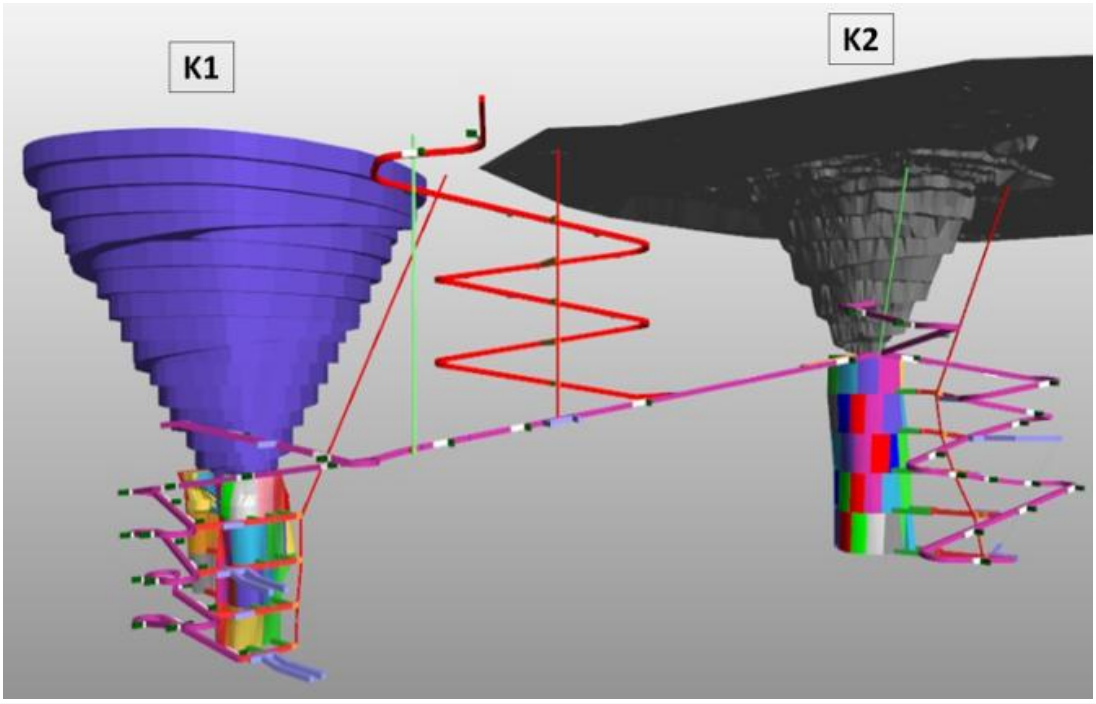
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY
FOR
KOIDU LIMITED'S UNDERGROUND MINING PROJECT



EXECUTIVE SUMMARY & MAIN REPORT
VOLUME 1A

Prepared by

CEMMATS Group Ltd

Freetown, Sierra Leone

August 2016

On Behalf of

KOIDU LIMITED

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Signed by:

Andrew Keili

CEMMATS Group Ltd

Beyoh House

7A Cantonment Road

Off King Harman Road

Brookfields

Freetown

Sierra Leone

Email: akeili@CEMMATSsl.com

Tel: +232 76602174

Website: www.CEMMATSsl.com

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We acknowledge the assistance, cooperation and active participation of the Koidu Limited Team, who made it possible for us to successfully carry out the study by availing us relevant documents and information, taking time out to have meetings with us, and reviewing the reports.

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LIST OF ACRONYMS

^{0}C Degrees Celsius

% Percentage

″ Inch

AC Affected Community

CBO community-based organisation

CC Conservation Concern

CDAP Community Development Action Plan

CEMMATS Construction Engineering Maintenance, Manufacturing and Technical Services

CHO Community Health Officer

CI Corrugated Iron

CITES Convention on International Trade in Endangered Species on wild flora and fauna

cm centimetre

Cm^2 Square centimetre

COD Chemical Oxygen Demand

dB decibels

DO Dissolved Oxygen

EC Electrical Conductivity

EPA-SL Environment Protection Agency Sierra Leone

ESIA Environmental and Social Impact Assessment

ESMP Environmental and Social Management Plan

ERP Emergency Response Plan

FAO Food and Agricultural Organization

FC Faecal coliforms

ft feet

GDP Gross Domestic Product

GIS Geographic Information Systems

GoSL Government of Sierra Leone

GPS Global Positioning System

H+ Hydrogen ion

HDI Human Development Index

IMR Infant Mortality Rate

JSS Junior Secondary School

kg kilogram

km kilometre
Km^2 Square kilometre
Le Leones
LoM Life of Mine
m metre
MCH Maternal and Child Health
MDA Ministries, Departments and Agencies
MAFFS Ministry of Agriculture, Forestry and Food Security
MFIs micro-finance institutions
mg milligram
mg/L Milligram per litre
mg/m^3 Milligram per cubic metre
MLCPE Ministry of Lands, Country Planning and the Environment
mm millimetre
Mm^3 Million cubic metres
MoHS Ministry of Health and Sanitation
MWHI The Ministry of works, Housing and Infrastructure
N North
NTU Nepthielometric Turbidity Unit
Na+ Sodium ions
NaCl Sodium chloride
NaOH Sodium hydroxide
NE North-east
NGO Non-Governmental Organization
ORP Oxidation-reduction potential
PAPs Project Affected Persons
PCDP Public Consultation and Disclosure Plan
PMU Project Management Unit
POPs Persistent Organic Pollutants
ppm Parts per million
ppt Parts per trillion
PRSP Poverty Reduction Strategy Paper
PS Performance Standard
RAMSAR Convention on wetlands of international importance

RAP Resettlement Action Plan

RH Relative Humidity

RPF Resettlement Policy Framework

S^{2-} Sulfide

SIA Social Impact Assessment

SLEPAA, 2008 Sierra Leone Environmental Protection Agency Act, 2008

Sp. Dist. Species Distribution

Sq. km Square kilometre

SSS Senior Secondary School

STDs sexually transmitted diseases

TC Total coliforms

TDS Total Dissolved Solids

TOR Terms of Reference

Turb. Turbidity

UGM Underground Mine

UN United Nations

UNCBD United Nations Convention on Biological Diversity

UNCCD The United Nations Convention to Combat Desertification

UNICEF United Nations Children's Fund

UNDP United Nations Development program

VES Visual Encounter Survey

VPL ventilated pit latrine

WHO World Health Organization

WMP Waste Management Plan

GLOSSARY

Aquatic Ecosystem	An aquatic area where living and non-living elements of the environment interact. This includes the physical, chemical, and biological processes and characteristics of rivers, lakes, and wetlands and the plants and animals associated with them
Avifauna	birds that live in a certain place or at a certain time
Biochemical Oxygen Demand (BOD)	A measure of the amount of oxygen consumed by aquatic organisms in the degradation of organic material. This is important because it is an indicator of how much oxygen will be removed from the water and the resulting stress on the aquatic ecosystem
Board of EPA-SL	This is a board of directors that form the governing body of EPA-SL; it is headed by the Executive Chairperson and consists of representatives of a number of line ministries and three other members of society
Client	One who uses the services or advice of a professional person or organization
Communities	A group of interacting people, living in some proximity (i.e., in space, time, or relationship) that shares common values and has social cohesion.
Community Development Action Plan (CDAP):	A CDAP is a plan of action to address key community issues that are based on the expressed needs and aspirations of the local residents of the community Project area. These issues are deemed as basic developmental needs in the Project area
Conservation	The planning, management, and implementation of an activity with the objective of protecting the essential physical, chemical, and biological characteristics of the environment against degradation; The process of managing biological resources (e.g., timber, fish) to ensure replacement by re-growth or reproduction of the part harvested before another harvest occurs. A balance between economic growth and environmental and natural resource protection.
Dissolved Oxygen	A measurement of the amount of oxygen available to aquatic organisms. Temperature, salinity, organic matter, biochemical oxygen demand, and chemical oxygen demand affect dissolved oxygen solubility in water
Ecosystem	A community of interdependent organisms together with the environment they inhabit and with which they interact

Environmental and social management plan:	A plan of action for the management of and minimising the loss of hazardous waste to the environment and maximising the reuse of waste where possible, as well as maintaining compliance with relevant legislature.
EPA-SL "checklist"	A list of procedures developed and provided by EPA-SL to be systematically followed by a client for the conduct of ESIA and the issuance of an EIA licence
Framework	An organized structure of policies, legislation, programs and tasks created to achieve a specific outcome. There can be frameworks for broad policies and strategic initiatives at various scales (*e.g.* provincial, regional, sector, media); programs and program delivery; and short-term tasks and projects
Freetown	The Capital City of Sierra Leone
Herpetofauna	General name for amphibians and reptiles
Human Development Index:	The Human Development Index (HDI) is a composite statistic used to rank countries by level of "human development", taken as a synonym of the older terms (the standard of living and/or quality of life), and distinguishing "very high human development", "high human development", "medium human development", and "low human development" countries
Invertebrates	Animal species that do not develop a vertebral column. This in effect includes all animals apart from the subphylum Vertebrata
Mammals	Members of class Mammalia , air-breathing vertebrate animals characterised by the possession of endothermy, hair, three middle ear bones, and mammary glands functional in mothers with young. Most mammals also possess sweat glands and specialised teeth
pH	A measure of the intensity of the acid or base chemistry of the water. A pH of 7 is neutral, while below 7 is acidic and above 7 is basic. pH in surface water is regulated by the geology and geochemistry of an area and is affected by biological activity. The distribution of aquatic organisms and the toxicity of some common pollutants are strongly affected by pH
Potable Water	Water that is used for drinking, cooking, dishwashing, or other domestic purposes requiring water that is suitable for human consumption

Project interested and affected persons	Any person who, as a result of the implementation of a project, loses the right to own, use, or otherwise benefit from a built structure, land (residential, agricultural, or pasture), annual or perennial crops and trees, or any other fixed or moveable asset, either in full or in part, permanently or temporarily
Project Proponent	An individual or organization that together with others, each of which is also a project proponent, has over all control or responsibility for the project
Reservoir	An artificial lake or impoundment from a dam that is used to store water for a regulated supply to generate electricity
Resettlement Action Plan (RAP)	The document in which a project sponsor or other responsible entity specifies the procedures that it will follow and the actions that it will take to mitigate adverse effects, compensate losses, and provide development benefits to persons and communities affected by an investment project
Resettlement Policy Framework	A framework for projects with subprojects or multiple components that cannot be identified before project approval. This instrument may also be appropriate where there are valid reasons for delaying the implementation of the resettlement, provided that the implementing party provides an appropriate and concrete commitment for its future implementation
Runoff	Water that moves across (or through) soils on the land during snowmelt or rainstorms
Salinity	Salinity is defined as the total solids in water after all carbonates have been converted to oxides, all bromide and iodide compounds have been replaced by chloride, and all organic matter has been oxidized (Shugar and Bauman 2001). The WHO recommended permissible limit for salinity is 0.4 ppt.
Seismicity	The types, frequency and size of earthquakes that happen over a period of time in a certain area
Socio-economic data/study	A data or study that examines social and economic factors to better understand how the combination of both influences something
Social Indicators	A "direct and valid statistical measure which monitors levels and changes over time in a fundamental social concern." Such as economic growth, values or goals

Stakeholders	Any and all individuals, groups, organizations, and institutions interested in and potentially affected by a project or having the ability to influence a project
Turbidity	The cloudiness of a fluid due to dissolved particles not individually visible to the naked eye.
Water Quality	The chemical, microbiological, and physical characteristics of water
World Bank	The World Bank is an intergovernmental pillar supporting the structure of the world's economic and financial order, it is an organization whose focus is on foreign exchange reserves and the balance of trade

EXECUTIVE SUMMARY

To be completed in Final Report

1 INTRODUCTION

CEMMATS Group Ltd. (CEMMATS) was appointed by Koidu Limited (KL) as an independent consultant to update its ESIA studies to cover the change of KL's operation from surface to underground mining. Digby Wells Environmental ("Digby Wells"), in association with CEMMATS, were appointed as independent consultants to assess the potential environmental and social impacts associated with the expansion of the existing mine's production plant from 50 tonnes per hour (tph) to180 tph, at the Koidu Kimberlite Project in 2011. Koidu Limited's operation is located in the Kono District of Sierra Leone, approximately 330 km east of the capital Freetown.

Development of the mine commenced in 2003, with the construction of a 50 tph dense media separation (DMS) plant and associated mining infrastructure required for bulk sampling and trial mining of No. 1 Pipe (K1) and No. 2 Pipe (K2). Processing of the first kimberlitic material from K1 began in January 2004 and continued until mid-2004, when sampling switched to K2. This allowed for preparation of the planned vertical pit at the K1, which required waste rock stripping and construction of the headgear, hoist and winder at the collar of the planned K1 vertical pit. Between August 2005 and December 2007, the mine focussed on extracting ore from the K1 vertical pit and initiated a comprehensive exploration programme to locate and evaluate all kimberlite ore bodies on the property, develop an optimal life of mine (LoM) plan and compile a full bankable feasibility study. The exploration programme was completed in mid-2010 and the feasibility study completed by the fourth quarter of 2010. Koidu Holdings was awarded an Environmental Impact Assessment (EIA) Licence for its 50 tph operation in September 2003. However, the proposed mine plan to increase the life of the operation, mine larger and deeper pits required updating of the ESIA and identification of any new impacts on the social and physical environments within the lease area as well as beyond its boundaries.

The purpose of the 2011 report prepared by Digby Wells and CEMMATS was to present the findings of the Environmental and Social Impact Assessment (ESIA) that had been undertaken for the Project, and to propose an Environmental Management Plan (EMP) to maximise the positive aspects of the project and to minimise or manage the negative implications.

With open pit mining on pipes K1 and K2 now drawing to a close, with operations on K2 already concluded since 2013, and operations on K1 completed by October, 2016 the financial uncertainties encountered with the open pit mining operations necessitated intense consultations with various parties including the GOSL, which included the possibility for underground mining. For Koidu Limited, the new underground scheme will have two distinct advantages:

1. It will enable Koidu Limited. to mine more economically and for a longer period with Life of Mine (L.O.M) being extended from December 2016 if utilising the open pit mining method, to 2021 using the underground mining method. This will have positive consequences for the country, especially its economy;

2. Many of the inimical environmental and social effects experienced with the current open pit operation will be greatly minimised by going underground.

After securing funding for the much anticipated mining by underground methods and finalizing plans for its implementation KL submitted the final revision of the "Octéa Limited Underground Mine Plan" to AMEC, SCB and GoSL. BSGR which gave final approval and commitment of financial responsibility for the Koidu Limited Underground Mine Plan on 18 February 2016.

KL then applied to EPA-SL for an amended Environmental licence for the transition to underground mining and was told it would require a new Environmental and Social Impact Assessment to do so. The old EIA licence acquired for its open pit mining operations does not cover the proposed underground mining operations and the changes in the overall mining operations warrant a comprehensive ESIA which will depict the associated environmental, social and health impacts of the new mining methodology as stipulated in the EPA Act, 2008 & MMA Act 2009 respectively.

This report constitutes the results for these studies carried out by CEMMATS. EPA has specifically stated that although the ESIA will concentrate primarily on the underground mining, the report should also cover the entire operation and should be current. This essentially means that the original ESIA study done by Digby Wells and Associates and CEMMATS will be utilised. Full credit has been given to DWA where this has been done.

1.1 Terms of Reference

In terms of Section 24 of the Environment Protection Agency Act, 2008 (Act 11 of 2008), any person who wishes to undertake a project in the mining and extractive industries must apply to the Sierra Leone Environmental Protection Agency (SLEPA) for an Environmental Impact Assessment (EIA) licence. The undertaking of an ESIA for the proposed underground mining programme is also a requirement of the Mines and Minerals Act, 2009 (Act 12 of 2009), which states that when the holder of a mining licence proposes to make a change in its mining operations that would cause a need for a material change in the Environmental Management Programme (EMP), the mining licence holder must submit an updated EMP for approval by the Director of Mines. This ESIA report has been compiled in fulfilment of the above legislative requirements and further aims to comply as best as possible with the Equator Principles (EPs) for socially and environmentally responsible project finance and the International Finance Corporation (IFC) 'Environmental, Health and Safety Guidelines, 2007'.

1.1.1 Scope of Work

The scope of work is split into the following two areas:

1. Work dealing directly with the underground mining operation and its impacts

2. Work dealing with updating the ESIA in areas of the existing operating as these areas will still be in use even with the new underground mining scheme.

The scope described would apply to the various stages of the operation viz planning, development, operation and closure stages.

The work could however be subject to slight variations after relevant discussions with the client and EPA-SL.

Work Dealing Directly with the Underground Mining Operation and its Impacts

Table 1.1-1: Underground Mining Issues

Field	Objectives	Methodology
Technical Operations	Describe operational aspects of the project with the view of determining possible impacts on the environment. This includes details of the underground mining project.	Relevant parts of the project, such as location, scale, capacity, equipment, installations, staff and support, schedule, risks, operations, facilities etc, will be described. Detailed mine plan will be reviewed and pertinent information used. Technical staff will be asked to do a technical description on how they would handle various issues. Specific reference will be made to laws related to underground mining in the operational regulations Attention will be paid to subsidence and hydrology, ventilation, electrical installation, fire safety considerations, occupational safety, waste management system, operations management (including, staff training), scheduled equipment maintenance and record keeping on site etc. Risks associated with these activities will be assessed.
Legal and regulatory issues	Describe and discuss legal and regulatory issues, international and local, that would be germane to the project	Pertinent, up-to-date legislation, regulations, and standards including operational regulations -sections dealing with UG mining and IFC guidelines governing all facets of Underground mining activities and how it affect society and environmental quality will be covered
Tailings and waste	Discuss and describe fundamental component of the design and operation of tailings and waste management facilities.	The design construction and operation of the waste and tailings facility will consider both engineering and environmental parameters in a manner that optimizes protection of human safety and the environment. On-land tailings impoundment systems will be designed and constructed in accordance with internationally recognized engineering practices, local seismic

Field	Objectives	Methodology
		conditions, and precipitation conditions.
Hydrology	Determine direct physical impacts of the project on both surface and groundwater.	Causes of floodwater and measures to handle floodwater will be investigated. This will include floodwater dams and the installation of floodwater pumps. Measures taken at various levels for flood protection will also be investigated. Data will be reviewed on ground water movement, structural geology, etc. Pumping requirements for water for various types o uses in and out o the underground mine operation will also be investigated.
Geology and Hydrogeology	Describe and discuss all relevant geological and hydrogeological information from the Client for studies performed in the area to date, and an assessment of the possible risk on the ground water table.	Review information available on the geology of the concession and on possible effect on ground water resources of the project. Onsite monitoring of surface and groundwater depth and level respectively. Hydrocensus data pertaining to the current groundwater conditions, abstraction point and current usage volumes will be taken into consideration.
Geotechnical Assessment	To characterize the soils and rock features in the study area that will be affected by the proposed project. Assess the stability of the land and proposed recommendation to prevent potential subsidence.	Rock/soil stability, stress and strain investigations to assess competence of materials in the area especially during mine development. Geotechnical data from previous studies will be reviewed and updated
Ventilation and Air Quality	To assess ventilation requirements and details of provision for air passage (inlet and outlet). Identify key aspects that might have significant air quality impacts during the project execution.	➢ Review and update ventilation assessment report ➢ Identification of point source of dust emission. ➢ Identification and quantification of dust emissions sources; ➢ Identification of types and sources of emissions
Noise Assessment	To identify the types and number of equipment used	➢ Preliminary survey of noise generated by equipment Sound pressure readings will be done

Field	Objectives	Methodology
	along with level(s) of noise generated by each. To identify potential measuring points	of the different equipment, the duration of use of equipment will be considered
Occupational Health and Safety	To identify the occupational health and safety hazards and / or risk employees will be exposed to and ensure their safety, health and welf are.	Risk assessment of the proposed underground mining will be carried out. The following Occupational health and safety issues will be considered: General workplace health and safety, Hazardous substances, Use of explosives, Electrical safety and isolation, Physical hazards, Ionizing radiation , Fitness for work, Travel and remote site health, Thermal stress, Noise and vibration and Specific hazards in underground mining (Fires, explosions, confined spaces and oxygen deficient atmospheres) will be done by a combination of desk studies, physical observation, and group discussions.
Ecology	A baseline investigation involving a desktop assessment and limited ground truthing will be undertaken covering the site to assess the ecology in the project area.	Previous data (on birds, amphibians, invertebrates, bats, small mammals, and primates. Sensitive and critical plant and animal species) will be reviewed and updated
Waste management	To characterise the different types of waste (Overburden, waste rock, tailings, mine water, gaseous waste etc) that will be generated at the different stages of the underground mining development and operation.	A review and update of the various types of waste. A description of specific waste to be generated and propose a plan for their management In compliance with good International industry practices as will be stipulated in the waste management plan.

Work Dealing with Updating the ESIA in Areas of the Existing Operations

The work to be done will be updating areas of the original ESIA. The extent of such work is indicated in the following table which is a modification of the original ESIA by Digby Wells.

1.2 Background and Context

The following section sets the scene for the ESIA report by providing a brief description of the history of Koidu Limited, as well as an overview of the proposed project.

1.2.1 Company History

The rights to the Koidu Kimberlite Project were originally secured in 1995 by Branch Energy Limited ("Branch Energy"). Branch Energy had obtained a 25-year mining lease for the Koidu Kimberlite Project and initiated development of the property in November 1996. The democratically elected government (which was elected in 1996) ratified and re-enacted the 1994 Mines and Minerals Decree under which the lease was issued. The Koidu mining lease was specifically ratified by an Act of Parliament in December 1996. In 1996, a Canadian listed company called DiamondWorks, acquired Branch Energy and all its mineral rights. In May 1997, the project was at the plant commissioning stage when a coup d'etat took place in Sierra Leone. Branch Energy was forced to halt its activities and invoke force majeure and, over the ensuing 5 years of conflict, the company's assets at Koidu were completely destroyed and no further work could be undertaken on the exploration properties. DiamondWorks revisited the mineral holdings in Sierra Leone after the war in 2002, targeting the Koidu Kimberlite Project, and began construction and redevelopment of facilities damaged during the period of civil unrest. In June 2002, DiamondWorks and Magma Diamond Resources Limited entered into a 50/50 joint venture agreement for the re-development of the Koidu Kimberlite Project. Magma was a wholly owned subsidiary of the privately owned BSG Resources Limited ("BSG Resources"). BSG Resources is the resources arm of the Beny Steinmetz Group ("BSG"), a private international investment group focusing on diamonds, natural resources, real estate, finance and asset management. BSG Resources has been involved in various major investments in the natural resources arena worldwide.

The initial joint venture was replaced by a new joint venture agreement, entered into between inter alia DiamondWorks, Branch Energy and Magma during September, 2002. In terms of the New JV Agreement, Magma and Branch Energy each held a 50% equity stake in the newly formed JV Company, Koidu Holdings S.A and were obliged to fund the working capital and running cost requirements of the Company pro rata their shareholding in the Company. Koidu Holdings S.A was incorporated in the British Virgin Islands and licensed to do business in Sierra Leone in terms of the Business Registration Act on 29 September 2003. A Certificate of Registration of Business and a Licence were issued to Koidu Holdings on 1 October 2003 in accordance with the Companies Act, Cap. 249 of the Laws of Sierra Leone 1960. Magma and Branch Energy agreed to a dilution of Branch Energy's shareholding in Koidu Holdings, such that the shareholding would be in proportion to the contributions made by the Shareholders to the Company. Further, Magma and Branch Energy agreed to the assignment by Magma of a portion of its Shareholders' loan to its holding company BSG Resources, and the introduction of BSG Resources as a Shareholder in Koidu Holdings. In terms of the Shareholders' Agreement, the new shareholding in Koidu Holdings became: 40%

DiamondWorks, 35% Magma and 25% BSG Resources. In January 2004, BSG Resources assumed overall direction, supervision and management of Koidu Holdings. In February 2007, BSG Resources acquired the shareholding of DiamondWorks (renamed Energem Resources Ltd) in Koidu Holdings S.A. and Magma's 25% holding was transferred to BSG Resources. Koidu Holdings therefore became wholly owned by BSGR Diamonds, Ltd, which is wholly owned by BSG Resources.

Inspired by the success of the Koidu operations, a major restructuring exercise was initiated towards the end of 2011 to enable the group to invest in other exploration and development opportunities in Sierra Leone and to attract financing partners for the injection of a further anticipated capital into the country's mining sector.

