fungurume); poorest baseline water quality	36		39.0		41.0
surface water quality	5	furthest from rivers or drainages; further to pipe effluent	15		16.3		17.1
natural habitats	10	about 25% open woodland, remainder agricultural	20		21.7		22.8
biodiversity	10	lowest biodiversity due to mainly agricultural use	20		21.7		22.8
SOCIAL				43.3		45.6	
land use	8	area is 79% agricultural, but least productive	80		48.8		51.4
relocation	9	low present use for housing	81		49.4		52.0
public safety	5	close to largest urban area	30		18.3		19.3
visual impact	10	least visual impact, near large urban area	40		24.4		25.7
cultural resources	10	site is furthest from valley bottoms where most artifacts found	20		12.2		12.8
induced development impacts	10	furthest from concession area; already located near major urban area	100		61.0		64.2
mitigating foreseeable induced development impact	5	further from mine but close to costruction camp	50		30.5		32.1
social equity	1	Tenke will be upset	10		6.1		6.4
economic impact	5	mainly benefits Fungurume	50		30.5		32.1
TECHNICAL				43.3		30.4	
ore condemnation	8	located in outer zone (low to moderate probability of copper ore)	80		182.5		128.0
distance to work sites	1	furthest distance from pits and plant site	4		9.1		6.4
transport in/out	10	minor new road construction needed	50		114.0		80.0
SUSTAINABILITY						30.4	
relative energy use	10	close to Fungurume, a main supply center	30		n/a		41.5
potential for small business development	5	poor soils; less used, but more purchasers	45		n/a		62.2
ability to meet long-term housing/commercial needs	10	close to Fungurume	100		n/a		138.2
Total			1,059.0		900.1		1,081.8

Growth Center	C - Tenke						
Issue	Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)	
	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score
ENVIRONMENTAL				43.3		45.6	
air quality	5	close to smaller urban area, but also closer to plant site than A or B	35		37.9		39.9
noise	4	close to smaller urban area, but also close to plant site, pits and railway line	28		30.3		31.9
groundwater quantity	10	assume site has adequate groundwater supply	100		108.3		114.0
groundwater quality	6	adjacent to smaller urban center of Tenke; poor baseline water quality	54		58.5		61.6
surface water quality	8	intermediate distance to rivers compared to A or B	24		26.0		27.4
natural habitats	5	area is equal mix of open woodland and grassland	10		10.8		11.4
biodiversity	7	higher biodiversity than agricultural area, but lower than closed woodland	14		15.2		16.0
SOCIAL				43.3		45.6	
land use	5	50% agricultural; soils have not been sampled	50		30.5		32.1
relocation	9	low present use for housing	81		49.4		52.0
public safety	4	very close to smaller urban center	24		14.6		15.4
visual impact	7	low visual effect; near urban area	28		17.1		18.0
cultural resources	5	closer to valley bottoms	10		6.1		6.4
induced development impacts	7	outside concession area and near urban area	70		42.7		45.0
mitigating foreseeable induced development impact	6	close to mine, induced development predictable	60		36.6		38.5
social equity	2	Fungurume will be less upset, if construction camp located nearby, but will still be upset	20		12.2		12.8
economic impact	5	mainly benefits Tenke	50		30.5		32.1
TECHNICAL				43.3		30.4	
ore condemnation	5	located in buffer zone (moderate to high probability of copper ore)	50		114.0		80.0
distance to work sites	5	closest to pits and plant site	20		45.6		32.0
transport in/out	8	needs more new road construction than A or B	40		91.2		64.0
SUSTAINABILITY						30.4	
relative energy use	9	close to Tenke, a smaller supply center	27		n/a		37.3
potential for small business development	5	high utilization around Tenke, but fewer purchasers than Fungurume	45		n/a		62.2
ability to meet long-term housing/commercial needs	8	close to Tenke, a smaller center	80		n/a		110.5
Total			920		777.8		940.5

Notes:
Env. = Environment
Sust. = Sustainability
Soc. = Social
Tec. = Technical
n/a = Not applicable

Table 6 Scoring for the Alternative Main Access Roads with the Concession Alternatives