BSG Diamonds was renamed OCTÉA Ltd. Four wholly owned subsidiaries of OCTÉA Ltd were established namely: OCTÉA Mining Ltd, OCTÉA Diamonds Ltd, OCTÉA Services Ltd and the OCTÉA Foundation. OCTÉA Mining Ltd now owns the mining assets of the group, including the Koidu Kimberlite Project held by Koidu Limited (previously named Koidu Holdings S.A. but changed to Koidu Limited in July 2015, by the Registrar of Companies).

1.2.2 Exploration & Mining History

The property hosts two small diamondiferous kimberlite pipes and four diamondiferous kimberlite dyke zones, along which four small blows or enlargements have been discovered. Development of the mine commenced in 2003, with the construction of a 50 tph Dense Media Separation (DMS) plant and mining infrastructure required for bulk sampling and trial mining of K1 and K2. Processing of the first kimberlite from K1 began in January 2004 and continued until mid-2004, when sampling switched to K2 to allow for waste stripping and establishment of the headgear, hoist and winder and associated infrastructure required at the collar of the planned vertical pit at K1. During the period August 2005 to December 2007, the mine focussed exclusively on extracting ore from the K1 vertical pit, and was successful in establishing the largest and deepest one of its kind in operation world-wide, while attempting to minimise the impact on the nearby Koidu community. Given the limited lifespan of the vertical pit (maximum 80 m from collar), the Company embarked on an exploration core drilling programme to delineate sufficient resources for at least the remaining life of the mining lease period. From 2003 to 2008, four phases of core drilling were completed and once the magnitude of potentially mineable resources began to emerge, desktop studies considering the possible scenarios for the future expansion of the mining operation were undertaken. The full extent of the diamond resources at Koidu was understood towards the end of 2008, at which time the Company entered the prefeasibility study stage, contracting industry leaders in resource estimation, geohydrology, mine design and various other disciplines required in order to ultimately bring the project to a bankable feasibility study level. After significant additional bulk sampling exercises in 2009 and 2010, both from large scale surface excavations and large diameter drilling programmes on K2, Dyke Zones A and B, as well as the four blows intended to form part of the LoM plan, 4.175 million tonnes of

indicated resources and 10.162 million tonnes of inferred resources were signed-off by independent competent persons, with an additional 3.707 million tonnes of kimberlite identified as geological potential requiring further drilling and sampling. While the feasibility study was being concluded and following on after the completion of the bulk sampling programmes at K2, the first cut of the open pit mining schedule for K2 was initiated in order to fund the operation, with the intention of dovetailing with the final pit design determined in the feasibility study.

The feasibility study demonstrated that the optimal project plan for the expansion of operations at Koidu was technically and economically viable. The plan included mining both kimberlite pipes by open pit methods, to a depth of approximately 310 m below surface for K1 (March 2011 to September 2016) and approximately 244 m below surface for K2 (from September 2010 to October 2015), at which time the transition to underground mining methods would be made. Taking into account the additional production that could be derived by mining the kimberlite dykes and blows from underground, an optimal plant size of 180 tph was selected, mining at a rate of 100,000 tonnes of ore per month and 1.4 million tonnes of waste per month.

The open pit mining phase of the operation will be followed by underground mining of kimberlite pipes, as well as the dyke zones and blows, for the remainder of the life of the mine. With open pit mining on pipes K1 and K2 drawing to a close, with operations on K1 already concluded since 2013, and operations on K2 set to be completed by May, 2016 the financial uncertainties encountered with current open pit mining operations necessitated intense consultations with various parties including the GOSL, which included the possibility for underground mining.

1.3 Project Motivation

With open pit mining on pipes K1 and K2 drawing to a close, with operations on K1 already concluded since 2013, and operations on K2 set to be completed by May, 2016 the financial uncertainties encountered with current open pit mining operations necessitated intense consultations with various parties including the GOSL, which included the possibility for underground mining. For Koidu Limited, the new underground scheme will have two distinct advantages:

1. It will enable Koidu Limited. to mine more economically and for a longer period with positive consequences for the country, especially its economy;
2. Many of the inimical environmental and social effects experienced with the current open pit operation will be greatly minimised by going underground.

The following details on the new operation will collectively result in a significant reduction in environmental and social impacts of the project:

1. With underground blasting, no community evacuation is needed as at present because it will not affect the community
2. Limited water is needed to drill underground, and we will be using the water pumped from the open pit to supply the underground operation
3. The ground water and drilling water gets pumped back into the surface dam and re-used underground
4. Equipment requirement is much less than with open pit; the existing legacy fleet will continue to be used, and Articulated Dump Trucks (ADTs) sourced for underground use.
5. The waste (granite) tonnages will not even be one tenth of what it was with open pit mining, thus the waste dumps will not get any bigger. This in effect helps solve our current waste disposal problems.

Year	Waste tonnages	Comments
2012	10,716,615	Open Pit cut 1
2013	15,253,306	Open Pit end of cut 1 and start of cut 2
2014	15,508,431	Open Pit end of cut 2 and start of cut 3
2015	12,407,928	Open Pit cut 3
2016	1,166,353(60,996)	Open Pit end of cut 3 and start of underground
Total Open Pit	**55,052,633**	
2017	245,224	
2018	247,978	
2019	76,565	
2020	0	
2021	0	
Total Underground	**630,763**	

6. Dust and noise levels will reduce considerably

1.4 Objectives of the ESIA

The objectives of this ESIA report are to: Provide important background information to the project and its proposed expansion; Describe the project and its proposed expansion in terms

of the project applicant, location, scale, timing, duration and sequence; Describe the need and desirability of the proposed project; Identify all legal and legislative requirements that should be fulfilled prior to the commencement of the proposed expansion; Consider and analyse all possible alternatives to the proposed expansion; Describe the current biophysical, cultural and social environment of the project area; Identify the potential environmental and social impacts associated with all of the phases of the proposed project and determine their significance; Describe cumulative impacts of the proposed expansion; Formulate a management plan for achieving the environmental and social objectives for the project and mitigate the identified impacts; Indicate the public consultation and disclosure (PCDP) process that was conducted in support of this ESIA; and Formulate a preliminary closure plan for the proposed expansion.

1.5 Project Team

The ESIA process will be jointly undertaken by CEMMATS, an experienced Environmental Assessment consultancy with vast experience of working in the mining sector, and staff of Koidu Limited with considerable experience not only in the current operation but in underground operations worldwide. This collaboration would make for a comprehensive assessment that adequately addresses all the major issues that may arise from the new underground mining operations. Whereas the CEMMATS team has considerable experience in carrying out Environmental Assessments satisfying the requirements of EPA-SL, they will rely to a considerable extent on the technical information provided by the Koidu team; together they will address the various issues, their impacts, mitigation and management measures.

A summary of the relevant experience of both companies is presented below, including a description of the key qualifications of the key team members.

1.5.1 CEMMATS Group Limited

CEMMATS Group Ltd. is a multidisciplinary Engineering and Environmental Consultancy with considerable expertise in undertaking ESIA studies in Sierra Leone.

The CEMMATS team has been selected to give the right blend of skills and proven experience necessary to ensure both high technical quality and cost-effectiveness. Core team members are as follows:

Andrew K. Keili: M.Phil. (Min Studies), B.Sc. Hons. (Mining), (Newcastle Upon Tyne), C. Eng., FSLIE,. MIMM –Project Director

Mr Keili has responsibility for directing projects of a mining, technical services and environmental nature at CEMMATS Group Ltd. He is a mining and management professional with over 38 years of professional experience in Sierra Leone, United States of America and

Ukraine. Prior to founding CEMMATS, Mr Keili worked for Sierra Rutile Limited in several capacities including Chief Metallurgist, Chief Mine Planning Engineer and Operations Superintendent. Prior to this he worked for three years in supervisory capacities at the National Diamond Mining Company in Sierra Leone. Since founding CEMMATS with colleagues in 1995 he has worked in private industry, public institutions and in consultancy services and has been on the Boards of several private sector and public institutions including being a past member of the Environmental Board. Mr Keili has been engaged in the formulation and review of miscellaneous government policies in the mining, environmental and infrastructure areas and in technical feasibility studies and technical training. He was a member of the consultancy team that formulated the Operational and environmental regulations for the mining sector. He is currently a member of the panel of experts for the Sierra Leone Extractive Sector benchmarking process.

Mr Keili has spearheaded several Environmental Impact Assessment studies for various types of Industries including several types of mining companies over the past two decades. He is the Project Director.

Vanessa James: BSc (Hons) Mechanical Engineering, FBC, USL; MSc Environmental Management, University of Derby (ongoing)

Vanessa has worked with CEMMATS Group Limited as an Environmental Engineer over the past three years and is now the Manager of the Environmental Department. She has spearheaded work in Environmental Impact Assessments, Environmental Auditing and Environmental monitoring for various types of projects including projects in the hydropower, infrastructural development, agricultural development, manufacturing and processing sectors. She has also managed environmental engineering design projects involving the development and implementation of wastewater treatment systems. Before joining CEMMATS, she worked in the downstream petroleum sector as a Mechanical Engineer. Vanessa has undertaken a accreditation training course to undertake ESIAs in Liberia and is also fully certified by the Liberian EPA.

Josephine Turay: Master of Science in Development Studies, Njala University (NU), 2011 B.Sc. (Hons.) in Environmental Sciences, NU 2010

Josephine Turay is a proficient EHS professional, with over 10 years of experience in Environmental Health and Safety (EHS) management systems. She is the Project Environmentalist for CEMMATS. She was with Sierra Rutile Limited (SRL) for four and half years, during which she served in various capacities; as EHS Supervisor, Acting GIS Specialist, and EHS Scientist. Her experience includes safety, environmental, human resources, social affairs administration compliance and training.

She is knowledgeable in the development, implementation and review of high impact Environment and safety management systems: Including but not limited to, Environmental Impact Assessment, Environmental Management Plans, Monitoring, Risk Assessment,

Mapping, Safety Management Systems, Safety Audit and Project Management. Ms. Turay will work on all issues requiring environmental health and safety related to the project and will be responsible for report preparation and compilation.

Mr. Arnold Mason: MSc Mineral Exploration Delft, Netherland; B.Sc. (Hons) GeologyFourah Bay College University of Sierra Leone

Mr. Mason is an Exploration Geologist experienced in Geological mapping, geostatistics and exploration for rutile , gold, diamond and base metals, etc. with over twenty years' experience in the Ministry of Mineral Resources and Mining Industry in Sierra Leone with over 35 years of professional experience.

He worked as Director of the Geological Survey of the National Minerals Agency of Sierra Leone, which is the technical arm of the Ministry of Mines and Mineral Resources (2013 - 2015), with the responsibility for advising the Government of Sierra Leone on all matters pertaining to Geology, mineral resources and monitoring of geological Information. Mr. Mason is the geology specialist for this project.

Mr Mason has worked for several companies including the National Diamond Mining Company and Sierra Rutile Ltd. and has explored for several minerals including diamonds, titanium minerals, bauxite and gold.

Mr. Anthony Thomas Mansaray: MSc Mining Engineering, University of Mines and Technology Tarkwa (UMaT) Ghana, 2013. BSc (General) Geology, Fourah Bay College University of Sierra Leone, 2010

Mr. Mansaray is a Mining Engineer and Geologist working on projects in the areas of Mining, Geology and Environmental Services for CEMMATS; he has had working experience in Environmental and Social Impact Assessment (ESIA) studies on various projects ranging from Mining, Agriculture, Real Estate, Waste Oil Recycling etc. He also has experience in mining operations and geological field work (exploration project). Mr. Mansaray will be working on all mining and operations issues related to the project.

Mr Henry Maada Kangbai: B.Sc. (Honours, Upper Second Class), Mining Engineering, University of Wales, Cardiff, U.K. (1968)

A Mining Engineer by profession with forty seven years of diversified experience in the Operational, Personnel Management, and Community Relations areas of the Mining Industry. After working initially as a Mining and Mineral processing Engineer in the National Diamond Mining Company in Kono, he briefly worked as a Mineral processing Engineer in Sierra Rutile before becoming Personnel Manager. He later took over the Community Affairs Department at Sierra Rutile handling all community relations issues for the company including community development and Resettlement Planning. Hr has worked with

CEMMATS over the past ten years as a social scientist on several Environmental and Social Impact Assessments for various companies.

Mr. Kangbai will deal with all issues related to socio-economic and socio-cultural aspects of the project. Health, educational, cultural issues living conditions, expectations of the populace and several other allied issues will be handled by him.

1.5.2 Koidu Limited Team

The Koidu Limited team comprises an experienced group of personnel with extensive experience in underground mining development and operations.

The core team members are as follows:

Christo Swanepoel:

A Mining Engineer with 25 years experience in underground and open pit mining. Christo holds a Masters Degree in Project Management and a Mine Manager Certificate of Competency and is part of the Mine Manager Association of South Africa (AMMSA) and registered as a Professional Engineer. He is currently employed as the General Manager for Octea Mining. Christo Swanepoel joined the Koidu Kimberlite Project in 2012 just before the first cut was mined. Christo has been involved in an open pit to underground transition from the start and has been an integral part of the mine design and planning. Christo was part of the Delegation in 2010 to visit the mine in Chile where the 33 miners were trapped to review their mine design and planning.

Christo has started up 5 underground operations in the last 8 years practicing as a Mining Engineer with different underground mining methods with the focus on rock engineering strata control and support stability

Publications: Hard Rock Safety Conference

http://www.ammsa.org.za/knowledge-hub/presentation-archive/2010/finish/14-2010/895-samancor-chrome-rock-engineering-western-chrome-mines

Derick Van Der Merwe:

A Health/Safety and Emergency rescue specialist with 19 years' experience in Emergency and Disaster management and since 2011 part of the Koidu Limited Team. He has had considerable experience in the formulation and implementation of health and safety procedures and systems. Currently, the Koidu Limited acting Head of Department of SHEQ; overseeing all Safety, Health, Environmental and Quality operations.

Qualifications

- Chamber of Mines Safety Officers Diploma (Chamber of Mines)
- National Certificate in Emergency Care and Technology (University of Johannesburg)

- Advanced Rescue Technician (North West School of Emergency Care)
- Rope Technician (North West School of Emergency Care)
- Fire Fighter II (SAESI)

Frederick Petersen

Frederick Petersen has 27 years of mining experience. He has worked, trained and qualified in South-Africa deep level gold mines, completed a variety of courses in Rock Mechanics, Health & Safety Management and MQA Certificate in the narrow tabular rock formation. Frederick completed a two year course as Learner Official, obtained blasting ticket, on setter's ticket, Shift Boss certificate, Production Mine Overseers course and Mine Overseers Certificate of competency.

From 2004 Production Mine Overseer and Unit Business Manager on Deep level gold Mines. Mining method conventional.

From 2010 Mine Overseer/Site Manager in Zambia. Mining methods were high-speed trackless development. Frederick joined the Koidu Limited team in 2014 as Acting Mining Superintendent.

Miles van Eeden (Pr.Sci.Nat)

Board certified Geologist by the South African Council of Natural Scientific Professions. He is a multi- commodity professional with specialisation in applied geology and a second major in Environmental and Water Sciences. He is currently employed as the Chief Geologist and acting HOD of Technical Services at Koidu Limited. Miles van Eeden was part of a mine study group for Rio-Tinto on an open pit to underground transition and a subsequent second lift block cave development at a copper magnetite mine. This involved geotechnical characterisation of the rock mass below an 898m deep open pit.

Miles has also managed offshore diamond exploration and production projects for De-Beers Marine using GIS and Ocean Floor Bathymetry for diamond placer exploration and exploitation. Miles has also been involved as a consultant in Shale Gas Exploration in the Karoo Basin his methods of exploration included X-Ray Diffraction, Modal, and Principal Component Analyses on potential reservoirs and Scanning Electron Microscopy on potential source rocks and thin section analysis respectively.

Publications:
http://inkaba.org/publications/workshops/workshop8/presentations/InkabaWS8_S4_Pres17.pdf

http://www.sagaonline.co.za/2009Conference/CD%20Handout/SAGA%202009/PDFs/Abstracts_and_Papers/vaneeden_abstract.pdf

Freddie van Urk

Freddie has over 20 years' experience in the area of diamond processing. Having started off in the diamond dredging operations in various African countries, including Sierra Leone as Project Manager in alluvial diamonds; he later acquired the knowledge and skills regarding kimberlite diamond processing. Being part of the Koidu Limited team since 2004 with the startup of the mine, he has gained extensive knowledge in the field of diamond processing as Plant Manager. He was also involved with the planning and commissioning of the new 180tph Processing Plant during 2013 and has since been appointed Koidu Limited HOD Metallurgy.

Henry Robert Vagg

A qualified and registered Engineer in building construction and has been working over 30 years in resettlement programs, community based programs with UNHCR, USAID, DANCHURCH AID, DFID and the EU and British Council. Henry has worked in Iraq for 8 years in resettlement/refugees programs and in Kosovo/Albania/Liberia/Afghanistan, as well as Sri Lanka after the 2014 tsunami.

Henry Vagg has over the last 16 years been working in Sierra Leone involved with DDR program funded by World bank Trust, EU resettlement programs, DFID Ex-Combatant Re-Integration Program, and DFID/GOSL Infrastructure Program.

He has worked over the 16 years within almost all of the chiefdoms throughout Sierra Leone and has expansive knowledge in working with traditional leaders, elders and communities as well as understanding the culture.

Henry Vagg has been working as the Koidu Limited HOD Community Development department for almost 5 years and is now responsible for the resettlement program for Koidu Limited.

Mumbi Mulele

Human Resource Manager who has 15 years of administrative and management experience. In her current role, she has been exposed to technical aspects of the mining business and industry. Contemporary issues of diversity, culture and human resource policy implementation in Sierra Leone is part of her resource management function. She has been involved in various human resource aspects such as; mass recruitment, on-boarding and staff retention programmes of the operation's phases from expansion to full stage.

As part of Koidu Limited's corporate social responsibility in respect of community stakeholder engagement, she has held the position of Treasurer for the Village Resettlement Committee, which is a Resettlement Action Plan committee overseeing project affected person and other aspects. Budgets asset and management auditing was the main tasks of the job.

Alain A. Sultan

A strategic and hands-on executive deeply experienced in financial management. Expert Financial executive overseeing all aspects of business performance. Professional that uses an "out-of-the-box" approach to problem solving and consistently drives bottom-line.

1.6 Assumptions and Limitations

- The EIA study will be done to meet the local requirements for securing the EIA license. The Sierra Leone Environment Protection Agency Act, (SLEPAA) 2008 and the EIA Supplementary Acts, 2010, stipulate an Environmental Impact Assessment (EIA) must be undertaken before the proposed underground mining commences. The EIA must ensure that environmental consequences are considered at all stages of the project. In addition, the EIA will assist Koidu Holdings and its consultants to proceed with its underground mining with sound environmental principles. It should be remembered that the term 'environment' in the context of an EIA refers to the biological, physical, economic and social environments.
- EPA has specifically stated that although the ESIA will concentrate primarily on the underground mining, the report should also cover the entire operation and should be current. This essentially means that the original ESIA study done by Digby Wells and Associates should be updated.
- KL will provide as much technical information to CEMMATS as possible relating to several aspects of the project, infrastructure development, processing, manpower, occupational health and safety, community development programmes etc. CEMMATS would require information from Koidu Limited on the various facets of the underground mining programmes; information on technical issues and processes are to be supplied by the KL specialists.
- Consultation will be carried out and relevant information disseminated throughout the execution of the project which will keep to the tenets of a proper Public Consultation and Disclosure Process (PCDP) for an EIA.

2 PROJECT DESCRIPTION

2.1 Applicant Details

Koidu Limited is a diamond mining company in Kono District, Eastern Sierra Leone, with a current mining lease concession area of 4.9873 Km^2 approximately 360Km east of the capital city, Freetown.

The applicant details and contact information are summarised in the following table.

Table 2.1-1: KL Management Details

Project title:	Koidu Limited Underground Mining Project
Project applicant:	Koidu Limited
Contact person:	Mr Christo Swanepoel – General Manager
Postal address:	PO Box 72, Freetown, Sierra Leone
Telephone no:	+232 99222002
E-mail address:	cswanepoel@octeagroup.com
Project location:	Koidu Town, Kono District, Sierra Leone

2.1.1 ESIA Licensing

Koidu Limited was awarded an Environmental Impact Assessment (EIA) Licence for its then 50 tph operation in September 2003. Following the projects expansion to incorporate a 180tph processing plant, an ESIA was carried out and a new EIA Licence issued in 2012.

KL, after applying to EPA-SL for an amended Environmental licence for the transition to underground mining, was told it would require a new Environmental and Social Impact Assessment to do so. The old EIA licence acquired for its open pit mining operations does not cover the proposed underground mining operations and the changes in the overall mining operations warrant a comprehensive ESIA which will depict the associated environmental, social and health impacts of the new mining methodology as stipulated in the EPA Act, 2008 & MMA Act 2009 respectively.

2.2 Current Project Details and Location

The Koidu Limited mine site is situated approximately 2 Km south of the town of Koidu within the Tankoro Chiefdom of the Kono District in Eastern Sierra Leone.

The 4.9873 Km^2 concession area hosts two small diamondiferous kimberlite pipes and four diamondiferous kimberlite dyke zones, along which four small blows or enlargements have been discovered.

Development of the mine commenced in 2003, with the construction of a 50 tph Dense Media Separation (DMS) plant and mining infrastructure required for bulk sampling and trial mining of K1 and K2. Processing of the first kimberlite from K1 began in January 2004 and continued until mid-2004, when sampling switched to K2 to allow for waste stripping and establishment of the headgear, hoist and winder and associated infrastructure required at the collar of the planned vertical pit at K1.

During the period August 2005 to December 2007, the mine focussed exclusively on extracting ore from the K1 vertical pit, and was successful in establishing the largest and deepest one of its kind in operation world-wide, while attempting to minimise the impact on the nearby Koidu community.

Given the limited lifespan of the vertical pit (maximum 80 m from collar), the Company embarked on an exploration core drilling programme to delineate sufficient resources for at least the remaining life of the mining lease period. From 2003 to 2008, four phases of core drilling were completed and once the magnitude of potentially mineable resources began to emerge, desktop studies considering the possible scenarios for the future expansion of the mining operation were undertaken.

The full extent of the diamond resources at Koidu was understood towards the end of 2008, at which time the Company entered the prefeasibility study stage, contracting industry leaders in resource estimation, geohydrology, mine design and various other disciplines required in order to ultimately bring the project to a bankable feasibility study level.

After significant additional bulk sampling exercises in 2009 and 2010, both from large scale surface excavations and large diameter drilling programmes on K2, Dyke Zones A and B, as well as the four blows intended to form part of the LoM plan, 4.175 million tonnes of indicated resources and 10.162 million tonnes of inferred resources were signed-off by independent competent persons, with an additional 3.707 million tonnes of kimberlite identified as geological potential requiring further drilling and sampling.

While the feasibility study was being concluded and following on after the completion of the bulk sampling programmes at K2, the first cut of the open pit mining schedule for K2 was initiated in order to fund the operation, with the intention of dovetailing with the final pit design determined in the feasibility study.

Open pit mining on pipes K1 and K2 is drawing to a close, with operations on K2 already concluded since 2013, and operations on K1 set to be completed by mid 2016. The financial uncertainties encountered with current open pit mining operations necessitated intense consultations with various parties including the GOSL, which included the possibility for underground mining. For Koidu Limited, the new underground scheme will have two distinct advantages:

3. It will enable Koidu Limited. to mine more economically and for a longer period with positive consequences for the country, especially its economy;
4. Many of the inimical environmental and social effects experienced with the current open pit operation will be greatly minimised by going underground.

2.2.1 Regional Setting

Kono District is in the Eastern Province of Sierra Leone, and borders with Kenema District to the southwest, the Republic of Guinea to the East, Koinadugu District to the northeast and Kailahun district to the southeast. Its headquarter town and also largest town in the district is Koidu, which lies to the north of the Koidu Limited project area (OCHA, 2015).

Figure 2.2-1: Kono District

Kono District is the largest diamond producer in Sierra Leone, with diamonds first discovered in the area during the 1930s (OCHA, 2015).

The diamond mining industry has attracted many people from other parts of the country to settle down in Kono, making the district a cosmopolitan one. Gold and alluvial diamond mining are important economic activities of the residents. Although agriculture has not been the main source of livelihood of the majority (less than 30% rely on farming), in some areas rice, cassava, corn, and beans are grown and small groups of residents grow coffee, cacao and palm oil (OCHA, 2015).

2.2.2 Local setting

The Project area is located in Tankoro Chiefdom, Kono District; the concession area and boundary coordinates are shown in the following table.

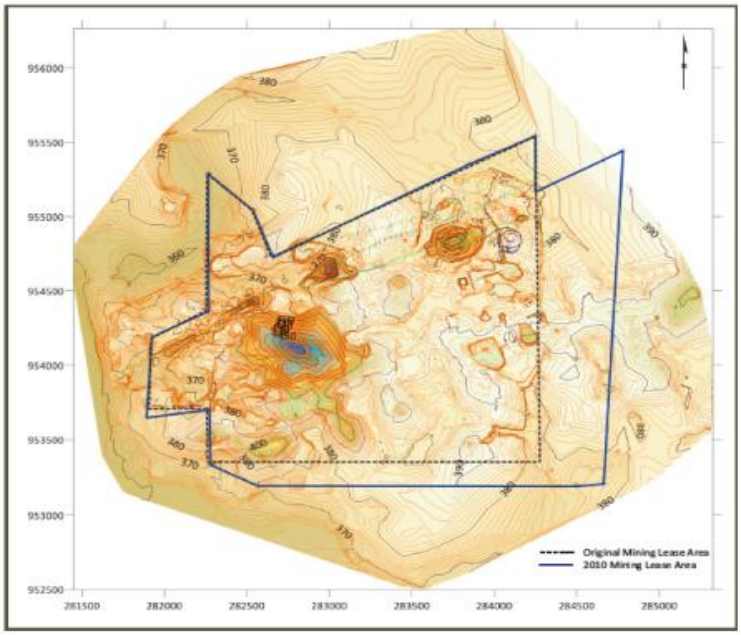


Figure 2.2-2: Koidu Limited Kimberlit Mining Lease area

Beacon	Coordinates		WGS-84 UTM Zone
	X (m)	Y (m)	
1	282268	955286	29
2	282542	955042	29
3	282662	954725	29
4	283850	955350	29
5	284251	955540	29
6	284251	955165	29
7	284780	955440	29
8	284660	953210	29
9	284500	953200	29
10	282569	953198	29
11	282283	953340	29
12	282276	953701	29
13	281900	953650	29
14	281930	954195	29
15	282268	954363	29

2.2.3 Land Tenure

The mining lease issued in 1995 was valid for a 25 year period. However, due to the civil war, force majeure was invoked in May 1997 and was lifted following the official declaration of the end of the war on 18 January 2002. The 1995 mining lease was transferred to Koidu Limited, including all rights, privileges, duties, obligations, title and interest as from 1 October 2003.

In terms of the Mining Review Process initiated by GoSL in 2008, the mining lease held by Koidu Limited was renegotiated and a new agreement entered into between the Republic of Sierra Leone and Koidu Limited on 6 September 2010. The term of the mining lease was extended to 22 July 2030 and shall continue in force until the expiry, surrender or termination of the mining lease. The mining lease may be renewed for a further period of 15 years.

In addition to the mining lease, Koidu Limited holds a surface lease over the land adjacent to the western boundary of the mining lease area which is used for the accommodation complex.

2.2.4 Nearby settlements

Within the surveyed project area there are five main settlements, namely New Sembehun, Saquee Town, Sokogbe, Swarray Town and Yormandu. These settlements fall within or

border on the mining lease area. A sixth settlement, Manjamadu (which includes the existing resettlement site), is located along the eastern boundary of the mine. Other neighbouring settlements are Old Meama, Wordu and Kanya.

2.2.5 Accessibility

The Koidu Limited mine site can be accessed by vehicle in an approximately 5 hour drive from Freetown. The road linking Freetown and Koidu has undergone massive rehabilitation and construction, with road works now nearing completion.

Roads inside the concession area are on average 9 m wide and cover approximately 15.5Km. Roads are constructed with waste rock and topped with compacted kimberlite tailings. Most of the roads in use are utilised by heavy mining and light vehicles and are maintained regularly.

2.3 Project Description and Resource Requirements

2.3.1 Underground Mining Operations

The development phase of the project is projected to be carried out over a period of ten (10) months. Activities involved during this phase are presented in this section.

2.3.1.1 Development phase

2.3.1.1.1 Development of access adit

This will start with the development of an adit to access the ore. The location of the adit is based on many factors, but mainly on ground conditions. De-watering operations will ensure that surface water is minimal at the time of construction to avoid potential flooding. The access adit will be drilled using a Sandvik DD420-40C drill rig. The adit will be blasted using Megapump (pumpable) emulsion. The support drilling will be done with a Sandvik DD420-40C drill rig and the support sets will be installed manually by the drill rig, with the assistance of a modified cassette on a FEL (to replicate a scissors lift). The loading of blasted material will be done with Sandvik 410 LHDs. The hauling of loaded material will be done with Volvo A40 ADT's that are currently used in the open pit; hence, no new dumptrucks would be required. The access adits will be developed measuring 5.0m x 6.0m. A specialist raise boring company will be brought in to undertake raise boring required for the planned ventilation holes. Both the access and development tunnels will be supported throughout with split sets which is an active support system; additional supports will be installed at geological intersections of concern.

Figure 2.3-1: Development of an Entrance Adit

2.3.1.1.2 Pit slope stability

The majority of the joints encountered in the pits are sub-vertical, resulting in a tendency towards localised toppling and ravelling failures. However, the J1 joint set has flatter dip angles in certain areas, resulting in the formation of complex wedges. The persistence of these flatter dipping joints is of crucial importance to pit slope stability and pit – underground interaction. The presence of groundwater negatively impacts on the stability of the slopes. However, experience shows that the K1 pit was successfully dewatered. This dewatering will need to be maintained for as long as access to the mining operations is required.

Geomechanical design parameters for the Koidu slopes were derived from an adequate geotechnical material strength database and are considered equally valid for underground design purposes. This data is based on geotechnical logging from exploration holes, which fall mostly in the open pit mining areas. Due to the geological conditions at Koidu a significant variation in geotechnical conditions from the open pit to underground rock masses is not expected. A well maintained dewatering programme is required for on-going stability of the slopes. Stack angles exceeding 60° are not recommended due to the associated high rockfall risk. This rockfall risk was analysed and considered to be acceptable at the recommended slope angles. With on-going access to planned future mining operations, there is a requirement for on-going slope stability monitoring and rockfall risk mitigation until the pit haul roads are no longer required for access.

2.3.1.1.3 Floodwater dams and chamber

Initially, the surplus decline development is to be used as dams to hold floodwater in the event of a 10 or 20 year flood lower down in the mine, where the flooding cannot affect production. As the stoping catches up to the decline development, the floodwater dams on every second level are completed and the emergency floodwater pumps are installed.

However, a floodwater dam and pumping chamber are to be situated on every second level in the decline of each pipe.

2.3.1.1.4 Water supply

Service water will be pumped from surface water dams and fed into the mine as service water for operations. Bottled water will be purchased for drinking.

2.3.1.1.5 Power supply and communications

Power supply to the property is currently from a generator station, comprising five 1.8 MW diesel generators. This power plant is still relatively new as it was commissioned in 2012.
The current generator set up of the existing power plant is as follows:-

- 2 generators are in continuous use for the process plant and other users;
- 1 generator is used for power surge;
- 1 generator is kept for maintenance and;
- 1 generator is spare.

Power will be fed via cables to the underground workings.

2.3.1.1.6 Occupational health and safety issues

Workers will be exposed to occupational health and safety hazards and risks. Risk assessment of the proposed underground mining will be carried out before development activities commence. A system of hazard identification and risk assessment inherent to activities undertaken will be implemented in order to define procedures, controls and equipment aiming to minimize risks to a level as low as reasonably practical. Accident/ Incident reporting is promoted to ensure proper investigation determining the root causes followed by implementation of corrective/ preventive action minimizing potential recurrence.

Several OHS issues will be considered. These include but will not be limited to: General workplace health and safety, Hazardous substances, Use of explosives, Electrical safety and isolation, Physical hazards, Ionizing radiation, Fitness for work, Thermal stress, Noise and vibration and Specific hazards in underground mining (Fires, explosions, confined spaces and oxygen deficient atmospheres).

Management will implement several hazard control systems. OHS issues are fully covered in section 2.3.1.2.6.

2.3.1.1.7 Workshops

A 6.0m by 7.0m height underground workshop will be situated along the middle of the K1 and K2 underground connecting crosscut with a design of 2.0m by 20.0m long service bays.

The facilities for the proposed project will include the following:

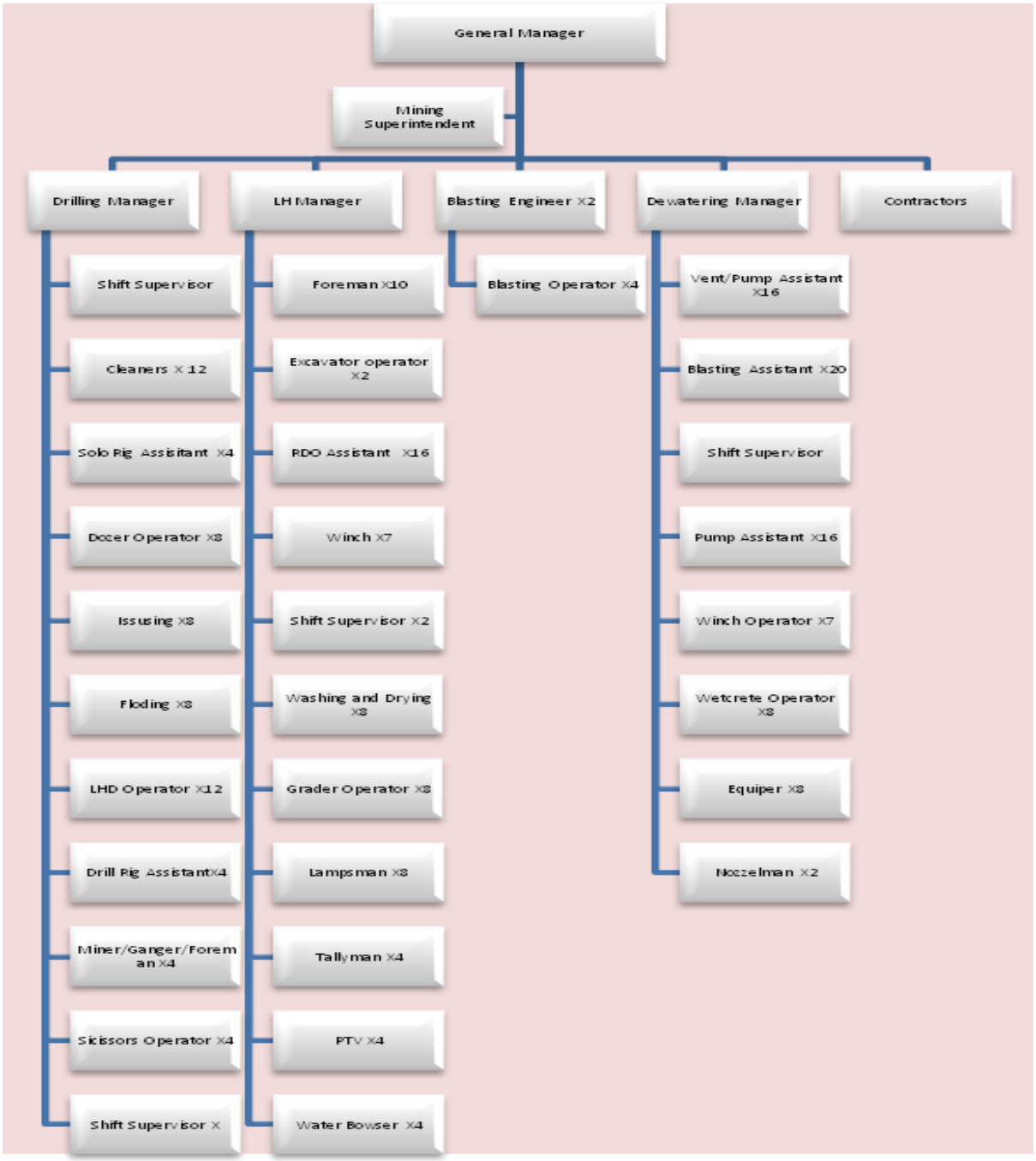
- Service Bay 1 will be equipped with 10t electric overhead travelling crane
- Service Bay 2 will be equipped with 1 wash bay and 1 bypass loop.

The major engineering work will be done at the existing on-surface workshop while minor servicing of all drill rigs and load haul dumps will be in service cubbies on the sub-levels. All tyres will be serviced on surface while Fuelling and lubrication will be by bowsers or utility vehicles supplied from the surface.

2.3.1.1.8 Organisational structure

The organizational chart below shows the structure of proposed underground mining operation and the relationships and relative ranks. There will be contractors for various specialist operations. Meanwhile the structure for the rest of the operations will not change much from the present as many aspects of the operation will still be functional during the development phase. As part of strategy drive to achieve the Company's goals, i.e. the change of operation from open pit to underground Mining, the current structure will be use as a tool to ensure adequate resource allocation for assurance of operations continuity and target achievement, job allocation, outlined job specifications and descriptions with clear line of reporting.

Overall, the structure is a guide to ensure proper communication flow with in different departments.



2.3.1.2 Operations phase

2.3.1.2.1 Mining method

The sub level open stoping method has been selected as the mining method to be employed for the operation. All stopes (Ore Blocks) are planned at a height of 40m with K1 having four stopes and K2 having 3 stopes. In order to successfully mine the SLOS a method using 40m up-hole drilling has been chosen based on the size of the pipe and the time constraint to develop the first ore block. Three kimberlite drives (4.5 X 4.5m) will be developed through the pipe spaced 20 m apart. To successfully mine the SLOS a breaking point (free face) is

required to create the first slot. A 1.5m diameter slot will be drilled from the centre drive to create a breaking point for the 76mm up holes to break into. Once the slot has been created the ring drilling can commence. The rings will be drilled from the kimberlite drive by means of a Sandvik DL421 solo long hole drill rig with a 76mm hole size. The spacing of the rings will be 2m apart. Fan drilling is where holes are drilled fanning out from the roof of the sublevel.

It is recommended that a minimum of 2 rings are charged per blast. These 2 rings will be blasted as a unit. This removes a panel of ore from the working end of the drift allowing for retreat away from broken ore. The second blast will use the open space from the first blast to expand into. Rings from the other drives will be pre drilled for efficiency and can allow for multiple blasts at one time. This will allow for the bigger and more productive blasts and also improves the efficiency.

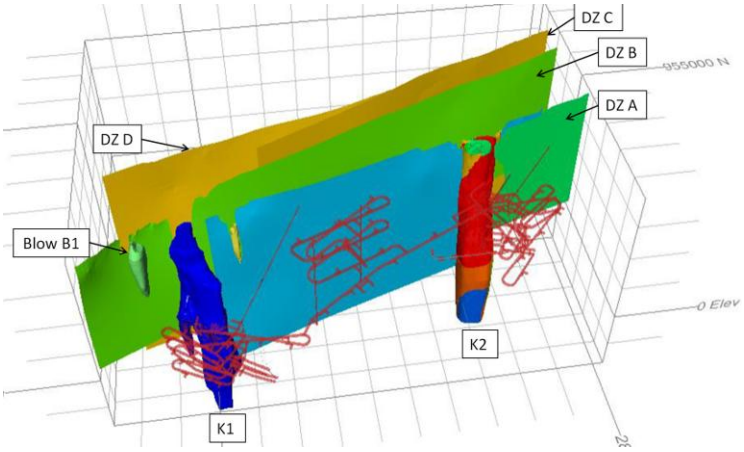


Figure 2.3-2: Underground Mining Design showing Ore Reserves

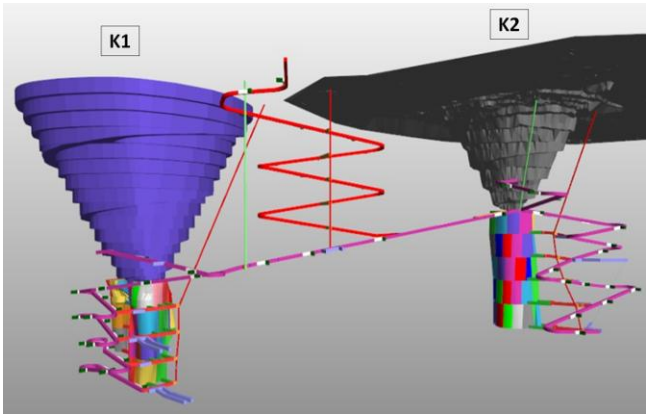


Figure 2.3-3: Underground Mining Design

2.3.1.2.2 Mining equipment

Several equipment will be required for underground development and production. These will include drill rigs, explosives transportation equipment, loading equipment, hauling

equipment, graders, compressors and generators. The fleet of Volvo A40 ADT's, which are currently in use in KL's open pit will be utilised as the underground haulage fleet (KL currently owns 21) as their size specifications are within the required limits for underground.

Below is a list of the total equipment required for underground development and production:

Table 2.3-1: Open Pit Mining Machinery

Function	Description	New Requirements	Second Hand Requirements	Total
Drilling	Sandvik DD420-40C Double Boom Drill Rig	1	2	3
Drilling	Sandvik DL421Solo Long Hole Rig	1	0	1
Blasting	BME Charging Unit	2	1	3
Blasting	Explosives Transport	0	2	2
Blasting / Support	FEL Basket attachment	0	2	2
Blasting / Support	AARD UV80 SL3030	1	0	1
Support	Shot Crete Machines	0	2	2
Support	30m of steel set	1	0	1
Loading	Sandvik LHD 410	1	2	3
Loading	Sandvik LHD 514 (Remote controlled)	2	0	2
Hauling	Volvo A40 ADT	0	11	11
Auxiliary	Grader	0	2	2
Services	Mobile Compressor	0	2	2
Services	500kva Generator	0	5	5
Total		**9**	**31**	**40**

In May 2016, the first of the underground mining equipment arrived at the mine site. The Sandvik Toro 007 LHD will be used to load material in the underground infrastructure development. Other equipment to have arrived to date include one drill rig and two more LHDs.

2.3.1.2.3 Engineering support

Support will be required by both the access adits and development tunnels. Both will be supported with split sets and wire meshed, and additional straps will be installed at the required geological Intersections. When a welded mesh is required, a minimum wire thickness of 5mm is mandatory. For a diamond mesh, the minimum wire thickness allowed is 4.5mm. The aperture size of the mesh must be a minimum of 100mm x 100mm and a maximum of 200mm x 200mm Support holes will be drilled using the Sandvik DD420-C double boom drill rig. The initial 30m of the access adits will be supported with permanent steel sets. Split sets with a washer size of at least 1.5 times the mesh aperture size must be used.

2.3.1.2.4 Ventilation

Koidu Limited intends to firstly implement primary ventilation at K1, then at a central point and then finally at K2. Intake ventilation will be drawn from the open pit

It is good ventilation practice to ensure that fresh available air from surface enters the decline adit and flows down the mine into the exhaust fan column situated at the face or where the development is actually taking place. This practise allows for all or most of the pollutants to be controlled within the ventilation ducting and not exposing employees in the "back area "to harmful pollutants such as heat and gasses. The development is to be treated as a "force/ exhaust system" whereby air enters the underground workings and flows down the haulage. The air then enters the exhaust column. Prior to the air entering the exhaust column, it is picked up by a "force fan system" and deposited on the face. The available air and force fan air then enters the exhaust column and is "dumped" outside the mine. This system allows for the majority of the underground operations to be in through ventilation almost all of the time.

The ultimate primary ventilation required for Koidu underground mine (during steady state mining – Phase 5), is 405 m^3/s from a total of six main forcing fans (two fan stations) on surface at K1 and K2. This air flow is sufficient for the dilution of pollutants (heat, dust, blast

fumes and diesel emissions) and to meet minimum air velocity requirements for production and services (workshops, etc.)

A ventilation officer will be hired to oversee the installation and maintenance of the ventilation systems. A specialist raise boring company will be brought in as a Contractor to undertake raise boring required for the planned ventilation holes.

2.3.1.2.5 Occupational health and safety issues

a) General Occupational Health and Safety Issues

The Safety Management Plan documents the systems and processes that will be implemented over time during the underground development of the Koidu Limited mine site to ensure compliance with local and international standards.

Koidu Limited (KL) will attempt to manage risks in the workplace by applying accepted and systematic risk management principles combined with expert skills and experience of staff members. KL will ensure best practice at all times at the same time ensuring that all systems and procedures are based on the principle of safety first. Koidu Limited understands that they are ultimately responsible for Health and Safety of their workplaces, and they actively empower their employees to drive Safety across the organization and will commit to working toward a ZERO harm policy. The company will set goals and objectives to determine Health and Safety progress and will work according to Sierra Leone Legislative standards and requirements.

Risk Assessment which KL will adopt is a basic management tool and a fundamental process in meeting the Employer's Duty of Care obligation to provide safe systems of work and a safe working environment where employees are not exposed to hazards.

Department Heads are responsible for ensuring that they are continually working towards improved Safety and health standards across the business and that known risks are controlled as far as is practically possible. Department Heads are responsible for committing to and leading a positive safety culture and ensuring that this commitment is reflected throughout Koidu Limited.

Koidu Limited will develop Occupational Health and Safety Procedures and Management Plans that set minimum and mandatory operational requirements for all staff and Support Service Providers on all Koidu Limited Site.

The Operational Mandatory Procedures may include but may not be limited to: Safe work place declaration, Working at Heights, Permit To Work, Incident - Event Reporting, Confined Space Entry, Fatigue Management, Lifting and Lowering Management, Electrical Safety, Excavation & Penetrations, High Voltage Switching, Vehicles and driving, Isolation and Tagging, Hot Works, Personal Protective Equipment, Elevated Work Platforms, Barring Down, Inspection of Ladder-ways Installing, Ventilation, Underground Support

Emergency Response and Preparedness

Koidu Limited's Emergency Management Methodology demonstrates an integrated framework of incident response, emergency and crisis management plans designed to enable all relevant parties associated with the Company to act quickly, decisively and cooperatively in any crisis or emergency situation, ensuring an appropriately-measured level of response and recovery actions, depending on the nature, location and potential gravity of any given incident.

For the purpose of enabling consistent response and recovery actions and responsibilities across of Koidu Limited, all component plans of the framework recognize a consistent three level company Incident Classification System. The level at which an incident is declared determines which response and recovery plans are implemented and which response and recovery teams are mobilized.

The Koidu Limited Emergency Management Team comprises competent and trained senior management who are responsible for managing high level emergency and crisis response and recovery for the Company, in accordance with the provisions of the Emergency Management Plan.

b) Specific Underground Health and Safety Issues

General Electrical Safety issues

KL's Policy on General electrical safety applies to the Electrical department-all electricians and personnel working with or near electrical equipment, on surface or underground. Procedures are outlined so that personnel can be safety conscious when working with or near electrical installations/equipment, on surface or underground, to reduce the risk of injury.

Handling of Underground Explosives

The policy on handling of underground explosives outlines the standard procedures that should be adhered to during storage and transportation of explosives. These procedures cover the storage and transportation of all explosives from the magazine to the end users and the destruction of expired explosives. They also take into consideration the following stipulations in the mining regulations:

MR 103 License to Store
MR 106 Application for a License to Construct a Mining Magazine and to store Explosives
MR 110 Storage of Explosives in Magazines, Days Boxes or Vehicles
MR 111 Safety Measures

Working in a Confined Area and Blasting

The aim of this Standard Procedure by KL is to protect equipment and machinery installed in existing excavations where blasting is to take place. This Procedure is applicable to Koidu Limited Workers and contractors.

Handling General Emergencies

The policy ensures that a formulated action plan is in place to cover the various scenarios which would constitute an emergency.

It covers several types of emergencies including the following:

- Basic Emergency Plan.
- Attack on Isolated Employee.
- Armed Robbery.
- Protest / Demonstration Action.
- Civil Unrest. Peace in Koidu Town and surrounds may be disrupted as a result of Civil Unrest. Unrest
- Military Threat.
- National Emergency (Coup d' Etat).

Communications

The communications system covers several facets of the operation, namely:

- Voice Communication System
- Entry/Exit Tracking
- Proximity Alert System
- Evacuation System
- Gas Monitoring
- Wi-Fi Access Points
- Electronic Tag Board

The Head end Cabinet will connect via fibre back to the SCC building and onto the existing security network. From the head end cabinet going down the underground tunnel there will be field nodes placed 300m apart with PoE switches that will connect cameras and other services back to the control room for monitoring. Cameras will be installed according to field node placement 120m from the node back and forth. Cameras will be utilized for emergency incident reporting and will be monitored on a 24 hour basis.