Access Road					Route 1 - Southern Route-Kafwaya Cutoff Road						
		Weighting			Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)	
Issue	Description	Total Weight	Weight	Notes on Weight	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score
ENVIRONMENTAL		20						26.7		30	
noise	noise and vibrations		6	noise and vibrations can affect residents vibrations noted as a concern during consultation	8	bypass around Kwatebala Gare (387) note: no population estimates available for population outside of villages	48		64.0		72.0
air quality	emissions and dust		5	dust from road traffic can be a nuisance to residents, but it can be mitigated	8	bypass around Kwatebala Gare, population of 387	40		53.3		60.0
surface water quality	potential for spills, and dust, at creek crossings		4	potential for spills is low; dust can be mitigated for	1	most (8) creek crossings	4		5.3		6.0
natural habitats	minimize clearing of woodland and copper-cobalt flora, wetlands		3	loss of natural habitats is not a large concern given the degraded nature of the concession	1	route crosses the most miombo woodland (38%). No other sensitive habitats affected.	3		4.0		4.5
biodiversity	fragmentation effects. Better to use existing roads.		2	fragmentation not a large concern due to current and potential future (even without project) land clearing. All 3 routes use existing or old rights of way	6	fragmentation of miombo woodland, and crossing of streams (8) may affect biodiversity	12		16.0		18.0
SOCIAL		30						26.7		30	
land use	effects to agricultural lands		9	loss of farmland is a concern to local residents	10	route crosses the least agricultural land (59%)	90		80.0		90.0
relocation	relocation of houses		10	relocation may be necessary to widen road and to replace farmland	9	route to avoid village of Kwatebala Gare	90		80.0		90.0
public safety	avoid towns and built up areas		10	human-vehicle collisions are likely in built up areas assumes bike trail built to parallel whatever road route is selected	3	many people walk the main east west road in Fungurume, sell wares by and on the road, etc. Total population along route is 387.	30		26.7		30.0
cultural resources	loss of cultural resources		1	cultural resources are primarily in valley bottoms and can be mitigated for	7	potential for archeological resources along river valleys	7		6.2		7.0
TECHNICAL		30						26.7		20	
total length	length is proportional to cost of construction and transport		8	construction and transport cost over the life of the mine is important	10	21 km total, but assume that National Highway will be upgraded. Therefore, only 10 km from junction.	80		71.1		53.3
number of bridges	bridges influence cost		6	bridges influence cost less than total length of the road	4	8 creek crossings	24		21.3		16.0
terrain	terrain can influence cost of construction and erodibility of road surface		6	terrain may require more road maintenance, which can be costly	8	route crosses valley bottoms, some side slopes	48		42.7		32.0
flooding potential	seasonal flooding affect usability and maintenance costs		10	if the road is impassable, it is useless	5	route crosses Dipeta River and associated low lands	50		44.4		33.3
SUSTAINABILITY		20								20	
total length	emissions related to total length		2	emissions a concern but not overriding	8	21 km from Fungurume	16		n/a		16.0
maintainability	how costly for others to maintain post-closure?		9	if cost is too high, road will not be used	5	portion of route crossing the Dipeta River is subject to flood damage	45		n/a		45.0
conversion to uses post closure	usefulness for local communities post-closure		9	use of roads at closure would benefit local communities	10	upgrading the National Highway is of benefit to most number of users	90		n/a		90.0
Total							**677**		**515.1**		**663.2**