Entry/ exit tracking

Entry/exit tracking is accomplished by stationing a wired tag reader before and after the mine's portal. Mine Tracker will provide the appropriate algorithm for determining whether

personnel or vehicles have entered or exited the tunnel. Inside the tunnels and different work areas, additional tracking would occur by means of cages with card readers granting access to personnel for specific areas in the mine, this will be monitored via the current access control system.

Proximity Alert system

The PAS-LVZ proximity alert system will be installed on each surface and underground vehicle to provide proximity awareness of other vehicles and personnel. RFID, GPS and up to 4 Electromagnetic (EM) sensors and/or Radar can be provided for each vehicle.

Evacuation System and Procedures

The evacuation system proposed consists of a master evacuation station located at the Head-End and remote evacuation stations situated at the required locations throughout the mine. The remote units are required to be within 20m line-of-sight of the RCN. The master evacuation station engages and disengages a site wide alert by means of a twist-to-release mushroom button. Once the alert is made active the station transmits a signal along the RCN, activating all remote stations. As an alternative, the evacuation can also be enabled by closing an IP switch location at the Security Command Centre. A total of 3 remote evacuation stations will be installed underground, placed at strategic locations within the coverage area of the RCN. The design is modular and placement can be changed based on specific requirements

Gas Monitoring

Gas monitoring stations sample the environment, and produce information which will be available for the operator to view on the Mine Tracker application computer. The system will display current gas levels as well as provide information on station communications and sensor failures.

Gas level alerts will notify the operator when levels have reached a critical set point. These set points will be determined during final design phase and is adjustable as per specific user requirements.

Each gas station will include the following sensors:

- Carbon Monoxide (CO)
- Nitric Oxide (NO)
- Nitrogen Dioxide (NO_2)
- Methane (CH_4)

The gas sensors are powered from a 24 VDC underground power station, with battery backup functionality. The sensors are also interconnected to a wireless trunk interface (Model 1965V) from where the information is communicated to the Mine Tracker computer and

related Mine Tracker software. There will be 5 environmental monitoring stations in use on the project. The design is modular and placement can be changed based on specific requirements.

Handling Underground Fires

The fire prevention system outlines the procedure for preventing, and responding to fires in offices and in the Mining environment. This procedure is applicable to any person who is involved /Faced with Fires at the work place on how to approach a fire safely and to evacuate if the fire cannot be extinguished. This procedure also covers incidences of fire underground.

Methane Testing and Handling Methane Explosions

Standards procedures have been established to test for methane in developing ends.

It also specifies what should be done in the event of a methane explosion. In general the following should be adopted:

- Safe workplace declaration is to be done prior to the start of the shift by the safe entry examination team.
- See if workplace is safe and free from dust and gasses
- Ventilation is working and adequate
- See if workplace is bared and needs more barring to be done.
- Conclude proceedings.

Personal Protective Equipment

The following personal protective equipment is required: Hard hat, Gloves, Uniform with reflectors or reflective vest, Steel cap safety shoes or boots.

Siting and Operation of Refuge Bays

The policy specifies the way that Refuge Bays are to be sited, constructed, equipped, ventilated, and inspected. In the event of a fire, explosion or any other occurrence which seriously affects the ventilating air, the risks to the health and safety of employees will be, as far as is reasonably practicable, minimised. A "Refuge Bay" shall mean a place in the underground workings which is inaccessible to air containing noxious smoke, fumes or gases and which, having regard to the maximum number of persons likely to be present in the area served by the refuge bay. The bay shall be:-

i) equipped with means for the supply of respirable air;

ii) equipped with a sufficient supply of potable water;
iii) provided with first-aid equipment;
iv) Equipped with toilet facilities;
v) of sufficient size to accommodate that number of persons;
vi) equipped with a telephone
vii) situated, where possible, in an area free of combustible material;

The Mine Manager shall provide Refuge Bays or other safe places in the mine within easy reach of all workmen and within the limits of protection afforded by self-rescuing devices in the event of an explosion, fire or other emergency.

2.3.1.2.6 Organisational structure

Koidu Limited has a small to medium Organisational structure with over 800 local staff and over 100 expatriate staff. The structure consists of Top Management which is overall responsible for the company's long term strategic, tactics and vision. The middle management like most operations consists of Heads of Departments who are responsible to execute through direction of set goals from our board of directors, General Manager and Chief Financial Officer. The Lower and operational levels consists of Junior Managers and support teams that work with daily tasks which most have set targets for valuable objectives implementation.

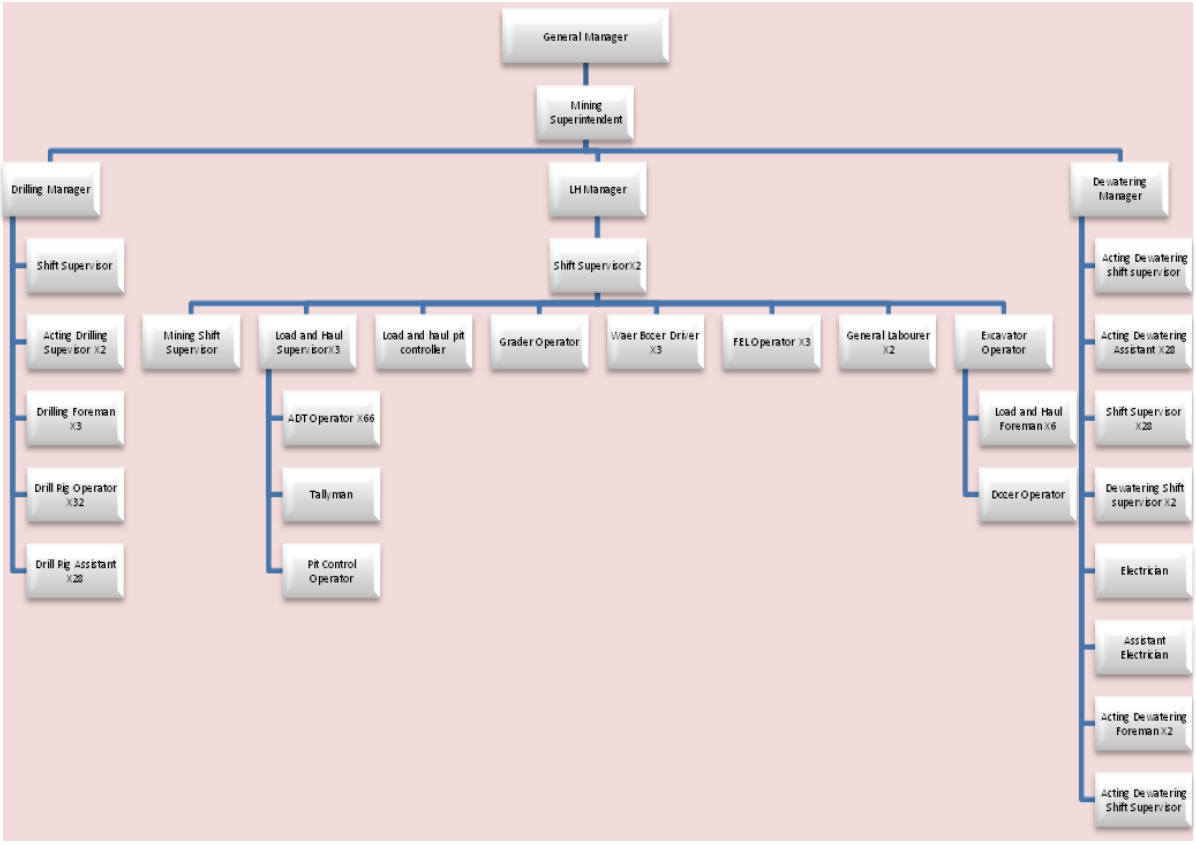
As part of strategy drive to achieve the Company's goals, i.e. the change of operation from open pit to underground Mining, our structure is used as a tool to ensure adequate resource allocation for assurance of operations continuity and target achievement, job allocation, outlined job specifications and descriptions with clear line of reporting.

Overall, the structure is our guide to ensure proper communication flow with in different departments so as to reach the same desired outcome.

To this end, KL shall:

- Ensure that all levels of management are adequately trained and held accountable to ensure recruitment and selection is done in a professional manner.
- Continuously work with stakeholders in the Communities to establish work experience and qualification database workforce of personnel residing in the mine lease areas.
- Provide the framework to ensure recruitment and selection is non-biased and that the processes involved meets the guidelines agreed upon by KL Management and the Unions where applicable
- Ensure that all positions are advertised (locally, nationwide and external of Sierra Leone), and recruitment/selection is based on merit, qualifications, experience, job knowledge and suitable references where applicable

- Promote internal transfers where possible, thereby enabling development and promotional prospects of existing good performers in the work place.



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2.3.2 Surface components

2.3.2.1 Processing

Processing involves the treatment of extracted kimberlite ore through a series of processes for the recovery of diamonds. This process is carried out in 180 tons per hour plant commissioned for use in 2012, replacing the original 50tph plant.

The plant is made up of various broad components:

- The ore receiving and primary crushing
- The primary sizing and secondary crushing
- Fine Dense Media separation and re-crushing
- Final Recovery
- Water recovery circuit

Details of the processes that obtain in each of these sections are outlined in section 2.4 - Mineral Processing.

Figure 2.3-4: Processing Plant

2.3.2.2 Tailings and Mine Waste Disposal

The waste products from mining operations include waste rocks and tailings.

Waste rock is the material removed in the process of accessing and extracting the kimberlite. These materials are stockpiled in heaps within the concession, at calculated angles to reduce erosion and to also prevent rockfalls. Some of these waste rocks are donated to the communities and road construction/rehabilitation companies for use in their operations. The remaining heaps are dressed with laterite and seedlings planted to encourage revegetation.

Tailings and slimes are the waste products obtained from the processing of the kimberlite. From the process plant, slimes are pumped into the slimes dam, which is an impoundment type dam with walls constructed from laterite. Tailings are transported by a conveyor belt to the tailings storage facility where they are stored in heaps.

Figure 2.3-5: Waste Rock Stockpiles Layered with Laterite and Re-vegetated

Figure 2.3-6: Tailings Storage Facility

2.3.2.3 Power Supply

Power supply to the property is currently from a generator station, comprising five 1.8 MW diesel generators. This power plant is still relatively new as it was commissioned in 2012.

The current generator set up of the existing power plant is as follows:-

- 2 generators are in continuous use for the process plant and other users;
- 1 generator is used for power surge;
- 1 generator is kept for maintenance and;
- 1 generator is spare.

For the development of the underground mining project, the existing power lines that supply power to KL site will be extended to the boundaries of the open pit. Power will be fed via cables from the edge of the pit to the underground workings. Two 1.8MW replacement generators will be purchased for the operations.

2.3.2.4 Water Supply

For present consumption purposes, water is pumped from a local borehole to a temporary storage dam of approximately 70,000L capacity, at a distance of 1,000m from the source, situated on Monkey Hill. A substantial amount of used water at the facility is recycled.

Water from the processing plant is recirculated: slimes leaving the plant are pumped into the slimes dam, where the water is allowed to settle before being pumped back to the plant for reuse.

Domestic waste water from offices and staff quarters is sent to a water treatment facility where it is boiled and electronically manipulated to remove human waste. The raw water is then chlorinated and recirculated throughout the facility. The treatment plant supplies 72,000 litres of treated water daily.

During underground operations, service water will be pumped from Dyke Zone B and gravity fed into the pit acting as service water for operations. Drinking water will be supplied by means of onsite boreholes and then piped into the pit.

2.3.2.5 Ancillary Facilities

BME Sierra Leone Ltd Operations

BME Sierra Leone Limited is a subsidiary of Omnia Holdings Limited, a leading supplier of explosives in South Africa and other African countries. BME has been contracted by Koidu Limited to manufacture and supply the explosives component HEF 100 Emulsion that is used to make explosives for Koidu Limited's blasting operations, and operates from within the KL concession.

HEF 100, the oxidizing agent of choice, is an emulsion made generally from a super-saturated solution of ammonium nitrate, calcium nitrate and oil. The oxidizing agent is first prepared using calculated quantities of calcium nitrate, ammonium nitrate, sodium acetate, thiourea and water; it is then mixed in a poly mixer with diesel and used engine oil. Used engine oil is collected after servicing of large mining equipment used by Koidu Limited, providing an environmentally friendly means of waste oil disposal. The HEF is then stored in Silos from where it is loaded into bulk trucks for transportation to the mine site. A solution of sodium nitrite and water is also loaded into a different compartment of the trucks to be mixed with the HEF at the mine site. The Emulsion on its own is non-explosive and only becomes explosive when sensitised with sodium nitrate.

The plant complies with ISO 12001, 14001 and 18000 standards, which deal with noise from machinery and equipment, environmental management and occupational health and safety, and is subject to annual Management audits. Compliance with mine safety standards is enforced and regular audits are carried out by the Koidu Limited's Safety Department.

Figure 2.3-7: BME Storage Tanks (Silos)

Explosives Magazine

The explosives magazine encompasses a fenced and gated area of approximately 7,178 m². The main magazine consists out of a number of roofed containers which are situated inside a 4 m high sand/laterite berm barrier with a concealed entrance.

Access to the magazine is strictly controlled and is only permitted in the presence of security personnel.

Fuel Storage

The existing diesel storage area is situated between the workshop and logistical area and covers an area of approximately 256 m². Fuel is stored in two 40 500 L tanks and is distributed through a metered electric pump.

Fuel is obtained from the NP (SL) Ltd and Total (SL) Ltd depot in Freetown and is transported to Koidu by Total fuel bowsers.

Fuel is delivered into the tank that is used for daily distribution and pumped via a fuel polishing filtration system to the main storage tank.

Heavy machinery working in the different areas of the mining lease area are supplied fuel by a 10,000L mobile fuel bowser which receives its fuel from the fuel station.

A fuel consumption database is maintained by the logistics department and audited by the finance department.

Figure 2.3-8: Fuel Station

Chemicals and Refrigerants Storage and Handling

Chemicals

Milled FeSi is the most commonly used chemical and is used in the Dense Media Separation Technology employed by Koidu Limited. It has good magnetic properties which allows for easy recovery and demagnetization, and is used in the 180tph plant for final recovery. It is used in powder form and poses minimal health risks, mainly related to eye and skin irritation

when exposed to high concentrations; these symptoms are easily treated by flushing with water.

Sudfloc is another chemical used in the production process. It is a flocculent (clarifying agent which causes suspended particles in water to aggregate), and is used to clean the water used in processing.

Chlorine is also generally used in water and sewage treatment to reduce the microbial content of the water.

All chemicals are stored under specific temperatures. Access control measures are rigidly applied and only trained technicians are allowed to handle them. Fire extinguishers are also stored close by.

Koidu Limited provides on the job training to all technicians required to handle chemicals, and they are provided with the Material Safety Data Sheets and Personal Protective Equipment. In addition to this, risk assessments are carried out and documented prior to the commencement of a job requiring the use of chemicals.

The list of chemicals used by the company is as follows:

No.	Simple Code	Description	Qty./Month
1	DMS POWDER	Milled Ferro Silicon in 250kg plastic drums, Magnetic properties that allows easy recovery and de-magnetization	100
1	SUDCHLOR	Chlorine - Camp Water System (25lt Container)	9
2	CHLORINE40KG	Chlorine Calcium hypochlorite (45kg drum)	3
3	ACIDBAT001	Battery Acid for battery recharging.	50L
4	SASH001	Soda Ash	9
5	PYMISTSPRAY	Pymist Solution for Fumigation	8
6	CHEM005	Weedkiller (Roundup)	5
7	CO_2 FIRE EXTINGUISHER	Dry powder fire extinguisher	
8	SUDFLOC	Floculant - Sudfloc 3456 25lt	5
9	DISTWATER001	Distilled Water 1000ml	60L
10	CHLORINE10KG	Chlorine Sodium hypochlorite (10kg drum)	9

Refrigerants

The following refrigerants are used in the indicated applications:

No	Type Gas	Application	Bottle size	Consumption per month
1	R 22	Air Conditioners	13.6 Kg	19 kg
2	R 404 A	Cold room	13.6 Kg	4.3 kg

No	Type Gas	Application	Bottle size	Consumption per month
3	R 134 A	Fridge	13.6 Kg	1 kg
4	R 600 A	Freezers	13.6 Kg	4.3 kg

Air conditioners are the most widely used cooling systems in the facility and consume the highest proportion of refrigerant. R22 is often used as an alternative to the highly ozone-depleting CFC-11 and CFC-12, because of its relatively low ozone depletion potential.

In order to ensure that the cooling systems are functioning properly which includes ensuring that no gas is leaking out into the environment, all the units undergo regular maintenance by certified, tertiary level trained technicians. Refrigeration units are serviced once a week, while air conditioning units receive preventive maintenance every 3 months.

2.3.2.6 Waste Management

Koidu Limited's waste management programme involves the following components:

Type of Waste	Disposal Method
Solid non-hazardous wastes	Incineration - 2 incinerators are operated: one within the processing facility which handles all the waste from within this section, to prevent any material leaving (due to the sensitive nature of this area), and the second, larger incinerator which handles waste materials from the rest of the facility.  **Figure 2.3-9: Incinerator House** Waste materials are separated at source, with the use of colour coded bins for the collection of specific types of waste. Waste collected from the various sources are spread out for inspection and drying before incineration. Any reusable material is removed and set aside.
Empty drums, containers, etc	Carefully cleaned and donated to communities for re-use.

Type of Waste	Disposal Method
	 **Figure 2.3-10: Donation of Empty Drums to Community**
Old worn out drums and tyres	Painted and used to decoratively line the mine roads within the concession. Some tyres are also used as flower pots.
Waste water/Sewage	**Water from offices and residences**: sent to water treatment plant where it undergoes boiling, electronic removal of human waste and chlorination before being recycled to different areas of the facility. The boiler compartment of the septic tank heats the contents to boiling point, killing bacteria and other harmful substances, until the wastes are reduced to a harmless form which can be released to the environment with little or no negative effect  **Figure 2.3-11: Water Treatment Plant** **Process water:** on exiting the processing plant, it is allowed to settle in the slimes dam, before being pumped back to the plant for reuse.
Waste/Used Oil	Collected in drums and stored in a bunded area until a disposal option in made available.

Type of Waste	Disposal Method
	 **Figure 2.3-12: Waste Drum Storage Area** Uncontaminated used oil (diesel) is used in the blasting process.
Waste rock, tailings and slimes	Mine wastes are stored in heaps, at angles to prevent rock tumbling and erosion. Waste heaps are being reclaimed by dressing with laterite and planting seedlings to promote revegetation.  **Figure 2.3-13: Semi-dressed Waste Rock Heap** Waste rock and tailings are also donated to community construction and roads projects. Tailings are also used to line the mine roads, and are also donated to individuals in the resettlement community who want to spread it in their compounds.

Other Ancillary Facilities

The location of other support facilities within the mine is illustrated in the following table

Table 2.3-2: Other Ancillary Facilities

Infrastructure	Dimensions	Descriptions
		• The main gate with a floor space of 840 m^2 allows

Infrastructure	Dimensions	Descriptions
Main gate	3 222 m^2	access to mining employees by means of a pedestrian entrance; • Searching facilities ensure property security; • A visitors counter issues visitor permits; • A vehicle entrance allows access to large vehicles; • A security staff manning station with ablution facilities.
Clinic	1 120 m^2	• Clinic is to consist of 3 wards, an emergency treatment centre, an x-ray facility and dental facilities.
Mine mess	1 235 m^2	• Mine mess provides employees with a meal prior to the commencement of their shift; • Mess has seating facilities for 200 people, an industrial kitchen and ablutions and washing facilities.
Change house	5 640 m^2	• Change house accommodates 250 male and 80 female employees per shift; • Locker facilities for 600 people; • Laundry facility and change house (985 m^2).
SHE Department	2 142 m^2	• SHE Department with a floor space of 544 m2 fitted with a 70 seating training room; • PPE store with ablution facilities;
Mine stores	8 245 m^2	• Mine store with a floor space of 1,765 m^2 comprised of a sheeted secure building with industrial racking for items up to a weight of 200 kg; • Outside lay down area for heavier items; • Facilities for loading and off-loading trucks carrying containers up to 12 m; • Storage area for emulsions, lubricants and FeSi; • Ablutions facilities.
Mine workshops	40 275 m^2	• The workshop with a floor area of 6 658 m2 consists of a machine shop section and a separate building for tyre repairs and hydraulic pipe repairs; • A wash bay for the cleaning of fleet.
Explosives Components store	506 m^2	• Explosives components store has earth walls around the perimeter and a Q-deck roof;
Incinerator house	4 570 m^2	• Incinerator house consisting of a brick building with a chimney through the roof has a floor space of 80m^2 for incineration of general waste from the mine
Generator house	500 m^2	• Generator house with a floor space of 345 m^2
Camp mess and kitchen	4 580 m^2	• Located at the foot of Monkey Hill; • Kitchen facility caters for 150 seated people;

Infrastructure	Dimensions	Descriptions
		• Ablution facilities, washing facilities and relaxation areas; • Swimming pool and gym facilities.
Main camp	6 880 m^2	• Accommodation for 90 personnel consisting of ablution facilities and single room bedding.
Security and fencing		• Central security control centre supplies 2 tier security monitoring; • 3 m x 1 m gabion wall around the entire concession area • The store, workshops and buildings also fenced off with standards perimeter fencing; • The plant area has double fencing around the perimeter.
Power supply		• Power plant with an installed capacity of 5600 kV consisting of two prime mover low voltage generators with a minimum of 30 dB sound attenuation; • Output voltage is 400 kV, stepped down to 11 kV; • Substation housed in a brick building with a steel sheeted roof; • Oil and lubricants storage areas are bunded with a drainage and pumping system.
Sewage treatment		• Two sewage collection networks cater for the entire infrastructure at Monkey Hill and the entire mining area • Each treatment plant has the capacity to support 250 people; • Treatment will take place via anaerobic and aerobic processes leading to minimum odour; • Clean treated water will be discharged to the environment.
Waste disposal		• Waste is stored at demarcated areas within the concession and collected on a fixed roster and transported to the incinerators; • Two incinerators are in operation; • One unit includes a mild steel chimney, oil burners and a control panel and is capable of burning 500 kg/hour of general waste with a plastic content of 5%; • One unit is capable to dispose of 50 kg/hour waste with a plastic content of 15%; • Incinerators comprise features leading to smokeless operation and saving of valuable fuel.

2.4 Mineral Processing

2.4.1 Ore receiving

The ore will be tipped into a receiving bin which is fitted with a 600 mm square aperture static grizzly. Any oversize material that has not passed through the 600 mm opening will be hydraulically lifted and discharged into an oversize chute.

The material that passes through the 600 mm static grizzly will be drawn out of bin using a vibrating grizzly feeder. The vibrating grizzly feeder has a setting of around 120 mm and any material that does not pass through the opening is discharged into a primary single toggle jaw crusher. The jaw crusher has an open-side setting of around 90 mm and delivers a discharge product of around 150 mm.

Both the jaw crusher product and the vibrating grizzly undersize discharge onto the primary feed conveyor. The primary feed conveyor discharges into a 2.4 x 6.0 m roller supported scrubber. The scrubber has been included in the circuit to allow for flexibility in material processing, should the characteristics of the material from the pit change. Although the plant should be treating very competent Kimberlite, there is still the possibility that the plant will be fed with material that contains clay. The scrubber is able to process the material and remove the clay.

2.4.2 Primary sizing, secondary crushing and coarse DMS

The scrubber discharges onto the 1 830 mm x 3 600 mm primary sizing screen. The primary sizing screen is a double deck fitted with 32 and 1.2 mm panels. The >32 mm material is then feed to the secondary crushing section. The 1.2 to 32 mm fractions are classified as fines and the <1.2 mm as slimes.

The >32 mm material discharges onto the secondary screen feed conveyor. The secondary screen is a double deck 2 100 mm x 4 200 mm screen fitted with 55 mm and 32 mm panels. The >55 mm material is conveyed to the secondary crusher surge bin. This conveyor is fitted with a weightometer for accounting purposes. The material is drawn out of the surge bin with a 750 mm x 1 500 mm vibrating pan feeder into a Sandvik CH440EC secondary cone crusher. The cone crusher product is discharged onto a conveyor and is re-circulated back to the secondary screen.

The 32 to 55 mm fractions report to the 150 tph coarse DMS feed conveyor. This conveyor is fitted with a weightometer for accounting purposes. The coarse DMS has been designed with a large diameter 800 mm DMS cyclone to handle the bigger size fractions delivered to it. Due to the fact that there is a good chance of a large diameter diamond being present in the feed, it is important that the possible recovery of this diamond is maximised before the material goes to secondary crushing.

The coarse DMS can handle a high tonnage throughput. The size fraction being fed into the coarse DMS has been set at around 55 mm. This allows utilisation of the DMS to its capacity and reduction of the DMS requirements downstream. The coarse DMS is fitted with a 2 440

mm x 4 270 mm floats screen. Once the material has passed through the DMS, the floats portion is conveyed to the secondary crusher.

The sinks from the coarse DMS is conveyed using a specialised and secure pipe conveyor to the final recovery building.

2.4.3 Fines Dense Media Separation (DMS) and re-crusher

The <32 mm material from the primary and secondary screens is conveyed to the fines 100t DMS surge bins. The fines DMS surge bins discharge onto the DMS feed conveyors using two 750 mm x 1 500 mm variable speed vibrating pan feeders. The pan feeders are connected to a weightometer which regulates the feed to the DMS.

The fines are configured as 130 tph DMS utilising two 510 cyclones each. The DMS has a double deck floats screen with an 8 mm aperture. The >8 mm material is conveyed to the re-crusher 2 500t stockpile. The re-crusher stockpile conveyor is fitted with a weightometer for accounting purposes.

The re-crusher feed is drawn out from underneath the stockpile using two 750 mm x 1500mm variable speed vibrating pan feeders and will discharge into the tertiary crusher feed conveyor. The conveyor will feed two Sandvik CH440F tertiary cone crushers. The cone crushers will be wet flushed (if required) to assist in the crushing process and will discharge directly onto the re-crusher sizing screen.

The re-crusher sizing screen is a 2 440 mm x 4 200 mm double deck screen fitted with an 8 and 1.2 mm aperture. The >8 mm material is transported back to the re-crusher stockpile. The <8 mm is conveyed back the fines DMS surge bin and the <1.2 mm material reports to slimes.

The <8 mm material from the fines DMS is conveyed to a camel back movable stacker conveyor that will deposit the tailings onto the tailings dump. The sinks material from the fines DMS is jet pumped to the final recovery

2.4.4 Final recovery

The concentrate from the fines DMS jet pump is received into a concentrate holding bin. The concentrates are drawn out of the holding bin into the attrition scrubber. The 1 m x 3.5 m attrition scrubber has been designed for a 12 minute retention time to give adequate scrubbing. The material is then jet pumped up to the 1 220 mm x 2 440 mm primary dewatering screen. The primary de-watering screen is fitted with 1.2 mm2 polyurethane panels and is inclined at 5o to facilitate maximum drainage.

The oversize from the de-watering screen discharges onto the 610 mm x 4 270 mm x-ray sizing screen. Here the material is sized into 16 to 32 mm; 8 to 16 mm; 4 to 8 mm; and 1.2 to 4 mm fractions. These fractions are stored in the 1 m3 x-ray surge hoppers under the screen.

The undersize from the de-watering screens drains to a splitter box. The splitter box operates as a decanting device which allows for the separation of the fine material and water. The fines material separated in the splitter is diverted to the final tailings screen. The water from the splitter is then diverted back to the jet pump motive sump for re-use.

The 32 to 55 mm material is delivered to a 15 t surge bin from where it is drawn out and hand sorted. The 16 to 32 mm is fed through a double stage coarse wet x-ray sorter. The 8 to 16 mm material is delivered to the same double stage wet x-ray sorter. The 4 to 8 mm material is split and fed through two double stage wet x-ray sorters. The 1.2 to 4 mm material is split and fed through two double stage wet x-ray sorters.

The rejects from the ultrafine x-ray sorters are discharged into a tube feeder and the rejects from the x-ray sorters treating the fines, middlings and coarse fractions are discharged into another tube feeder. Both tube feeders discharge onto the rejects tailings conveyor which reports back to the re-crusher circuit.

The concentrate from the ultrafine x-ray sorters is discharged into a tube feeder and the concentrate from the x-ray sorters treating the fines, middlings and coarse fractions is discharged into another tube feeder. Both tube feeders discharge into the concentrates bin ahead of the dryer.

All effluent from the other operations in the plant, namely x-ray effluent and dewatering screen effluent, report to the final tailings pump. The final tailings pump delivers the effluent to the thickening section of the plant.

All concentrates are then fed through the Parsep dryer. The Parsep dryer is a rotary belt dryer utilising both low frequency infra-red drying and hot air blowers to dry the concentrate.

Once dried, the concentrates are discharged onto the sort house sizing screen where the concentrates are sized into five fractions, namely >32 mm; 16 to 32 mm; 8 to 16 mm; 4 to 8mm; and <4 mm. The concentrates are then split into two tube feeders which will distribute the concentrate into the glove boxes.

All glove box pickings are sent from the glove boxes to the accounting glove box. Here the diamonds are weighed and sized. A drop safe is attached to the accounting glove box to facilitate direct deposit of packaged diamonds. All pickers' rejects are conveyed out of the sort house and onto the recovery tailings conveyor which will exit the side of the recovery building and discharge onto the recovery tailings stockpile conveyor.

2.4.5 Water Recovery Circuit and Process Water

All <1.2 mm material from the primary screen, secondary screen, re-crusher screen and both DMS plants will be pumped to the thickener. The thickener is a high rate type thickener as currently used on the Koidu site.

The slimes being pumped to the thickener will receive flocculent addition from an automated flocculent make-up and dosing plant. Thickener underflow will be pumped to the slimes dam at a distance of 400 m using high pressure high-density polyethylene (HDPE) piping. Clear

water overflow from the thickener will be collected in process water dam situated next to the thickener. The process water dam will have the plant process water pump connected to it.

Make up water from the river water pump at a distance of 2 000 m will supply any short fall of water required due to the loss of water through slimes pumped to the slimes dump. Slimes dump return water will also be returned to the process water dam through a penstock ring and overflow dam with pumps which have been provided.

2.5 Employment Opportunities

Manpower requirements for the existing operation have been estimated at 500 - 1000 employees. A training and apprenticeship programme will be implemented to assist local residents in gaining the skills required for the proposed underground mining. KL will examine training mechanisms such as apprenticeship programs for employees to upgrade their abilities and skill base. Training will focus on those skills and trades that are needed for the underground mining operation, but yet transferable to other jobs following mine closure.

2.6 Project Timing

The following approximate time scale will apply to the underground mining scheme:

1. The current open Pit mining in pipe K1 will be completed by end of August 2016
2. Treatment of the ore obtained from K1 mining operations up until august 2016 is estimated to continue till November 2016
3. Dyke Zone B
4. Development work preceding the underground mining will commence in August 2106. This will consist of developing an access adit with the underground tunnels developed by drilling and multi-blasting.
5. Underground mining will start 10 months after this.
6. Processing of Underground ore will start in April, 2017. In essence there will be no ore processed from mid December 2016 to March 2017 (a 3.5 month ore gap).

3 REGULATORY AND ADMINISTRATIVE FRAMEWORK

3.1 National policies

3.1.1 National Environmental Policy, 1994

This National Environmental Policy seeks to achieve sustainable development in Sierra Leone through the implementation of sound environmental management systems which will encourage productivity and harmony between man and his environment. It also promotes efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of people, and serves to enrich the understanding of ecological systems and natural resources important to the nation.

3.1.2 Core Minerals Policy, 2004

The Core Minerals Policy (CMP) aims to balance the conflicting interests of the industry's stakeholders, effectively deal with environmental and human rights protection and enable inward investment. The CMP is a comprehensive document that clearly states the Ministry of Mineral Resources' vision and priorities for the mining sector.

3.1.3 Draft National Lands Policy, 2012

The Land Policy of Sierra Leone aims at the judicious use of the nation's land and all its natural resources by all sections of the Sierra Leone society in support of various socio-economic activities undertaken in accordance with sustainable resource management principles and in maintaining viable ecosystems

3.1.4 National Water and Sanitation Policy, 2011

The policy contains the ambitious targets of extending national water supply and sanitation coverage to 74% and 66% respectively, aligned to the Millennium Development Goals (MDGs). The objective of this policy is to increase the political prioritisation for Water, Sanitation and Hygiene in Sierra Leone, accelerate access to safe, reliable, affordable and sustainable water and sanitation services throughout the country.

3.1.5 National Biodiversity and Strategic Action Plan, 2003

The action plan intended to conserve and promote the sustainable use of the different components of the country's biodiversity. Several key thematic areas are covered: terrestrial biodiversity, inland water ecosystems, forest biodiversity, marine and coastal biodiversity and agricultural biodiversity. In addition, actions are also proposed for key cross cutting issues affecting the sustainable utilization of biodiversity, including: policy, legislation and

institutional review, capacity building, identification and monitoring, sustainable use, incentive measures, research and training, public education and awareness, regulation of access to genetic resources, protection of indigenous knowledge and intellectual property rights of local communities, technology transfer and handling of biotechnology and exchange of information and technical cooperation.

3.1.6 The Draft Forestry and Wildlife Sector Policy for Sierra Leone, 2003

This document is still under review and awaiting parliament approval. The goal of the document is to support the development and exploitation of forests and wildlife of Sierra Leone in a sustainable manner for the material, cultural and aesthetic benefit of the people of Sierra Leone in particular and mankind in general.

3.2 National Legislation

Legislation governing environmental issues are found as Acts enacted by parliament. In addition to these there are regulations that give effect to the Acts. The pieces of legislation of the various government line ministries or institutions includes:

3.2.1 The Constitution of Sierra Leone (Act No. 6 of 1991)

Section 15 of the Constitution states that: "... every person in Sierra Leone is entitled to the fundamental human rights and freedoms of the individual." This includes protection from deprivation of property without compensation. Section 21(1) further stipulates that no property of any description shall be compulsorily taken possession of, and no interest in or right over property of any description shall be compulsorily acquired, except where land is required by the GoSL in the public interest.

3.2.2 The Environmental Protection Agency Act, 2008 (Act 11 of 2008)

The Environment Protection Agency Act, 2008 (Act 11 of 2008) was enacted to establish the Environment Protection Agency Sierra Leone (EPA-SL) and to provide effective measures for the management and protection of the environment. The Act repeals the Environment Protection Act, 2000 (Act 2 of 2000).

In terms of Section 24 of the Act, any person who wishes to undertake any of the projects set out in the First Schedule of the Act must apply to SLEPA for an EIA licence. The projects or activities in the First Schedule of the Act that require an EIA licence include extractive industries, e.g. mining, quarrying, extraction of sand, gravel, salt, peat, oil and gas.

The application for an EIA Licence must be accompanied by a description of the proposed

project to be undertaken. EPA-SL must within 14 days of receiving an application decide whether an EIA is required for the project or not. Section 25(2) requires EPA-SL to take the matters set out in the Second Schedule to the Act into consideration when deciding on whether an EIA is required in respect of the project. The factors for determining whether a project requires an environmental impact assessment includes the following:

- Environmental impact on the community;
- Location of the project;
- Whether the project transforms the locality;
- Whether the project has or is likely to have substantial impact on the ecosystem of the locality;
- Whether the project results in the diminution of the aesthetic, recreational, scientific, historical, cultural or other environmental quality of the locality;
- Whether the project will endanger any species of flora or fauna or the habitat of the flora or fauna;
- Scale of the project;
- Extent of the degradation of the quality of the environment
- Whether the project will result in an increase in demand for natural resources in the locality; and
- Cumulative impact of the project together with other activities or projects, on the environment.

The applicant will be advised in writing where a decision has been taken that an EIA is not necessary for the project. In instances where projects require an EIA Licence the applicant will be requested to prepare and submit an ESIA in respect of the proposed project. The content of the ESIA are included in the Third Schedule to the Act.

Section 27 of the Act provides that EPA-SL must after receiving an ESIA, circulate it to professional bodies or associations, Government Ministries and NGOs for their comments. The ESIA must also be made available for public review and comments. Notice of the public review must be given in two consecutive issues of the Government Gazette and two issues in a newspaper. In respect of the newspaper publication an interval of at least seven days must be afforded between the first and second publications. Public comments on the ESIA must be submitted to EPA-SL within 14 days of the last publication in the Gazette or newspaper. Failure to comply with the EPA Act of 2008 is a punishable offense.

3.2.3 Local Government Act, 2004

This Act stipulates that a local council shall be the highest political authority in the locality and shall have legislative and executive powers to be exercised in accordance with this Act or any other enactment. It shall be responsible, generally for promoting the development of the locality and the welfare of the people in the locality with the resources at its disposal and with such resources and capacity as it can mobilize from the central government and its agencies, national and international organisations, and the private sector. The local council should initiate and maintain programs for the development of basic infrastructure and provide works and services in the locality. A local council should prepare a development plan which shall guide the development of the locality.

Many companies are bound to operate within areas controlled by one local council or another. There is also a relationship between the local council and the Chiefdom within which a company operates. It is advisable for companies to involve local councils in their development work. The schedules to the Local Government Act outline the activities of various MDAs that have been devolved to local councils.

3.2.4 The Mines and Minerals Act, 2009 (Act 12 of 2009)

The Mines and Minerals Act, 2009 (Act 12 of 2009) The Mines and Minerals Act, 2009 (Act 12 of 2009) ushers in a new era of mineral development in Sierra Leone by consolidating and amending the previous minerals legislation and by introducing new improved provisions for exploration, mine development and marketing of minerals and mineral secondary processing for the benefit of the people of Sierra Leone. The Act intends to: Ensure that management of the mineral sector is transparent and accountable in accordance with international best practice; Promote improved employment practices in the mining sector; Improve the welfare of communities adversely affected by mining; and introduce measures to reduce the harmful effects of mining activities on the environment and to provide for other related matters. The Mines and Minerals Act, 2009 repealed the Mines and Minerals Act, 1994 as well as the Commission for the Management of Strategic Resources, National Reconstruction and Development Act, 1999. Any mineral right or permit granted under prior laws or amendments will continue to be valid until it expires by the passage of time. The holder of a mineral right granted prior to the Mines and Minerals Act, 2009 may apply for a mineral right covering the area subject to its existing right on a priority basis.

In terms of the Act, a mineral right is defined… "A right to explore for or to mine minerals by holding a valid reconnaissance licence, exploration licence, artisanal mining licence, small-scale mining licence, or large-scale mining licence, as the context requires". The mineral rights holder is hereby defined as… "The holder of a mineral right in whose name the mineral right is registered under this Act". 3.2.3.1 Environmental Impact Assessment Of particular importance to the Koidu

Kimberlite Project are the provisions of the Act contained in Part XV which deals with the protection of the environment. Section 131(2) of the Act provides that all small-scale and large-scale mining licence holders to acquire an EIA Licence as prescribed under the Environmental Protection Act, 2000 (Act 2 of 2000). The Environmental Protection Act, 2000 has since been repealed by the Environment Protection Agency Act, 2008 (Act 11of 2008) and the EIA Licence must therefore be obtained in terms of the provisions of the new Act. The holder of a mineral right is required to carry on its operations in a manner that is reasonably practicable in order to minimise, manage and mitigate any environmental impact including but not limited to pollution resulting from such operations and is subject to all laws of the Republic concerning the protection of the environment. Section 133 provides that an EIA prepared by a small-scale or large-scale mining licence applicant shall be based on environmental baseline assessment work and shall contain the types of information and analysis reflecting international mining best practice which shall include: A detailed environmental baseline description, backed up with applicable measurements (air quality, water quality, etc.) to present the environment prior to any mining operations; A detailed description of the project including all phases of development, operations, reclamation and closure including but necessarily limited to: Detailed resource requirements and emissions; Identification of the likely major environmental and social impacts; Review of residual and immitigable environmental impacts; Broad and detailed objectives regarding each major environmental and social impact and means of achieving them; Predicted or expected effect of each environmental mitigation activity; Timetables and budgets for implementation; Projected budget and budget timetable to achieve environmental objectives; Identification of employee position responsible for implementation of environmental mitigation; Mitigation measures for each major negative social impact; The person or agency responsible for monitoring, the methodologies to be used for monitoring of potential negative impacts and the effectiveness of mitigation and the source of funding for monitoring; and An Environmental Management Plan (EMP).

The public consultation requirements are included in Section 133(2) of the Act and provide that an applicant or mining licence holder is required to consult with the public to introduce the project and to verify the possible impact of the project from the public and stakeholders perspective. Further details in respect of public consultation are not provided in the Act. However, the Act does make provision for public access to the contents of the EIA report and the EMP [Section 133(3)], as well as the annual EMP Reports [Section 134(4)] which should be made available for public review at the Mining Cadastre Office. In instances where the holder of a mining licence proposes to make a change in its mining operations that would cause a need for a material change in the EMP, mining licence holder must submit an updated EMP for approval. Section 134 of the Act requires a mining licence-holder to annually update the EMP Report and to submit the updated EMP Report to the

Director in triplicate. The initial update must be submitted within a year after the first year in which commercial production first occurred. The updated EMP Report must be sufficiently detailed so that the Director can determine whether the EMP is succeeding. If the Director determines that the plan is not succeeding, the Minister may suspend the licence until such time as measures are taken to insure its success. The Director shall provide a copy of any annual EMP Report to SLEPA. The Act also introduces the requirement to provide financial provision for the performance against any obligation originating from an EIA and EMP. The eligible forms of financial provision include surety bonds, trust funds, insurance policies, cash deposits or annuities. A Section 137 directive may be issued to any mining company in order to comply with the condition of the mineral right for the protection of the environment. The Act provides that should a company not comply with the directive, the Minister may undertake the necessary steps or remedial measures as provided in the directive and recover the costs thereof from the mineral right holder. Where two or more persons constitute, or constituted, the holder of a mineral right, those persons are jointly and severally liable for the payment of any costs and expenses which may be recovered under this section from the person who is or was the last holder of the mineral right. 3.2.3.2 Compensation and resettlement Section 38 of the Mines and Minerals Act introduces the rights to resettlement for parties directly affected by mining operations. The Minister shall ensure that all owners or lawful occupiers of land who prefer to be compensated by way of resettlement as a result of being displaced by a proposed mining operation are resettled on suitable alternate land. The resettlement process must have due regard to the economic well-being and social and cultural value of the affected parties so that their circumstances are similar to or improved when compared to their circumstances before resettlement. Resettlement must be carried out in accordance with the relevant planning laws. The cost of resettlement shall be borne by the holder of the mineral right as agreed by the holder and the owner or lawful occupier of land or by separate agreement with the Minister. The mineral right holder shall on demand being made by the owner of any crops, trees, buildings or works damaged during the course of such operations, pay compensation for such damage. If the owner or lawful occupier of any land is dissatisfied with compensation offered, such compensation may be determined by the Minister on the advice of the Minerals Advisory Board. 3.2.3.3 Community development A general duty is placed on holders of a mining licence to assist in the development of mining communities affected by its operations to promote sustainable development, enhance the general welfare and the quality of life of the inhabitants and must recognise and respect the rights, customs, traditions and religion of local communities. Besides this general duty, companies may be required to enter into formal Community Development Agreements (CDA). A CDA does not replace other obligations and/or agreements associated with resettlement, surface rents, or compensation. The criteria used to establish whether a formal CDA is required depends on the mine's throughput and where the licence holder employs more than

100 employees or workers on a typical day. The CDA is intended to benefit the primary host community situated within 30 km of any boundary defining the mining licence area. The holder of the mining licence is required in terms of Section 139(4) to expend in every year that the community development agreement is in force no less than one percent of one percent (0.1%) of the gross revenue amount earned by the mining operations in the previous year to implement the agreement. The content of the CDA must be negotiated with the primary host community and must include the following: Details of the primary host community representative; Objectives of the CDA; Obligations of the licence holder, including: o Social and economic contributions that the project will make to the sustainability of the community; o Assistance in creating self-sustaining, income-generating activities, such as but not limited to, production of goods and services needed by the mine and the community; and o Consultation with the community in the development of mine closure measures that seek to prepare the community for the eventual closure of the mining operations. Obligations of the primary host community with regard to the licence-holder; the means by which the CDA will be reviewed by the licence-holder and primary host community every five calendar years, The consultative and monitoring frameworks and community participation in the planning, implementation, management and monitoring of activities carried out under the agreement; and A statement defining a dispute resolution process as prescribed by the Act. The CDA entered into by a mining licence holder and the primary host community must be approved by the Minister who is authorised to return the CDA for further deliberation and negotiations. In instances were parties cannot come to an agreement the Minister is empowered to make the relevant determinations.

3.2.5 The National Minerals Agency Act, 2012

This is an Act to establish the National Minerals Agency to promote the development of the minerals sector by effectively and efficiently managing the administration and regulation of mineral rights and minerals trading in Sierra Leone. This includes geological survey and data collection activities to establish a National Minerals Agency Board to provide technical and other support to the agency and to provide for other related matters.

3.2.6 The Forestry Act, 1988

This Act came into operation on 1st July, 1988 and the Chief Conservator of Forest, with the directives of the Minister, is responsible for the implementation of its regulations. He therefore has the role of preserving the forest environment, promoting the practice of forestry in all use of forestland, to ensure sustainability of forest products, and the protection of the soil and water resources that constitute the environment.

3.2.7 The Explosives Ordinance of 1955

The Ordinance provides for the licensing of the importation of explosives by the Chief Inspector of the Police Force. In addition, the Ordinance states in section 8 that "Subject to the provisions of the Arms and Ammunition Ordinance of 1955, any person who imports or exports any explosive into or from Sierra Leone except by sea at a prescribed port or by air at a prescribed aerodrome shall be guilty of an offence."

The Ordinance also makes provision for the licensing of:

- Purchase of explosives;
- Transportation of explosives within the country;
- Storage facilities for explosives.

Despite the provisions of the Ordinance, the importation and transportation of explosives into the country involves several arms of the government who all have to be informed and must individually issue clearance certificates. These include:

- The Sierra Leone Police Force;
- The National Security Coordinator;
- The National Revenue Authority;
- The Ministry of Defence;
- The Republic of Sierra Leone Armed Forces, Engineering Regiment.

3.3 National Regulations

3.3.1 Environmental and Social Regulations for the Minerals Sector, 2011

These regulations state that "All mining activities shall be carried out in a sustainable manner by minimizing or eliminating negative environmental and social adverse impacts in accordance with the provisions relating to environmental impacts contained in Section 132 (1) of the Mines and Minerals Act 2009 and those relating to social impacts contained in Section 133 (1) (b) (xii) and (xiii) of the same."

The regulations outline the environmental and legal responsibilities of a mining licence holder. The following are among the listed responsibilities:

- The holder of a mineral right shall be responsible for the environmental and social impacts of their activities, as well as for managing these impacts.
- Every holder of a mineral right shall carry on its operations in a manner that is reasonably practicable in such a manner as to prevent, minimize, manage and mitigate any adverse environmental impact including but not limited to pollution resulting from such operations and any adverse social impact.

- The holder of a mineral right shall be subject to the legal obligation to keep emissions and effluents resulting from its operations under the maximum level of pollutant concentration permitted by these Regulations and they shall manage and control residues, wastes, toxic substances and other contaminants in order to ensure that they will not cause adverse effects on the environment and public health.

3.3.2 Sierra Leone Operational Mining Regulations

These regulations outline the operational requirements of mining licence holders in the following aspects:

- Administrational responsibilities;
- Reporting methods for resources and reserves;
- Mine design of open pit mines;
- Occupational health and safety;
- Workplace Standards;
- Waste disposal and containment of tailings;
- Explosives and Blasting;
- Reclamation and Land Closure.

The following are some of the main obligations for mining licence holders:

- Mining Right Holders shall, as far as reasonably practicable, ensure that the mine is designed, constructed and equipped:

  (a) To provide conditions for safe operation and a healthy working environment;

  (b) With a communication system and with electrical, mechanical and other equipment as necessary to achieve a safe working environment.

- Mining Right Holders shall ensure, as far as reasonably practicable, that the mine is commissioned, operated, maintained and decommissioned in such a way that employees can perform their work without endangering the health and safety of themselves or of any other person.
- Mining Right Holders shall compile monthly health and safety statistics at the mine which must be kept pursuant to the terms of these Regulations and if the employer is a body corporate which employs more than 50 employees, the Mining Right Holder shall publish and make available the report in an appropriate form to shareholders or members on an annual basis.
- The Chief Executive Officer shall appoint a Health and Safety Officer who is suitably qualified to manage and supervise the health and safety operations in the mine.
- Right Holders shall pay the costs of all clinical examinations and medical tests performed in accordance with the terms of these Regulations.

Part XII- of the Operational Regulations for the Mineral Sector, 2011 stipulates specific

requirements to be fulfilled whist undertaking Underground Mining operations.