	Route 2 - Central Route						
	Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)	
Issue	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score
ENVIRONMENTAL				26.7		30	
noise	6	bypass around Fungurume, population on route is 504 note: no population estimates available for population outside of villages	36		48.0		54.0
air quality	6	bypass around Fungurume, population on route is 504	30		40.0		45.0
surface water quality	3	6 creek crossings	12		16.0		18.0
natural habitats	4	route crosses an intermediate amount of miombo woodland (27%); also affects copper-cobalt steppe savanna (5%)	12		16.0		18.0
biodiversity	8	route crosses an intermediate amount of miombo woodland (27%) and creeks (6); also affects copper-cobalt steppe savanna (5%).	16		21.3		24.0
SOCIAL				26.7		30	
land use	4	route crosses intermediate amount (68%) agricultural land	36		32.0		36.0
relocation	8	route to bypass Fungurume; will need to bypass Mwela Mpanda and Kwatebala also.	80		71.1		80.0
public safety	7	504 people live in villages along route	70		62.2		70.0
cultural resources	7	potential for archeological resources along river valleys	7		6.2		7.0
TECHNICAL				26.7		20	
total length	8	19 km total length	64		56.9		42.7
number of bridges	6	6 creek crossings	36		32.0		24.0
terrain	6	route crosses valley bottoms, more side slopes than southern route, and climbs west end of Kwatebala hill	36		32.0		24.0
flooding potential	1	route is predominantly in Dipeta River valley	10		8.9		6.7
SUSTAINABILITY						20	
total length	9	19 km total length	18		n/a		18.0
maintainability	1	route is subject to flooding and instability at multiple locations within the Dipeta valley	9		n/a		9.0
conversion to uses post closure	3	fewest people will benefit in long term (currently, 504 people)	27		n/a		27.0
Total			**499**		**442.7**		**503.3**

	Route 3 - Northern Route- Mulumbu Access Road						
	Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)	
Issue	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score
ENVIRONMENTAL				26.7		30	
noise	10	bypass around Fungurume; population on route will be 0 once Mulumbu, Amoni and Kiboko are relocated note: no population estimates available for population outside of villages	60		80.0		90.0
air quality	10	bypass around Fungurume; population will be 0 once Mulumbu, Amoni and Kiboko are relocated	50		66.7		75.0
surface water quality	10	fewest number (3) of creek crossings	40		53.3		60.0
natural habitats	10	route crosses the least miombo woodland (4.5%). Crosses small amounts of copper-cobalt steppe savanna (1.8%).	30		40.0		45.0
biodiversity	10	route crosses the least miombo woodland (4.5%). Crosses small amounts of copper-cobalt steppe savanna (1.8%).	20		26.7		30.0
SOCIAL				26.7		30	
land use	1	route crosses the most agricultural land (89%)	9		8.0		9.0
relocation	1	route to bypass Fungurume; Mulumbu, Amoni and Kiboko to be relocated	10		8.9		10.0
public safety	10	0 people liive in villages along the route (with Mulumbu, Amoni and Kiboko moved)	100		88.9		100.0
cultural resources	10	potential for archeological resources is lowest; away from river bottoms	10		8.9		10.0
TECHNICAL				26.7		20	
total length	9	17 km total length	72		64.0		48.0
number of bridges	10	3 creek crossings	60		53.3		40.0
terrain	10	route is on ridgeline for most of its way	60		53.3		40.0
flooding potential	10	route avoids lowlands and river valley areas	100		88.9		66.7
SUSTAINABILITY						20	
total length	10	17 km total length	20		n/a		20.0
maintainability	10	route is predominantly out of lowlands and not subject to flooding	90		n/a		90.0
conversion to uses post closure	1	no people in villages along route will benefit (when Mulumbu, Amoni and Kiboko moved)	9		n/a		9.0
Total			**740**		**640.9**		**742.7**

Notes:
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Table 7 Scoring for the Alternative Off-Site Transport Routes

Transport of Raw Materials and Product					Dar es Salaam, Tanzania						
Issue	Description	Weighting		Notes on Weight	Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)	
		Total Weight	Weight		Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score
ENVIRONMENTAL		10						13.3		12.9	
air quality	emissions related to route length		4	air quality effects can be mitigated	10	shortest distance	40		53.3		51.6
sensitive areas	route should avoid environmentally sensitive areas such as national parks, protected areas, water crossings, major wetlands, etc.		6	effects of spills, etc., can be mitigated	6	passes through Mikumi National Park (Tanzania), edge of Lavushi Manda National Park (NP) in Zambia, Usangu Flats wetland in Tanzania; 16 watercrossings. National Park areas are smaller than option 2	36		48.0		46.4
SOCIAL		10						13.3		12.9	
public safety	many people use railways and roads as footpaths. Longer routes may provide more potential for impacts. Minimize number of communities en route		10	public safety is a major concern	10	shortest route; least number of main communities (8)	100		133.3		129.0
TECHNICAL		20						13.3		8.6	
route condition	improvements or upgrades required		10	length and current condition will affect cost	5	shortest route; but in poor condition	50		33.3		21.5
border crossing	ease of border crossing		5	number of border crossings increases time and therefore cost	10	fewest border crossings (2)	50		33.3		21.5
security	security of cargo from theft, vandalism		5		5	less secure than South Africa	25		16.7		10.8
SUSTAINABILITY		3								8.6	
relative energy use	related to route length		3	not a major factor	10	shortest route	30		n/a		86.0
Total							**331**		**318.0**		**366.8**