Some of the specific requirements from the regulations focus on:

- Underground mine plans
- Ventilation in underground mines
- Underground mine safety
- Lighting in underground mines
- Mine safety planning and precautions
- Underground Outlets, Ladder ways and Travelling Ways
- Underground Emergency Preparedness and Response
- Reporting of accidents or dangerous occurrences in an underground mine
- Underground operations and safety of trackless transport machinery and Earth Moving Equipment
- Underground Mine Ventilation
- Prevention of Flooding
- Testing for flammable gas

3.3.3 The Forestry Regulation -1989

These regulations are deemed to have come into force on the 1st July, 1990. The Chief Conservator holds the same responsibilities as he does for the Act of 1988.

Generally community forests are managed by the Forestry Division or by agreement with the Division; it could be managed by the local government; or Community Forest Association. Based on this responsibility of the Division, no protected forest shall be tampered with in any way as is stated in section 21, subsection (2) of the Forestry Act - 1988, without written permission from the Chief Conservator of the forest.

3.3.4 The Draft Wildlife Regulation, 1997

The Wildlife Regulation came in to force in 1997. It describes Wildlife Conservation Estate as areas described under the 1972 Wildlife Conservation Act as a National Park, Game Reserve, Strict Natural Reserve, Game Sanctuary or Non-hunting Forest Reserve. The regulation prohibits all unlicensed hunting with a Wildlife Conservation Estate to include the removal of honey. It prohibits the hunting of young and immature wild animal or bird; female wild animal accompanied by its young; and birds which are apparently breeding. It also prohibits dazzling of birds and animals.

3.3.5 International Standards and Guidelines

3.3.5.1 World Bank Environment, Health and Safety (EHS) Guidelines1: Mining and Milling – Underground

The World Bank EHS guidelines provide guidance on how to identify risks, there potential impacts and to mitigate and manage risks as a way of ensuring sustainable way of doing business.

3.3.5.1.1 Tailings Disposal

Tailings must be disposed of in a manner that optimizes protection of human safety and the environment. On-land tailings impoundment systems must be designed and constructed in accordance with internationally recognized engineering practices, local seismic conditions, and precipitation conditions. On-land disposal systems should be designed to isolate acid leachate-generating material from oxidation or percolating water. Marine discharges must not have a significant adverse effect on coastal resources. Riverine discharges are not acceptable unless the project sponsor provides thorough documentation regarding: 1) environmental analysis of alternatives, and 2) effects on aquatic resources and downstream users of riverine resources. Project sponsors are encouraged to use tailings as backfill material to the extent feasible.

3.3.5.1.2 Liquid Effluents

The following are guidelines for liquid effluents discharged to surface waters from tailings impoundments, mine drainage, sedimentation basins, sewage systems and stormwater drainage. They do not apply to direct discharge of tailings to the marine environment. pH 6 to 9 BOD5 5 0 m g / l Oil and Grease 20 mg/l Total Suspended Solids 50 mg.

3.3.5.1.3 Residual Heavy Metals

The following are recommended target guidelines below which there is expected to be no risk for significant adverse impact on aquatic biota or human use. In cases where natural background concentrations exceed these levels, the discharge may contain concentrations up to natural background levels. Concentrations up to 110% of natural background can be accepted if no significant adverse impact can be demonstrated. Arsenic 1.0 mg/l; Cadmium 0.1 mg/l; Chromium, Hexavalent 0.05 mg/l; Chromium, Total 1.0 mg/l; Copper 0.3 mg/l; Iron, Total 2 mg/l; L e a d 0 . 6 m g / l; Mercury 0.002 mg/l; Nickel 0.5 mg/l; and Zinc 1.0 mg/l.

The following are recommended target guidelines for discharges below which there is expected to be no risk for significant adverse impact on aquatic biota or human use. In no case should the concentration in the receiving water outside of a designated mixing zone exceed 0.022 mg/l.

Free Cyanide 0.1 mg/l Total Cyanide 1.0 mg/l Weak Acid Dissociable 0.5 mg/l

Measures to prevent access by wildlife and livestock are required for all open waters (examples tailings impoundments and pregnant leach ponds) where WAD cyanide is in excess of 50 mg/l.

Temperature - at the edge of Max 5° C above ambient temperature a designated mixing zone of receiving waters - max 3° C if receiving waters >28° C

Ambient Air Quality

All components of above-ground material handling equipment such as belt conveyors and crushing systems should be covered, and all transfer points should be equipped with a suitable dust collector or other dust suppression measures.

Concentration of contaminants, measured outside the project property boundary, should not exceed the following limits:

Particulate Matter (<10 µm) Annual Arithmetic Mean 100 µg/m3 Maximum 24-hour Average 500 µg/m3

Nitrogen Oxides, as NO2 Annual Arithmetic Mean 100 µg/m3 Maximum 24-hour Average 200 µg/m3

Sulfur Dioxide Annual Arithmetic Mean 100 µg/m3 Maximum 24-hour Average 500 µg/m3.

Other General Environmental Requirements

Erosion and Sediment Control Plan

Project sponsors are required to prepare and implement an erosion and sediment control plan. The plan should include measures appropriate to the situation to intercept, divert, or otherwise reduce the stormwater runoff from exposed soil surfaces, tailings dams, and waste rock dumps. Project sponsors are encouraged to integrate vegetative and non-vegetative soil stabilization measures in the erosion control plan. Sediment control structures (e.g., detention/retention basins) should be installed to treat surface runoff prior to discharge to surface water bodies. All erosion control and sediment containment facilities must receive proper maintenance during their design life.

Mine Reclamation Plan

Project sponsors are required to prepare and implement a mine reclamation plan. The plan should include reclamation of tailings deposits, any open pit areas, sedimentation basins, and abandoned mine, mill, and camp sites. The main objectives of the mine reclamation plan are:

a. return the land to conditions capable of supporting prior land use or uses that are equal to or better than prior land use, to the extent practical and feasible
b. eliminate significant adverse effects on adjacent water resources

Mine reclamation plans should incorporate the following components:

a. conserve, stockpile, and use topsoil for reclamation
b. slopes of more than 30% should be recontoured to minimize erosion and runoff
c. native vegetation should be planted to prevent erosion and encourage self-sustaining development of a productive ecosystem on the reclaimed land
d. budget and schedule for pre- and post-abandonment reclamation activities

Upon mine closure, all shaft openings must be concrete capped. Mine adits should be sealed and, to the extent practical, measures taken to reduce or eliminate acid drainage.

Sewage Sludge Disposal

Sewage sludge must be disposed of in an environmentally acceptable way in compliance with local laws and regulations. Project sponsors are encouraged to evaluate the environmental and health implications of using sewage sludge in reclaiming tailings deposits, waste rock dumps, and mined out areas.

Solid Wastes Disposal

a. Project sponsors should recycle or reclaim materials where possible.
b. If recycling or reclaim is not practical, wastes must be disposed of in an environmentally acceptable manner and in compliance with local laws and regulations.
c. All hazardous materials, process residues, solvents, oils, and sludges from raw water, process wastewater and domestic sewage treatment systems must be disposed of in a manner to prevent the contamination of soil, groundwater and surface waters.

Workplace Air Quality

a. Periodic monitoring of workplace air quality should be conducted for air contaminants relevant to employee tasks and the plant's operations.
b. Ventilation, air contaminant control equipment, protective respiratory equipment and air quality monitoring equipment should be well maintained.
c. Protective respiratory equipment must be used by employees when the exposure levels for welding fumes, solvents and other materials present in the workplace exceed local or internationally accepted standards, or the following threshold limit values (TLVs):
    - Arsenic 0.2 mg/m^3
    - Asbestos, 0.5 $fibers/cm^3$
    - Carbon Monoxide 29 mg/m^3

- Copper 1 mg/m^3
- Hydrogen Cyanide 11 mg/m^3
- Hydrogen Sulfide 14 mg/m^3
- Lead 0.15 mg/m^3
- Nitrogen Dioxide 6 mg/m^3
- Particulate (Inert or Nuisance Dust) 10 mg/m^3
- Silica/Crystalline Quartz 0.1 mg/m^3
- Sulfur Dioxide 5 mg/m^3

d. All active working areas should be ventilated by a current of air containing not less than 19.5% oxygen or in excess of 5% carbon dioxide. e) Regular monitoring of workplace should be conducted for toxic gases.

Workplace Noise

a) Feasible administrative and engineering controls, including sound-insulated equipment and control rooms should be employed to reduce the average noise level in normal work areas.
b) Plant equipment should be well maintained to minimize noise levels.
c) Personnel must use hearing protection when exposed to noise levels above 85 dBA.

Hazardous Material Handling and Storage

a. All hazardous (reactive, flammable, radioactive, corrosive and toxic) materials must be stored in clearly labelled containers or vessels.
b. Storage and handling of hazardous materials must be in accordance with local regulations, and appropriate to their hazard characteristics.
c. Fire prevention systems and secondary containment should be provided for storage facilities, where necessary or required by regulation, to prevent fires or the release of hazardous materials to the environment.

Health - General

a) Sanitary facilities should be well equipped with supplies (e.g., protective creams) and employees should be encouraged to wash frequently, particularly those exposed to dust, chemicals or pathogens.
b) Ventilation systems should be provided to control work area temperatures and humidity.
c) Personnel required to work in areas of high temperature and/or high humidity should be allowed to take frequent breaks away from these areas.

d) Pre-employment and periodic medical examinations should be conducted for all personnel, and specific surveillance programs instituted for personnel potentially exposed to toxic or radioactive substances.

Safety - General

a) Trained and qualified personnel must inspect and test the roof and sides of the underground working areas before beginning operations.
b) Tunnels should be large enough to provide safe clearance for haulage and tramming, including adequate space for personnel to move around all equipment and vehicles.
c) Conveyors and similar machinery should be provided with emergency stops at multiple points.
d) Adequate lighting should be provided on all main haulages.
e) Shield guards or guard railings should be installed at all belts, pulleys, gears and other moving parts.
f) Elevated platforms and walkways, and stairways and ramps should be equipped with handrails, toeboards and non-slip surfaces.
g) Electrical equipment should be grounded, well insulated and conform with applicable codes.
h) Employees should be provided with hard hats, safety boots, cap lamp, self-rescuer, eye and ear protection, and snug fitting gloves as appropriate.
i) Masks and dust-proof clothing should be provided to personnel working in areas with high dust levels.
j) Procedures must be strictly enforced for the storage, handling and transport of explosives.
k) All blasting operations must be carried out only by qualified and certified personnel.
l) Fire-resistant hydraulic fluids and fire-suppression devices should be used on underground equipment.
m) A safety station must be provided on each mine level and provided with air, water and electrical connections to the surface, and the ability to seal each level off from the rest of the mine during emergency conditions.

Training

a) Employees should be trained on the hazards, precautions and procedures for the safe storage, handling and use of all potentially harmful materials relevant to each employee's task and work area.
b) Training should incorporate information from the Material Safety Data Sheets (MSDSs) for potentially harmful materials.

c) Personnel should be trained in environmental, health and safety matters including accident prevention, safe lifting practices, the use of MSDSs, safe chemical handling practices, and proper control and maintenance of equipment and facilities.
d) Training also should include emergency response, including the location and proper use of emergency equipment, use of personal protective equipment, procedures for raising the alarm and notifying emergency response teams, and proper response actions for each foreseeable emergency situation.

Record Keeping and Reporting

a) The sponsor should maintain records of significant environmental matters, including monitoring data, accidents and occupational illnesses, and spills, fires and other emergencies.
b) This information should be reviewed and evaluated to improve the effectiveness of the environmental, health and safety program.

3.3.5.2 World Bank Environmental, Health and Safety Guidelines

These guidelines are technical reference documents with general and industry-specific examples of good international industry practice. (IFC, 2012)

These safeguard policies follow the environmental and social due diligence requirements for World Bank financed projects. These policies provide:

- A mechanism for safeguarding environmental and social issues into project decision making;
- A set of specialized tools to improve development; and
- Support to participatory approaches and transparency.

3.3.5.3 IFC Performance Standards (PS)

The performance standards on environmental and social sustainability provide guidance on how to identify risks, there potential impacts and to mitigate and manage risks as a way of ensuring sustainable way of doing business. There are eight performance standards which a project is expected to meet throughout its life span.

Performance Standard 1: Assessment and Management of Environmental and Social risks; It establishes the importance of integrated management system to identify impacts, risks and opportunities of projects and effective community engagement.

Performance Standard 2: Labour and Working Conditions; this standard recognises that the pursuit of economic growth through employment creation and income generation should

be accompanied by protection of the rights of workers. The PS stipulates that a constructive worker-management relationship must be established, by treating workers fairly and providing safe and healthy working conditions. It also advocates against the use of child labour and forced labour. The Project Proponent must develop internal policies consistent with international standards, on work conditions which will be reviewed periodically.

Performance Standard 3: Resource Efficiency and Pollution Prevention; This PS recognises that increased economic activity and urbanisation may increase levels of pollution to air, water, and consume finite resources in a manner that may threaten people and the environment. PS 3 encourages the uptake of technologies and practises as far as feasible to minimise pollution. It outlines project level approach to resource efficiency and pollution control.

Performance Standard 4: Community, Health, Safety and Security; This PS recognises that in carrying out project activities adjacent communities may be exposed to increased risks and impacts increasingly more so in cases where a community is already subjected to impacts of climate change which could accelerate impacts due to project activities. It does not excuse role of public authorities in promoting the health and safety of the public but recognises the responsibility of the Project Proponent to minimise risks and impacts to the community as a result of the project's activities with a special emphasis on vulnerable groups.

Performance Standard 5: Land Acquisition and Involuntary Resettlement; this PS relates to land acquisition for project related activities and how this affects local communities and persons that use the land. In certain cases, a project requires communities to be relocated in order to access resources in/ on the land. The process of resettling communities should be properly managed to prevent hardship to persons and communities such that they lose their livelihood. PS 4 therefore outlines rules for resettling communities without adverse socio-economic impacts.

Performance Standard 6: Biodiversity, Conservation and Sustainable Management of Living Resources; PS 6 recognises that protecting and conserving biodiversity, maintaining ecosystem services and sustainably managing living natural resources are fundamental to sustainable development. Based on the risks and impacts to natural systems identified, this PS applies to projects located in modified, natural and critical habitats that potentially impact on or are dependent on ecosystem services over which the Project Proponent has direct management control or significant influence or an area that includes the production of living natural resources.

Performance Standard 7: Indigenous Peoples; indigenous peoples as social groups with identities distinct from mainstream groups in national societies are often among the most marginalised and vulnerable segments of the population. It stipulates how private sector projects can create opportunities for Indigenous peoples to participate in and benefit from project related activities that may help their aspiration for economic and social development.

Performance Standard 8: Cultural Heritage; this PS recognises the importance of cultural heritage for current and future generations. The current Project being situated in built-up urban area does impact on cultural heritage sites.

3.3.6 Other Relevant International Conventions

Other international conventions include:

- 1968 African Convention on the Conservation of Nature and Natural Resources;
- The United Nations Convention to Combat Desertification (UNCCD).

3.4 Institutional Stakeholders for a Project of this Nature

The following institutions will have a bearing on such a project:

1. Ministry of Mines and Mineral Resources;
2. National Minerals Agency (NMA) ;
3. The Environment Protection Agency Sierra Leone;
4. Ministry of Agriculture;
5. Ministry of Trade and Industry;
6. Ministry of Local Government and Community Development;
7. Ministry of Lands, Country Planning and the Environment;
8. Ministry of Finance;
9. Environmental Health and Sanitation Department (Ministry of Health and Sanitation).
10. Ministry of Water Resources

3.5 Applicable International Convention/Guidelines, Standards and Policies

Sierra Leone is a signatory to many relevant international conventions, some of which include:

3.5.1 United Nations Framework Convention on Climate Change

Sierra Leone ratified this convention on 22nd June, 1995. The objective of this convention is to regulate levels of greenhouse gas concentration in the atmosphere, so as to avoid the

occurrence of climate change on a level that would impede sustainable economic development, or compromise initiatives in food production.

3.5.2 The Stockholm Declaration

It is a general principle of international law that nation-States have sovereignty (i.e. supreme, independent, political and legal control) over their own natural resources. (UNESCAP & UNEP 4, Walden 49).

Principle 21 of the Stockholm Declaration states the following:

"States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."

3.5.3 Convention on Wetlands of International Importance (RAMSAR)

The Ramsar Convention on Wetlands (Ramsar) was signed by Sierra Leone on December 13, 1999, and went into effect on April 13, 2000. Signatory countries to the Ramsar convention agree to:

- Include conservation of wetlands in land use planning throughout the country, including the promotion of "wise use" of wetlands;
- Establish nature reserves within wetland areas;
- Promote training in the fields of research, management, and gardening; and
- Consult with other signatory countries about implementation of the convention especially in areas of shared wetlands, shared water systems, and shared species.

As required by Ramsar, Sierra Leone identified and listed one wetland site, located along the Sierra Leone River Estuary near Freetown, for inclusion on the Ramsar wetland list. There are no Ramsar wetland sites within or near the Koidu Limited concession.

3.5.4 United Nations Convention on Biological Diversity (UNCBD)

This convention, whose main objectives are to preserve biological diversity and rehabilitate all degraded areas, was ratified by Sierra Leone on 12th December, 1994. All signatory States are obliged to affect the prescribed undertakings which include:

- Development of national biological diversity strategy plan;
- Establishment of protected areas;
- Prevention, control and eradication of invasive and alien species; and

- Provision of educational facilities.

3.5.5 Convention of the International Trade of Endangered Species - (CITES)

The requirements of this convention became effective in Sierra Leone on the 16th January, 1995. The convention seeks to eliminate and/or reduce trade in certain species inclusive of those that are considered endangered. By this convention, a list has been produced comprising of species that require protection against trade. The majority of the species listed in CITES, are those also considered by the International Union for Conservation of Nature and Natural Resources (IUCN), as endangered and threatened. CITES also takes cognizance of species not necessarily threatened, but which require trade control to protect them from being threatened or endangered.

3.5.6 Other Relevant International Conventions

Other international conventions include:

- 1968 African Convention on the Conservation of Nature and Natural Resources;
- The United Nations Convention to Combat Desertification (UNCCD).

3.6 Equator Principles

The Equator Principles (EPs) will be adhered to during the Koidu Kimberlite Project and are as follows:

- Principle 1: Review and Categorisation - Projects are classified according to social and environmental impacts, in Category A (significant impacts), Category B (limited impacts) and Category C (minimal or no impacts);
- Principle 2: Social and Environmental Assessment - For Category A and B projects, sponsors complete an Environmental Assessment;
- Principle 3: Applicable Social and Environmental Standards;
- Principle 4: Action Plan and Management System;
- Principle 5: Consultation and Disclosure;
- Principle 6: Grievance Mechanism;
- Principle 7: Independent Review;
- Principle 8: Covenants;
- Principle 9: Independent Monitoring and Reporting; and
- Principle 10: Equator Principle Finance Institutes (EPFI) Reporting

3.6.1 Project Categorisation

As part of the review of a project's expected social and environmental impacts, EPFIs use a system of social and environmental categorisation, based on the IFC's environmental and social screening criteria, to reflect the magnitude of impacts understood as a result of assessment. These categories are:

- Category A – Projects with potential significant adverse social or environmental impacts that are diverse, irreversible or unprecedented;
- Category B – Projects with potential limited adverse social or environmental impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures; and
- Category C – Projects with minimal or no social or environmental impacts.
- The anticipated impacts on the existing biophysical and social environment, associated with the Koidu Kimberlite Project, led to the Project categorised at a Category A project. This categorisation is furthermore supported by:
- The anticipated impacts associated with open pit and underground mining; and
- Resettlement of people from within the 500 m blasting envelope.

3.6.2 Land Acquisition and Involuntary Resettlement

Involuntary resettlement according to Performance Standard 5 refers to both physical displacement (relocation or loss of shelter) and to economic displacement as a result of project related land acquisition. Land acquisition includes both outright purchase of property and purchase of access rights, such as rights of way.

Resettlement is considered involuntary when affected individuals or communities do not have the right to refuse land acquisition that result in displacement. This occurs in the case of:

- Lawful expropriation or restrictions on land use based on eminent domain; and
- Negotiated settlements in which the buyer can resort to expropriation or impose legal restrictions on land use if negotiations with the seller fail.
- This Performance Standard applies to physical or economic displacement resulting from the following types of land transactions:
- Type I: Land rights for a private sector project acquired through expropriation or other compulsory procedures; and
- Type II: Land rights for a private sector project acquired through negotiated settlements with property owners or those with legal rights to land, including customary or traditional rights recognised or recognised under the laws of the country, if expropriation or other compulsory process would have resulted upon the failure of negotiation.

3.6.3 Biodiversity Management

In accordance with the requirements of Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management the ESIA process must include the assessment of the significance of the project impacts on all levels of biodiversity. The services of a qualified and experienced external expert must be obtained to assist in conducting an ecological assessment of the Koidu project area.

The assessment must take into account the differing values attached to biodiversity by local communities and other interested parties and will identify impacts on ecosystem services and must focus on major threats to biodiversity which include habitat destruction and invasive alien species.

Once it has been identified that the Koidu area of influence includes critical habitats or species or legally protected areas a Biodiversity Action Plan (BAP) will be required for the project area. The ecological assessment should culminate in the development of

Management Plans relevant to the protection of fauna and flora, the management of alien invasive species and the introduction of indigenous species for rehabilitation and soil stabilisation purposes. Management plans should also consider the remedial measures required to deal with loss of biodiversity in the form of provisioning services and cultural services, such as the loss of grazing, use of firewood and building materials and the use of medicinal plants.

3.6.4 Closure Requirements

The EHS Guidelines for Mining includes particular requirements for closure and post-closure activities. Closure and post-closure activities should be considered as early in the planning and design stages as possible and a Mine Reclamation and Closure Plan (MRCP) must be prepared for the proposed mining operation. The MRCP should include the following key aspects:

- Drafted prior to the start of production;
- Clearly identify allocated and sustainable funding sources to implement the plan;
- Include both physical rehabilitation and socio-economic considerations;
- Be an integral part of the project life cycle;
- Designed that future public health and safety are not compromised;
- Designed that the after-use of the site is beneficial and sustainable to the affected communities in the long term and adverse socio-economic impacts are minimized and socioeconomic benefits are maximised;
- Should address beneficial future land use;
- Detailed consultation process which includes regulatory agencies, local communities, traditional land users, adjacent leaseholders, civil society and other impacted parties;

- Regularly updated and refined to reflect changes in mine development and operational planning, as well as the environmental and social conditions and circumstances;
- Records of the mine works should also be maintained as part of the post-closure plan;
- Include appropriate aftercare and continued monitoring of the site, pollutant emissions and related potential impacts;
- The duration of post closure monitoring should be defined on a risk basis, however, site conditions typically require a minimum period of five years after closure or longer;
- Include contingencies for temporary suspension of activities and permanent early closure.
- Further objective in respect of financial feasibility and physical, chemical and ecological integrity are included in the Mining Guidelines

3.6.5 ESIA Compliance

IFC PERFORMANCE STANDARD	IMPLEMENTATION OF THE IFC PERFORMANCE STANDARD TO THE KOIDU KIMBERLITE PROJECT	REFERENCE CHAPTER IN THE ESIA REPORT
Performance Standard 1: Social and Environmental Assessment and Management Systems	• The findings of the ESIA must be used to establish a Social and Environmental Management System; • The Social and Environmental Management System must be appropriate to the nature and scale of the project and commensurate with the level of social and environmental risks; • A Management Programme and Action Plans must be compiled to deal with specific mitigation measures and actions necessary for the project to comply with applicable laws and regulations and to meet the requirements of the IFC Performance Standards; • An organizational structure that defines, roles and responsibilities and authority to implement the Management Programme and Action Plans must be established • Employees and contractors with direct responsibility for activities relevant to the project's social and environmental performance must be trained in respect of IFC requirements so that they have the knowledge and skills necessary to perform their work. • A Grievance Mechanism must be compiled and implemented in order to respond to the communities' concerns related to the project and must establish a mechanism whereby affected communities concerns and grievances can be received and resolutions facilitated. • As an element of its Management System, the client will establish procedures to monitor and measure the effectiveness of the management program. This should also include dynamic	Social and Environmental Assessment and Management Systems are addressed throughout the ESIA report.

IFC PERFORMANCE STANDARD	IMPLEMENTATION OF THE IFC PERFORMANCE STANDARD TO THE KOIDU KIMBERLITE PROJECT	REFERENCE CHAPTER IN THE ESIA REPORT
	mechanisms, such as inspections and audits, where relevant, to verify compliance and progress toward the desired outcomes. • Internal and external reporting is required.	
Performance Standard 2: Labour and Working Conditions	• Koidu Limited must adopt a human resources policy that sets out its approach to managing employees consistent with the requirements of this Performance Standard. • Koidu will document and communicate to all employees and workers, directly contracted by Koidu, their working conditions and terms of employment, including their entitlement to wages and any benefits. • Where Koidu is a party to a collective bargaining agreement with a workers' organization, such an agreement will be respected. • Where such agreements do not exist, or do not address working conditions and terms of employment Koidu will provide reasonable working conditions and terms of employment that, at a minimum, comply with national law. • In countries where national law recognizes workers' rights to form and to join workers' organizations of their choosing without interference and to bargain collectively, Koidu will comply with national law. • Worker organizations are expected to fairly represent the workers in the workforce. • Koidu will not make employment decisions on the basis of personal characteristics unrelated to inherent job requirements. Koidu will base the employment relationship on the principle of	Labour and Working Conditions are primarily addressed in Koidu Human Resources Policies, Occupational Health and Safety Records, and employment procedures.

IFC PERFORMANCE STANDARD	IMPLEMENTATION OF THE IFC PERFORMANCE STANDARD TO THE KOIDU KIMBERLITE PROJECT	REFERENCE CHAPTER IN THE ESIA REPORT
	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. • Koidu will comply with national law of Sierra Leone that provides for non-discrimination in employment, • Koidu 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. • Koidu will provide a grievance mechanism for workers (and their organizations, where they exist) to raise reasonable workplace concerns. • Koidu 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. • Children below the age of 18 years will not be employed in dangerous work. • Koidu will not employ any form of forced labour.	
Performance Standard 3: Pollution Prevention and Abatement	• Koidu must avoid the release of pollutants or, when avoidance is not feasible, minimize or control the intensity or load of the release. This applies to the release of pollutants due to routine, non-routine or accidental circumstances with the potential for	Pollution prevention and abatement are covered in the Environmental and Social Management Plans.

IFC PERFORMANCE STANDARD	IMPLEMENTATION OF THE IFC PERFORMANCE STANDARD TO THE KOIDU KIMBERLITE PROJECT	REFERENCE CHAPTER IN THE ESIA REPORT
	local, regional, and trans-boundary impacts. • Koidu should examine and incorporate in its operations resource conservation and energy efficiency measures, consistent with the principles of cleaner production. • Waste management during the project lifecycle will be based on the principles of waste prevention, waste minimisation, re-use and recycling, treatment and finally disposal of waste in an environmentally sound manner. • A Hazardous Waste Management Plan must be developed in order to identify all potential sources of hazardous waste and quantities generated as a result of project processes and activities. Waste management options, including recycling, treatment and the safe disposal options will be identified for each hazardous waste stream, hazardous waste disposal landfill sites will be identified and reputable and licensed contractors investigated. • Koidu must avoid or, when avoidance is not feasible, minimize or control the release of hazardous materials resulting from the production, transportation, handling, storage and use for project activities. • Koidu must avoid the 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. • Koidu must prepare an Emergency Preparedness and Response Plan which addresses the training, resources, responsibilities,	

IFC PERFORMANCE STANDARD	IMPLEMENTATION OF THE IFC PERFORMANCE STANDARD TO THE KOIDU KIMBERLITE PROJECT	REFERENCE CHAPTER IN THE ESIA REPORT
	communication, procedures, and other aspects required to effectively respond to emergencies associated with project hazards. • Koidu must 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. These emission guidelines must be considered in light with Sierra Leone legislation and should Sierra Leone emission limits differ from the levels and measures presented in the EHS Guidelines, Koidu must achieve whichever is more stringent. • To address adverse project impacts on existing ambient conditions, Koidu must 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 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. • Koidu is required to promote the reduction of project-related	

IFC PERFORMANCE STANDARD	IMPLEMENTATION OF THE IFC PERFORMANCE STANDARD TO THE KOIDU KIMBERLITE PROJECT	REFERENCE CHAPTER IN THE ESIA REPORT
	greenhouse gas (GHG) emissions in a manner appropriate to the nature and scale of project operations and impacts.	
Performance Standard 4: Community Health, Safety and Security	This Performance Standard includes the following main features with which Koidu must comply: • Development of a Community Health and Safety Action Plan; • Undertake a risk assessment of mine infrastructure including tailings dams and other structural elements which may pose a significant risk to nearby communities; • Control the safety of deliveries of hazardous raw materials and transportation of hazardous wastes; • The establishment of an HIV/Aids policy; • The implementation of an HIV/AIDS programme • Undertake a risk assessment of security arrangements	Community Health, Safety and Security is integrated in various specialist sections throughout the report, with specific focus on the Socio-Economic baseline section, Impact Assessment, and Social Management Plans (CDAP, PCDP and RAP in volume 2 of the ESIA)
Performance Standard 5: Land Acquisition and Involuntary Resettlement	Based on the regulations of Performance Standard 5, the aim of this project is to avoid resettlement and minimise disturbance of communities. As resettlement is required to ensure the safety of inhabitants within a 500 m blasting radius, a resettlement action plan (RAP) is currently being undertaken to comply with performance standard 5.	A Resettlement Action Plan is already being implemented, and an updated RAP presented in the Management Plans.
Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management	• In accordance with the requirements of this Performance Standard, the Koidu ESIA process includes the assessment of the significance of the project impacts on all levels of biodiversity. • The services of a qualified and experienced external expert must be obtained to assist in conducting an ecological assessment of the Koidu Project area of influence.	Biodiversity Conservation and Sustainable Natural Resource Management is integrated and addressed throughout the report.

IFC PERFORMANCE STANDARD	IMPLEMENTATION OF THE IFC PERFORMANCE STANDARD TO THE KOIDU KIMBERLITE PROJECT	REFERENCE CHAPTER IN THE ESIA REPORT
	• The assessment must take into account the differing values attached to biodiversity by local communities and other interested parties and will identify impacts on ecosystem services and must focus on major threats to biodiversity which include habitat destruction and invasive alien species. • Once it has been identified that the Koidu area of influence includes critical habitats or species or legally protected areas a Biodiversity Action Plan (BAP) will be required for the project area. • The ecological assessment must culminate in the development of Management Plans relevant to the protection of fauna and flora, the management of alien invasive species and the introduction of indigenous species for rehabilitation and soil stabilisation purposes. • Management plans must consider the remedial measures required to deal with loss of biodiversity in the form of provisioning services and cultural services, such as the loss of grazing, use of firewood and building materials and the use of medicinal plants.	
Performance Standard 7: Indigenous Peoples	Performance Standard 7 defines indigenous people as "social groups with identities that are distinct from dominant groups in national societies, are often among the most marginalized and vulnerable segments of the population. Their economic, social and legal status often limits their capacity to defend their interests in, and rights to, lands and natural and cultural resources, and may restrict their ability to participate in and benefit from development."	This standard is not applicable to the Koidu Project as there are no highly vulnerable or indigenous people *per se*.
Performance Standard 8:	Performance Standard 8 includes four main features with which Koidu is committed to:	Cultural Heritage is integrated with social and cultural aspects and addressed in more detail in the Social

IFC PERFORMANCE STANDARD	IMPLEMENTATION OF THE IFC PERFORMANCE STANDARD TO THE KOIDU KIMBERLITE PROJECT	REFERENCE CHAPTER IN THE ESIA REPORT
Cultural Heritage	• Host country legislation applicable to archaeological and cultural heritage; • Compile an Archaeological and Cultural Management Procedure which covers chance finds during construction or operational activities; • Chance finds may not be disturbed until an assessment by a competent specialist is made and actions consistent with the procedure and legislative requirements are met; and • Ensure that an archaeologist is present during the bush clearing phase to provide guidance in terms of already identified cultural sites as well as to identify any additional archaeological or cultural sites and to stipulate mitigatory measures dependent on their level of importance, should any be identified at this phase of the project.	sections of the ESIA Report.

4 PROJECT ALTERNATIVES

4.1 Mining Method Alternatives

In January 2015, a complete conceptual study of underground mining project was undertaken at KL, couple with professional mining engineering models of the project to be implemented. This gave rise to the New Octéa Underground Concept.

Moreover, in September 2015, an update was made to the initial underground mining concept based on new geological and other information that were at the disposal of SRK, the consultant.

As a result Koidu Limited management believed that SRK's latest report was conservative, in particular with regards to the assumed development rate of 100m/month per drill rig and produced the UMP as an alternative plan for the KKP.

Moreover, prior to finalizing the UMP for the KKP, open pit mining protraction after Cutback 3 (Cut 3) completion was considered to be implemented by Koidu Limited to proceed with an additional Cutback (Cut 4) in order to maintain the status quo.

An economic analysis found that an additional cutback would prove uneconomical and capital intensive due to 80% of the mining fleet meeting its end of life hours with advent of the completion of Cut 3.

Another constraint was waste management as Cut 4 called for approximately **21Mt** of waste stripping in addition to the current waste dumps within the Koidu Ltd Mining concession.

Before now continuation of open pit mining was considered as the standalone option for KKP as the optimisations showed that K1 Cut 4, although viable, would be the end of the economic life of the mine.

In considering an open pit to underground transition-strategy it becomes clear that, for optimal project economics, Koidu Limited should initiate an underground section immediately.

The Cut 4 option also presented a financial risk in the form of an ore gap. Scenario planning was done and concluded that an accelerated underground mining plan would reduce or mitigate the aforementioned risk. Thus, the underground mining operation is the best plausible alternative to the open pit operations.

4.1.1 Free Caving vs Sublevel Open Stoping (SLOS)

Free caving methods versus sublevel caving (SLC), sublevel open stoping (SLOS) and vertical crater retreat (VCR) and KL's time constraints were evaluated as a potential mining method for the underground operations in the main ore bodies; Sublevel Open Stoping (SLOS) was chosen to be the preferred mining method for the KKP and will be used in both K1 and K2, due to the competent rock characteristics of the Koidu kimberlites, the hardness of which makes caving virtually impossible. This mining method (SLOS) has been used very

successfully in numerous underground Kimberlite operations around the world. Some recent successful applications are at the Finsch mine, Petra Diamonds, and BHP's EKATI Mine.

4.1.2 Dykes

Mechanised long holing was chosen over the labour intensive over-hand shrinkage method for the kimberlite dyke orebodies. This was mainly done due to better integration of the mechanised solution with the main production operations as well as the establishment of a safer work environment for the workers working in the dyke zones.

4.1.3 Underground access

During an earlier study, alternative underground access methods were evaluated. A vertical shaft was juxtaposed to a declined tunnel access. The decline tunnel option was chosen as the preferred option based on the life of mine cost benefit, with the fairly shallow operating depth and high cost of electricity penalising the vertical shaft option. From the previous underground access strategies and methods that were traded off; it was concluded that the decline access option was economically superior to the vertical shaft option and that the economic sensitivity is primarily driven by:

- Lead time to initial underground production.
- Production rate requirement from the underground.
- Depth of the underground workings.
- Electricity cost

The access options were again considered in light of the above and the conclusion made that most of the drivers were still in favour of the decline option.

The decision was also made to only develop one decline into the underground workings as oppose to the "double barrel" decline that was proposed during earlier work. The "double barrel" option does not present any quantitative benefits over the single decline option other than assistance with ventilation assistance and limited application as a second outlet.

The underground access will be protected by a "cut and covered" portal. The rationale behind this is to protect the underground working and access road-way from any sudden storm water ingress as a result of a flash flood – due to the relative high rainfall occurrence in Sierra Leone.

A single decline tunnel (6.0m x 5.0m) will be developed from the portal at an inclination of minus 14%. This is generally regarded as the optimum decline gradient for efficient haulage operations. The configuration of the decline allows access along the decline to the dyke zones in between the main pipes, access to K1 at the desired elevation of the first underground

levels and also access to K2 at the desired elevation of the initial underground production levels.

Lay-byes will be developed at intervals not exceeding 250m and provision for run-away "cubbies" have been made at intervals not exceeding 350m. These tunnels features will also serve as re-muck bays during the development phase.

To actualize the Open Pit to Underground Transition development, the first access adit will be blasted on the Southern side of the K1 pit at 208 Level. It will be drilled using a Sandvik DD420-40C double boom drill rig with a dimension of 5.0m x 6.0m. Then a Central Decline from surface to the K1-K2 Connecting Drive will be developed and the ramp will serve as the main access to the underground workings once the central drive from K1 is connected. Both people and material will use this decline as the primary access to the operations.

Mirroring the methods in K1, K2 access adit will be blasted at 257 Level. The scheduling for the K2 access adit development would ensure that all K1 ore blocks have been depleted and all of the Central development infrastructure and ventilation has been completed.

4.2 Beneficiation Plant

The following section details the mineral processing to be followed for the Underground Mining Project. The beneficiation will follow the current processing (180t/h process plant) operation at Koidu Ltd.

4.2.1 Ore receiving

The ore is tipped into a receiving bin which is fitted with a 600 mm square aperture static grizzly. Any oversize material that has not passed through the 600 mm opening is broken using a static rock breaker. The material that passes through the 600 mm static grizzly is drawn out of bin using an apron feeder and discharged onto a vibrating grizzly feeder. The vibrating grizzly feeder has a setting of around 120 mm and any material that does not pass through the opening is discharged into a primary jaw crusher. The jaw crusher has an open-side setting of around 90 mm and delivers a discharge product of around 150 mm. Both the jaw crusher product and the vibrating grizzly undersize discharge onto the primary feed conveyor. The primary feed conveyor discharges into a 2.4 x 6.0 m roller supported scrubber. The scrubber has been included in the circuit to allow for flexibility in material processing, should the characteristics of the material from the pit change. Although the plant should be treating very competent Kimberlite, there is still the possibility that the plant will be fed with material that contains clay. The scrubber is able to process the material and remove the clay.

4.2.2 Primary sizing, secondary crushing

The scrubber discharges onto the 1 830 mm x 3 600 mm primary sizing screen. The primary sizing screen is a double deck fitted with 28 and 1.2 mm panels. The >28 mm material is then fed to the secondary crushing section. The 1.2 to 28 mm fractions are classified as fines and the <1.2 mm as slimes. The >28 mm material discharges onto the secondary screen feed conveyor. The secondary screen is a double deck 2 100 mm x 4 200 mm screen fitted with 32 mm panels.

The >32 mm material is conveyed to the secondary crusher surge bin. The material is drawn out of the surge bin with a 750 mm x 1 500 mm vibrating pan feeder into a Sandvik CH440EC secondary cone crusher. The cone crusher product is discharged onto a conveyor and is re-circulated back to the secondary screen.

4.2.3 Fines Dense Media Separation (DMS) and re-crusher

The <28 mm material from the primary and secondary screens is conveyed to the fines 260 t DMS surge bins. The fines DMS surge bins discharge onto the DMS feed conveyors using two 750 mm x 1 500 mm variable speed vibrating pan feeders. The pan feeders are connected to a weightometer which regulates the feed to the DMS. The fines DMS modules are configured as 130 tph DMS utilizing two 510 cyclones each. The DMS has a double deck floats screen with an 8 mm aperture.

The >8 mm material is conveyed to the re-crush 2 500 t stockpile. The re-crush stockpile conveyor is fitted with a weightometer for accounting purposes. The re-crusher feed is drawn out from underneath the stockpile using two 750 mm x 1500 mm variable speed vibrating pan feeders and will discharge into the tertiary crusher feed conveyor.

The conveyor feed two Sandvik CH440F tertiary cone crushers. The cone crushers discharge directly onto the re-crusher sizing screen. The re-crusher sizing screen is a 2 440 mm x 4 200 mm double deck screen fitted with an 8 and 1.2 mm aperture. The >8 mm material is transported back to the re-crusher stockpile. The <8mm is conveyed back the fines DMS surge bin and the <1.2 mm material reports to the water recovery section. The <8 mm material from the fines DMS is conveyed to a camel back movable stacker conveyor that will deposit the tailings onto the tailings dump. The sinks material from the fines DMS is jet pumped to the final recovery.

4.2.4 Final recovery

The concentrate from the fines DMS jet pump is received into a concentrate holding bin. The material is then jet pumped up to the 1 220 mm x 2 440 mm primary de-watering screen. The primary de-watering screen is fitted with 1.2 mm2 polyurethane panels and is inclined at 5o to facilitate maximum drainage. The oversize from the de-watering screen discharges onto the 610 mm x 4 270 mm x-ray sizing screen. Here the material is sized into 16 to 28 mm; 8 to 16 mm; 4 to 8 mm; 2 to 4mm and 1.2 to 2 mm fractions. These fractions are stored in the 1

m3 x-ray surge hoppers under the screen. The undersize from the de-watering screens drains to a splitter box. The splitter box operates as a decanting device which allows for the separation of the fine material and water. The fines material separated in the splitter is diverted to the final tailings screen. The water from the splitter is then diverted back to the jet pump motive sump for re-use. The 28 to 55 mm material is delivered to a 15 t surge bin from where it is drawn out and sorted through a single pass, wet x-ray sorter. All other size fractions are fed through double stage wet x-ray sorters. The rejects from the x-ray sorters that is larger than 8 mm report to the re-crush section for further crushing and diamond recovery. All -8mm rejects is stockpiled in the recovery yard on a tailings stockpile. The concentrate from the ultrafine x-ray sorters is discharged into a tube feeder and the concentrate from the x-ray sorters treating the fines, middlings and coarse fractions is discharged into another tube feeder. Both tube feeders discharge into the concentrates bin ahead of the dryer. All effluent from the other operations in the recovery plant, namely x-ray effluent and dewatering screen effluent, report to the final tailings pump. The final tailings pump delivers the effluent to the thickening section of the plant. All concentrates are then fed through the Infrared dryer. This dryer is a rotary belt dryer utilizing both low frequency infra-red drying and hot air blowers to dry the concentrate. Once dried, the concentrates are discharged onto the sort house glove boxes. All glove box pickings are sent from the glove boxes to the accounting glove box. Here the diamonds are weighed and sized. A drop safe is attached to the accounting glove box to facilitate direct deposit of packaged diamonds. All pickers' rejects are conveyed out of the sort house and onto the recovery tailings conveyor which will exit the side of the recovery building and discharge onto the recovery tailings stockpile conveyor.

4.3 No-Mining Alternative

The "no go" alternative entails the maintenance of the status quo (open pit mining operations) by continuing to Cutback 4 after Cutback 3 is depleted. Without the underground mining transition of the existing open pit mining activities at the Koidu Kimberlite Project, the resource will not be exploited optimally by avoiding presented a financial risk posed by Cut 4. Moreover, the Cut 4 open pit opeartions will generate **21Mt** of waste compared to **639,997t** waste rock that the undergroung mining operation will generate. As all the underground operations would take place within Koidu Limited's existing mining area, the proposed project area will remain fallow. The current land use potential and capability to uplift the local population would thus remain unchanged and the resource would remain unused because it will not be exploited. The regional and national economic benefits associated with the project would not occur and no employment will be created.

When considering the "no go" alternative, it must be noted that assessment of potential impacts of the proposed ungerground operations would be made against the status quo, thus allowing the "impact" of the "no go" alternative to be inferred. If the project were not to proceed, the foreign revenue, economic activity and available jobs would not be created. This would have a negative impact on the country as Sierra Leone has a paucity of revenue

generating, profitable, operating mines and the Koidu Kimberlite project is a technically advanced, world class mining operation.

Koidu Limited from 2003 to date has a record of delivery by management. As a direct consequence of the mining operations and interventions by Koidu Limited management, the general environment has been vastly improved and much of the damage done during the time of the civil war reversed.

Therefore, considering the economic benefits, less waste rock generation and less environmental impacts from the proposed project; the 'no go' alternative is not feasible whilst going for the underground mining operation is best plausible option. Hence, the Open pit mining to Underground mining transition should proceed.

5 DESCRIPTION OF THE RECEIVING PHYSICAL ENVIRONMENT (FROM ORIGINAL DWA ESIA REPORT)

5.1 Introduction

This section presents the environmental conditions at the time of the Digby Wells ESIA study in 2010 and includes data, information and descriptions of the project area as they were at the time of the study.

5.2 Climate

The climate in the region is described as wet tropical monsoon, with a single wet season each year between mid-May and mid-November. The average rainfall is approximately 2 540 mm, with the wettest month usually in August and rivers attaining maximum discharge in mid-September. The dry season is between December and February. River discharge is at its lowest in March and April, and begins to increase gradually in May with the onset of the rains. Groundwater levels do not rise significantly until late July.

Normal temperature range is 20oC to 33oC, although it can drop as low as 10oC at night during the Harmattan season in January. Day temperatures average 31oC in the dry season and 28oC in the wet season.

Although the heavy rainfall does impact on the operation, making working conditions difficult, to date it has not resulted in any significant production delays.