Issue	Richards Bay or Durban, South Africa						
	Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)	
	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score
ENVIRONMENTAL				13.3		12.9	
air quality	5	greatest distance	20		26.7		25.8
sensitive areas	7	passes through or near Zambesi NP and Hwange NP (Zimbabwe); 17 watercrossings	42		56.0		54.2
SOCIAL				13.3		12.9	
public safety	1	greatest distance; 16 main communties	10		13.3		12.9
TECHNICAL				13.3		8.6	
route condition	5	greatest distance; assume most repairs	50		33.3		21.5
border crossing	5	most border crossings (4)	25		16.7		10.8
security	10	highest level of security	50		33.3		21.5
SUSTAINABILITY						8.6	
relative energy use	5	longest route	15		n/a		43.0
Total			**212**		**179.3**		**189.6**

Issue	Walvis Bay, Namibia						
	Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)	
	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score
ENVIRONMENTAL				13.3		12.9	
air quality	7	distance is intermediate between Options 1 and 2, but closer to Option 2	28		37.3		36.1
sensitive areas	10	does not traverse any national parks or protected areas; fewest watercrossings (9)	60		80.0		77.4
SOCIAL				13.3		12.9	
public safety	6	Intermediate distance between options 1 and 2; more main communities than option 1 (10) but not as many as option 2	60		80.0		77.4
TECHNICAL				13.3		8.6	
route condition	1	slightly longer distance than option 1; but no rail route between DCR and Grootfontein, so more costly.	10		6.7		4.3
border crossing	10	fewest border crossings (2)	50		33.3		21.5
security	5	less secure than South Africa	25		16.7		10.8
SUSTAINABILITY						8.6	
relative energy use	9	slightly longer route than option 1	27		n/a		77.4
Total			**260**		**254.0**		**304.9**

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Tec. = Technical
n/a = Not applicable

Table 8 Scoring for the No Project Alternative

No Project Alternative					Option 1 - The Project							Option 2 - No Project						
		Weighting			Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)		Simple			Normalized (Env .33, Soc .33, Tec .33)		Normalized (Env .3, Soc .3, Tec .2, Sust .2)	
Issue	Description	Total Weight	Weight	Notes on Weight	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score	Score	Notes on Score	Weighted Score	Total Normalized Weight	Normalized Score	Total Normalized Weight	Normalized Score
ENVIRONMENTAL		64						50.3		49.8					50.3		49.8	
air quality	effects of emissions and dust		10	need to meet DRC and international standards	2	DRC and International standards will not be met for some villages or towns	20		15.7		15.6	10	n/a	100		78.6		77.8
noise	effects of noise and vibrations		10	need to meet DRC and IFC standards	2	standards may not be met for some villages or towns	20		15.7		15.6	6	standards more likely met	60		47.2		46.7
groundwater quantity	effects due to groundwater abstraction		7	groundwater supply must be adequate for needs	3	possibly not enough water to meet all needs year round	21		16.5		16.3	6	more water available for other needs, e g., agriculture	42		33.0		32.7
groundwater quality	effects due to spills, urban pollution		7	groundwater quality influenced by nearby land uses	3	potential to add to negative effects on groundwater quality	21		16.5		16.3	4	groundwater quality already low in some areas	28		22.0		21.8
surface water quantity	effects due to diversion of streams		7	related to number and type of existing drainages in footprint	3	requires some stream diversion, but effects can be mitigated	21		16.5		16.3	4	less stream diversion	28		22.0		21.8
surface water quality	effects due to spills and dust at creek crossings, release of wastewater		7	spills and dust can be mitigated for	3	potential to further reduce surface water quality, but effects can be mitigated	21		16.5		16.3	4	surface water quality already poor; informal mining would resume	28		22.0		21.8
natural habitats	effects due to loss or alteration of sensitive habitats (miombo woodland, riparian, wetlands, Copper-cobalt flora)		8	not a large concern given the already degraded nature of the concession	2	copper flora areas, wetlands avoided; some miombo woodland would be cleared, but most of these areas already degraded	16		12.6		12.5	3	much degradation of natural areas exists; artisanal mining would resume	24		18.9		18.7
biodiversity	effects due to loss of terrestrial or aquatic biodiveristy		8	not a large concern given the already degraded nature of the concession	1	some loss of biodiversity possible, but much of area already degraded	8		6.3		6.2	2	much of area already degraded	16		12.6		12.5
SOCIAL		61						50.3		49.8					50.3		49.8	
land use	effects due to loss of agricultural lands		10	farmland is important to local residents	6	some agricultural land will be lost, but much will be reclaimed	60		49.5		49.0	7	status quo	70		57.8		57.1
relocation	effects due to resettlement of people due to air or noise emissions or loss of agricultural land		9	relocation of households is not desirable	1	some villages will need to be relocated	9		7.4		7.3	10	no relocation required	90		74.3		73.5
economic impact at national level	impacts to the national economy through royalties, involvement of Gécamines		10	national impacts desirable	10	significant national economic impacts	100		82.5		81.6	1	national impacts would not occur	10		8.3		8.2
induced development	effects due to influx of people		10	consider cost of providing services	3	will be necessary to provide services to areas to areas where people gather in hope of finding employment with project	30		24.8		24.5	5	status quo	50		41.3		40.8
economic impacts	benefits to local communities		10	there should be economic benefits to local communities, e.g., employment, training	10	benefits will flow to communties through direct and indirect employment; supply of goods and services; upgrading of facilities and services	100		82.5		81.6	1	no economic benefits realized	10		8.3		8.2
public safety	effects due to traffic - human interaction; disease vectors		6	traffic-related human mortality/injury can be high; concentration of people may promote spread of illness/disease	7	project may result in more public safety concerns; need to provide malaria control, clinic(s) and safe drinking water	42		34.7		34.3	3	status quo	18		14.9		14.7
visual impact	visual effects on landscape		4	visual aesthetics important to some people	4	some areas will be visually impacted	16		13.2		13.1	3	artisanal mining effects	12		9.9		9.8
cultural resources	effects due to loss of archaeological resources, cultural sites		2	sites in the Kwatebala/Goma area are few and can be mitigated	2	project unlikely to result in greater loss of cultural resources than status quo	4		3.3		3.3	2	status quo	4		3.3		3.3
TECHNICAL		26						50.3		33.2					50.3		33.2	
transport	effect on road and rail transport		10	road and rail routes will need to be upgraded	10	the improvement of the road and rail transport systems resulting from the project will be a significant benefit for the country and other countries in Africa	100		193.6		127.7	1	many roads and rail systems currently in poor condition	10		19.4		12.8
mining and mitigation methods	introduction/improvement of mining and mitigation methods		10	introduction of better mining and mitigation methods is desirable	10	project would improve on existing methods and mitigation	100		193.6		127.7	1	status quo	10		19.4		12.8
border crossings	effect on border crossings		6	some border crossings need improvement	10	benefits of improved border crossings will extend beyond project	60		116.2		76.6	1	currently long waits at some border crossings	6		11.6		7.7
SUSTAINABILITY		15								33.2							33.2	
international development	effects on international development in DRC		5	increased international development desirable	10	development of a mine by an international company will have positive impacts to development in the DRC, i.e., other development will follow	50		n/a		110.7	1	status quo	5		n/a		11.1
opportunities for small business development	e.g., market gardens, services		10	what are relative opportunities	10	project will provide opportunities such as market garden development, supply of services, etc.	100		n/a		221.3	1	status quo	10		n/a		22.1
Total							919		917.6		1,073.9			631		524.6		535.6

Notes:
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- Sust. = Sustainability
- Soc. = Social
- Tec. = Technical
- n/a = Not applicable