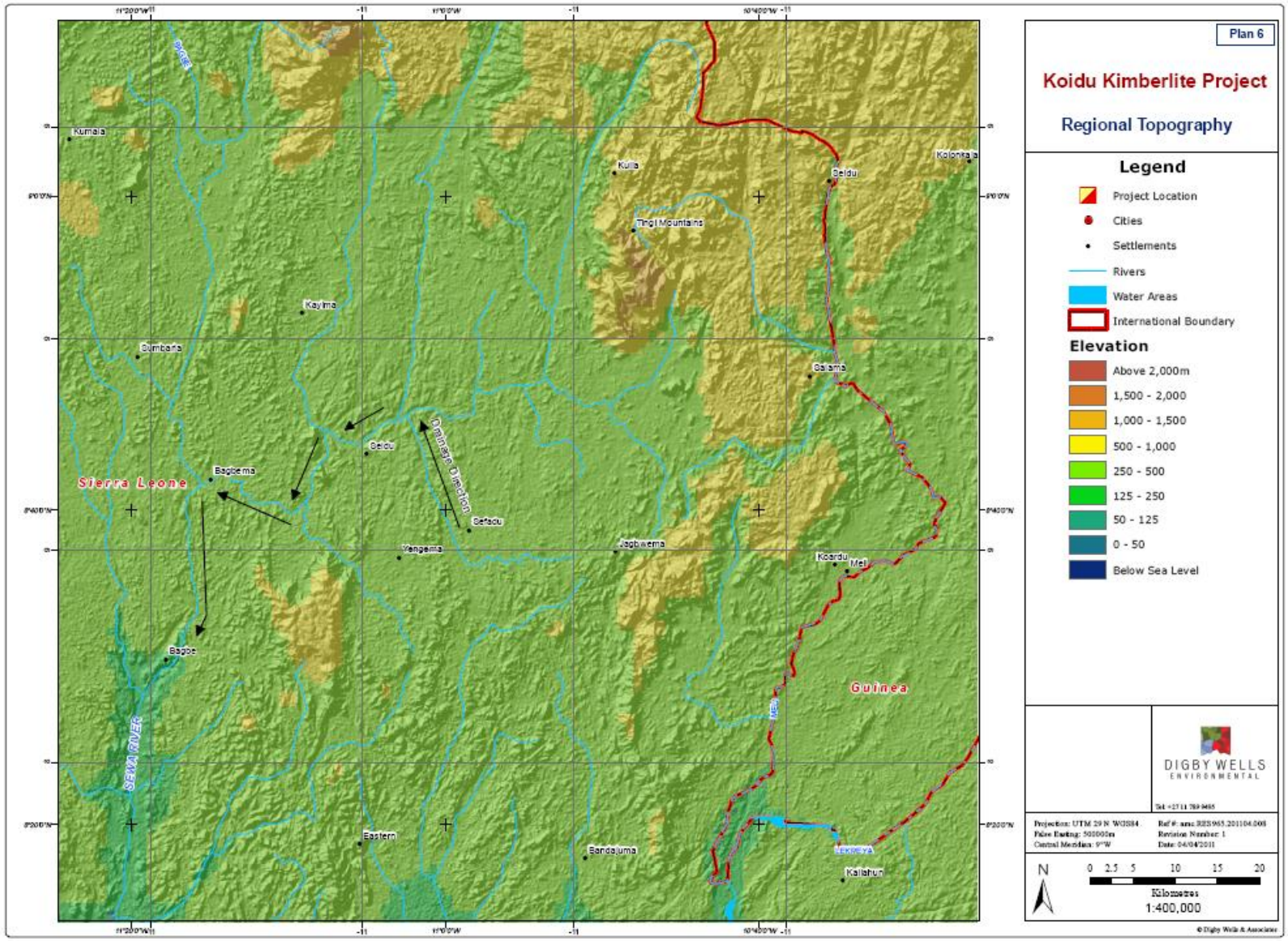
5.3 Topography

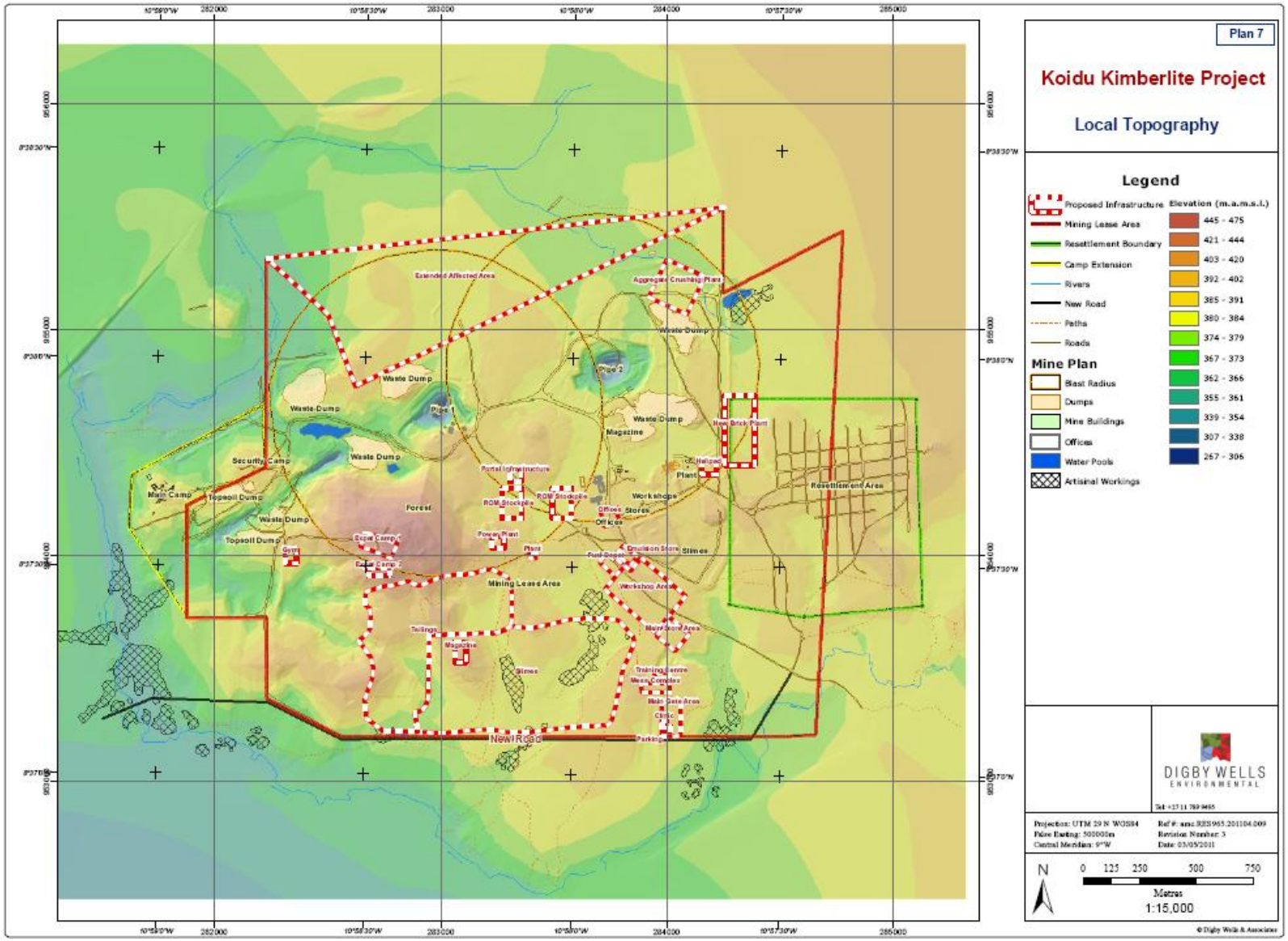
Regionally the Koidu site is located in the Tankoro Chiefdom within the Kono District of the Eastern Province of Sierra Leone. This area (Plan 6) is on a plateau which is typically higher in elevation in relation to the rest of the country. The Tingi Mountains, located approximately 40 km to the north of the site are one of the highpoints in the country at an elevation of 781 mamsl.

The stream directly south of the site drains in a westerly direction before turning north-west. Thereafter, the stream heads in a south-westerly to southerly direction and feeds into Sewa River which eventually terminates in the North Atlantic.

Locally, the site is located at an elevation of approximately 390 mamsl, with the significant natural topographical feature being Monkey Hill, which has a peak elevation of approximately 470 mamsl and is characterised by slopes which are steeper than that of the rest of the site (Plan 7). The topography of the site has been altered by historical and current mining activities focussed primarily on the alluvial deposits surrounding the town (both formal and artisanal). The waste rock and tailings facilities as a consequence of the mining of the K1 and K2 kimberlites have as a matter of course minimally altered the topography of the area, but this has since 2003 been properly planned and implemented by Koidu Holdings management.

Since the site is already topographically disturbed, the additional impacts associated with the project are estimated to be of low significance, as the waste rock and tailings deposition facilities have been properly planned by current management in order to minimize to impact on the topography of the area.





5.4 Air Quality

In characterising baseline air quality, reference is made to details concerning the study area, atmospheric dispersion potential and other potential sources of atmospheric emissions in the area. The consideration of the existing air quality is important so as to facilitate the assessment of the potential for cumulative air pollutant concentrations arising due to the proposed development.

5.4.1 Study Area

The local study area for the air quality impact assessment was selected based on the expected extent of air quality impacts and possible sensitive receptors such as individual homes and communities. A study area of approximately 5 km east-west and 5 km north- west with the pollution sources located approximately in the centre was identified.

Approximately 0.36 km² of the mining lease area is occupied by Monkey Hill, which reaches the height of just over 450 m above sea level, surrounded by gently undulating topography where the kimberlites occur. The topography of the study area is shown in the following figure.

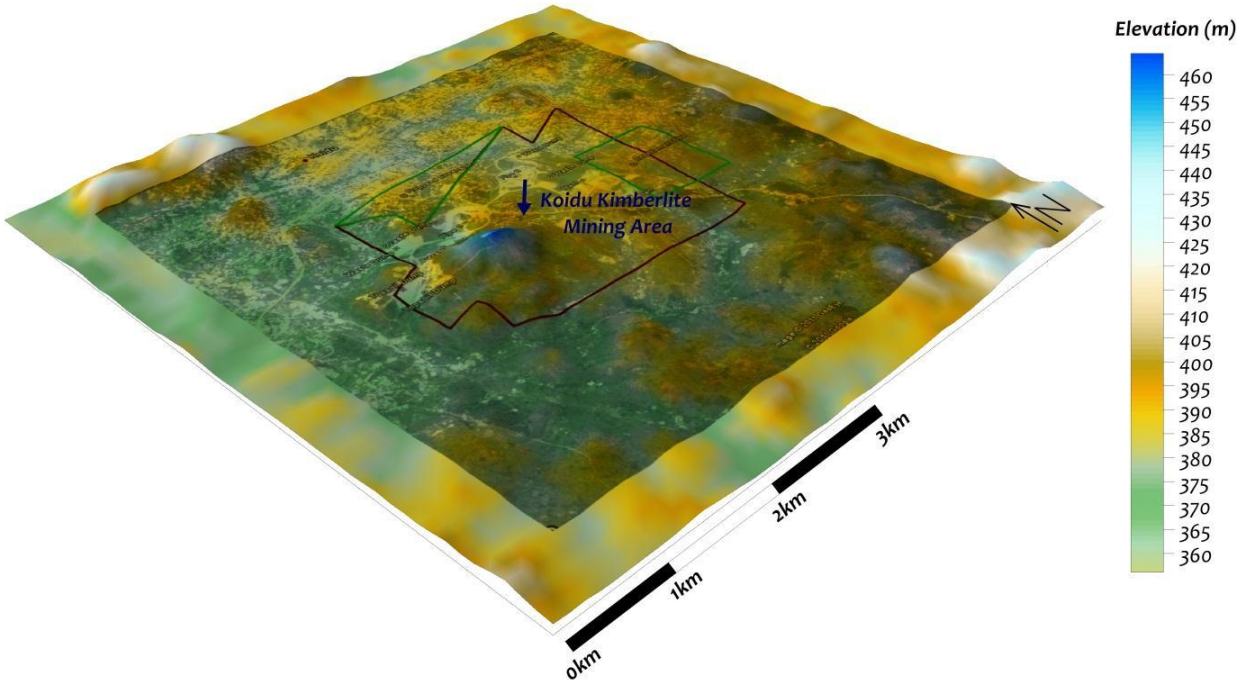


Figure 5.4-1: Topography of study area

This area is on a plateau which is typically higher in elevation in relation to the rest of the country. Locally the site is located at an elevation of approximately 390 m above sea level, with the significant natural topographical feature being Monkey Hill which is characterised by slopes which are steeper than of the rest of the site.

5.4.2 Atmospheric Dispersion Potential

In the assessment of the potential for air quality impacts on the surrounding environment and

human health, a good understanding of the regional climate and local air dispersion potential of a site is essential.

Meteorological characteristics of a site govern the dispersion, transformation and eventual removal of pollutants from the atmosphere (Pasquill and Smith, 1983; Godish, 1990). The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Dispersion comprises vertical and horizontal components of motion. The vertical component is defined by the stability of the atmosphere and the depth of the surface mixing layer. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field.

The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction and the variability in wind direction, determine the general path pollutants will follow, and the extent of cross-wind spreading (Shaw and Munn, 1971; Pasquill and Smith, 1983; Oke, 1990).

Pollution concentration levels fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field. Spatial variations, and diurnal and seasonal changes, in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales (Goldreich and Tyson, 1988). Atmospheric processes at macro- and meso-scales need therefore be taken into account in order to accurately parameterise the atmospheric dispersion potential of a particular area.

Parameters that need to be taken into account in the characterisation of meso-scale ventilation potentials include wind speed, wind direction, extent of atmospheric turbulence, ambient air temperature and mixing depth.

5.4.2.1 Local Wind Field

The analysis of hourly average meteorological data is necessary to facilitate a comprehensive understanding of the ventilation potential of the site, and to provide the input requirements for the dispersion simulations. A comprehensive data set for one year of detailed hourly average wind speed, wind direction and temperature data are needed for the dispersion simulations.

In characterising the dispersion potential of the proposed open cast pits, reference was made to hourly average meteorological data recorded at Koidu for the years 2009 and 2010 using the United States Environmental Protection Agency (US-EPA) approved AERMET meteorological model. The AERMET meteorological data was obtained from Lakes Environmental and comprised of surface hourly meteorological hourly average data in closer proximity to the proposed site. Upper air data used was also obtained from Lakes Environmental.

5.4.2.2 Surface Wind Field

The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness.

Wind roses comprise 16 spokes, which represent the directions from which winds blew during the period. The colours used in the wind roses below, reflect the different categories of wind speeds; the red area, for example, representing winds of 4 m/s to 5 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are also indicted.

Period, day-time and night-time wind roses for Koidu are presented in Figure 7. The wind regime largely reflects the synoptic scale circulation. The flow field is dominated by south-westerly and westerly winds, with little or no flow from the north-easterly sectors. Thermo-topographical impacts on the flow regime give rise to distinct diurnal trends in the wind field. During the day-time, the predominant wind flow is from the southwest, with frequent winds also from the south and the southeast. Strong winds (> 5 m/s) occur from the westerly sector. During night-time the decrease in winds from the south-easterly sector are evident with the prevailing winds from the southwest. A decrease in the wind velocity is also apparent with wind mainly between 1m/s to 3m/s for most of the time. This is typical of night-time airflow when calm periods and low wind speeds are generally more prevalent.

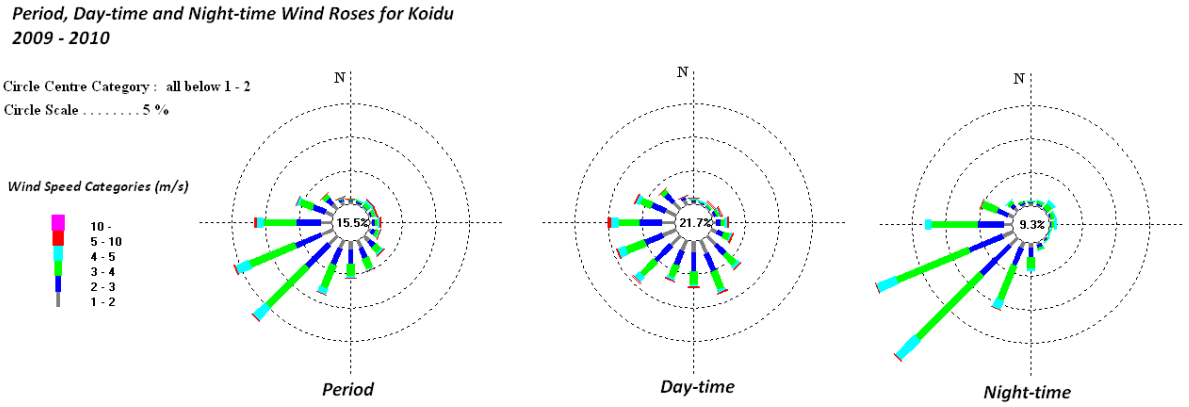


Figure 5.4-2: Period, day-time and night-time wind roses for Koidu (2009 – 2010)

Seasonal average wind roses reflect distinct shifts in the wind field between summer, autumn, winter and spring months. These are portrayed in Figure 8 overleaf. During the summer months the average wind direction is from the northeast, the southeast and southwest, with limited flow from the north. During autumn the north-easterly component decreases with increased airflow from the southwest. During winter the field shifts towards the west, with a distinct decrease in winds from the easterly sector. During spring time the wind field shifts again to reflect the prevailing wind directions as in autumn (i.e. southwest and west).

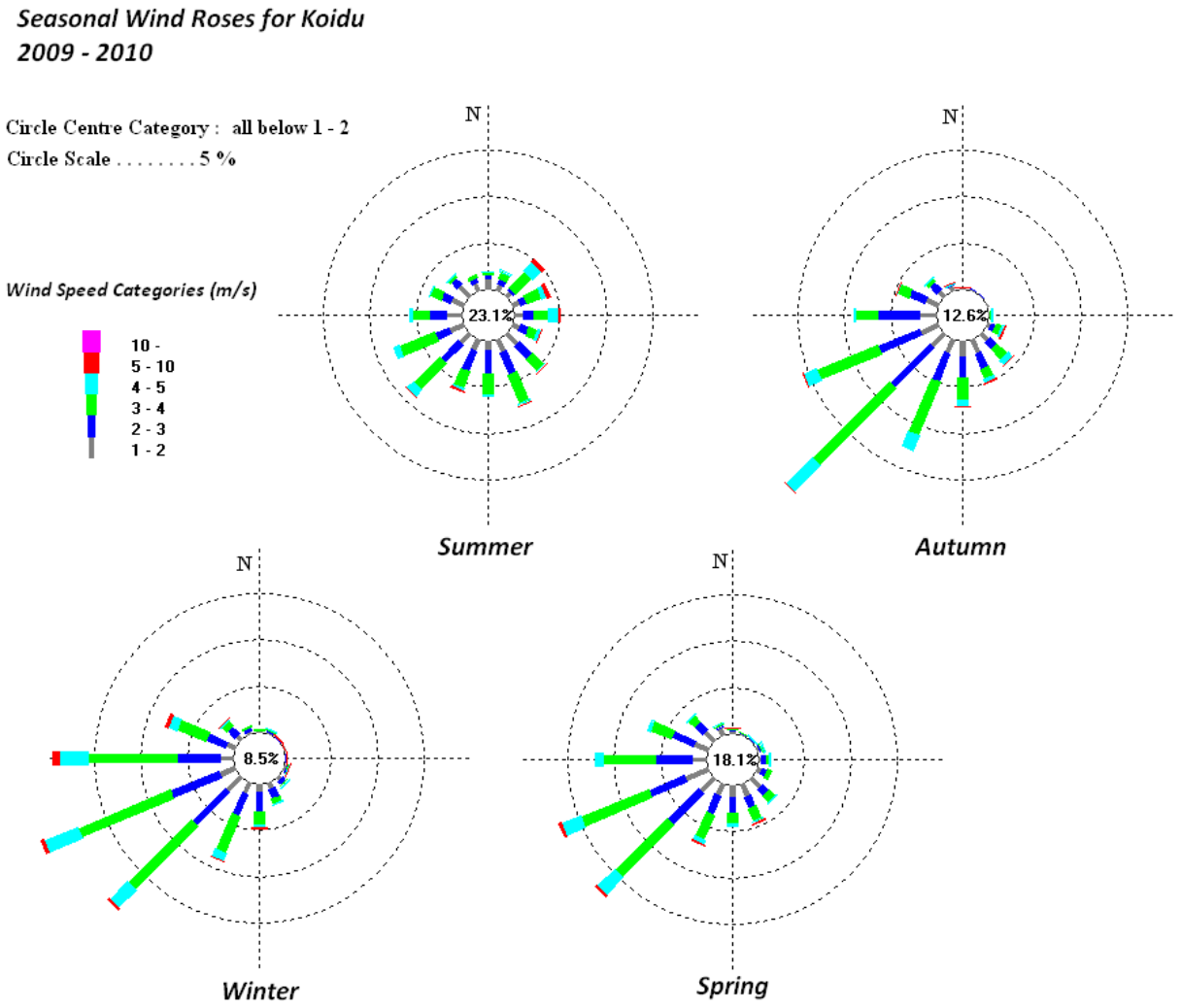


Figure 5.4-3: Seasonal average wind roses for Koidu (2009 – 2010)

5.4.2.3 Temperature

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers.

The seasonal and diurnal variations in temperatures recorded at Koidu are depicted in Figure 9. At Koidu the average daily maximum temperature is about 30.5 °C, the minimum temperature is 22.1°C and the average temperature of 25.9 °C.

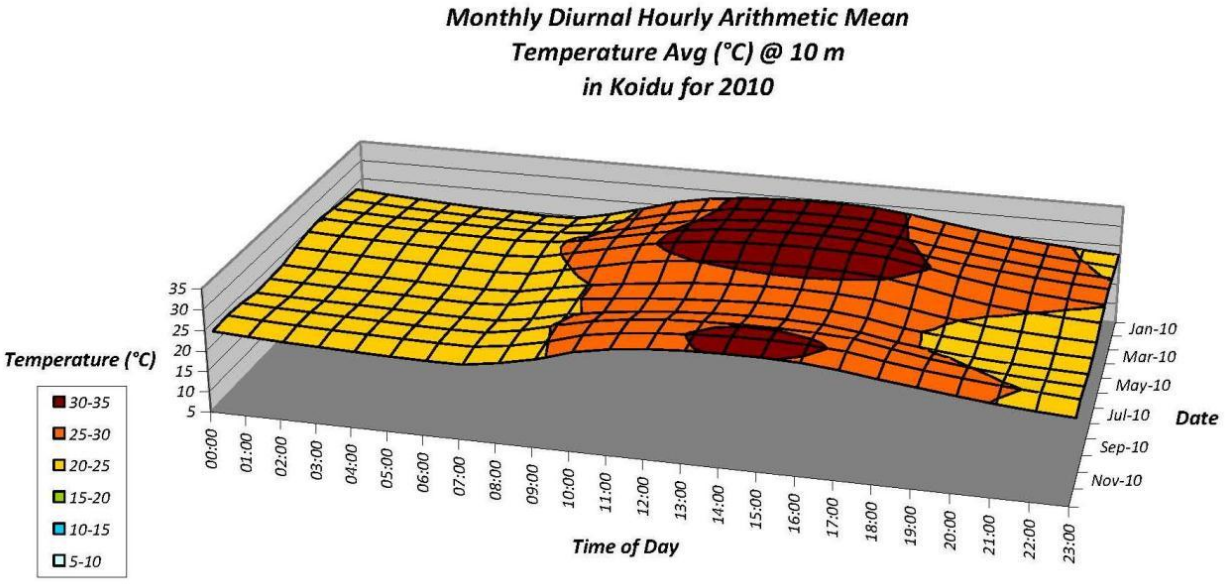


Figure 5.4-4: Diurnal temperature trends modelled at Koidu (2010)

The maximum, mean and minimum temperatures recorded at Koidu are given in Table 10. Annual maximum temperature of 32.5 °C was recorded during the month of May 2010 with minimum temperatures ranging from 21 °C to 24 °C in June.

Table 5.4-1: Minimum, maximum and mean temperatures (°C) recorded at Koidu (2010)

Month	Minimum	Maximum	Mean
January	21.1	31.2	25.9
February	22.2	31.1	26.4
March	23.4	31.7	26.9
April	24.0	32.5	27.7
May	23.4	32.5	27.6
June	22.4	31.0	26.4
July	21.3	28.9	24.7
August	21.3	28.3	24.3
September	21.2	28.5	24.3
October	21.7	29.9	25.4
November	21.9	30.6	25.8
December	21.2	30.1	25.3

5.4.2.4 Mixing Height and Atmospheric Stability

The vertical component of dispersion is a function of the extent of thermal turbulence and the depth of the surface mixing layer. Unfortunately, the mixing layer is not easily measured, and must therefore be estimated using prognostic models that derive the depth from some of the other parameters that are routinely measured, e.g. solar radiation and temperature.

During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated inversion. Radiative flux divergence during the night usually results in the establishment of ground based inversions and the erosion of the mixing layer. The mixing layer at the proposed site ranges in depth from ground level (i.e. only a stable or neutral layer exists) during night-times to the base of the lowest-level elevated inversion during unstable, day-time conditions.

Atmospheric stability is frequently categorised into one of six stability classes. These are briefly described in Table 11. For the model used here, atmospheric stability is described as a continuous variable in terms of the Monin-Obukhov length and the height of the mixing layer.

The atmospheric boundary layer is normally unstable during the day as a result of the turbulence due to the sun's heating effect on the earth's surface. The thickness of this mixing layer depends predominantly on the extent of solar radiation, growing gradually from sunrise to reach a maximum at about 5-6 hours after sunrise. This situation is more pronounced during the winter months due to strong night-time inversions and a slower developing mixing layer. During the night a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral.

Table 5.4-2: Atmospheric Stability Classes

A	very unstable	calm wind, clear skies, hot daytime conditions
B	moderately unstable	clear skies, daytime conditions
C	unstable	moderate wind, slightly overcast daytime conditions
D	neutral	high winds or cloudy days and nights
E	stable	moderate wind, slightly overcast night-time conditions
F	very stable	low winds, clear skies, cold night-time conditions

For elevated releases, the highest ground level concentrations would occur during unstable, daytime conditions. The wind speed resulting in the highest ground level concentration depends on the plume buoyancy. If the plume is considerably buoyant (high dust velocity and temperature) together with a low wind, the plume will reach the ground relatively far down-wind. With stronger wind speeds, on the other hand, the plume may reach the ground closer, but due to the increased ventilation, it would be more diluted. A wind speed between these

extremes would therefore be responsible for the highest ground level concentrations. The highest concentrations for low level releases would occur during weak wind speeds and stable (night-time) atmospheric conditions. Air pollution episodes frequently occur just prior to the passage of a frontal system that is characterised by calm winds and stable conditions.

5.4.3 Current Ambient Air Quality

The quantity of dust particles in the air was recorded within and around five settlements that will be affected directly or indirectly by the mining activities of the project. The measurements were recorded at different times and for different durations.

Readings were taken using a portable micro-dust aerosol monitoring system. This was done by carrying the equipment held above the head within and around the selected settlements. After recording the levels, the measurements were calculated, compiled and interpreted.

The following table indicates the air quality monitoring results in terms of the dust particle quantity in the atmosphere at the different settlements. The maximum value ranges between 0.036 and 0.049 mg/m³ while the average value ranges between 0.033 and 0.038 mg/m³. These values are below the WHO air quality guidelines discussed in section 2 above.

Table 5.4-3: Air quality levels for settlements within and close to the Koidu mining lease area (ESIA Report, 2010)

Location	Date	Starting time	Duration	Average values (mg/m³)	Maximum values (mg/m³)
Yormandu	05/11/2008	03:48 PM	41 mins	0.038	0.041
New Sembehun	06/11/2008	10:49 AM	3 hrs, 40 mins	0.034	0.038
Sokogbe	07/11/2008	10:14 AM	1 hr, 40 mins	0.038	0.049
Swarray Town	07/11/2008	04:02 PM	1 hr, 2 mins	0.033	0.036
Saquee Town	09/11/2008	10:14 AM	3 hrs, 10 mins	0.034	0.039

The results indicate that the settlements had a good air quality with respect to particulates when the measurements were taken. Yormandu and Sokogbe have the highest average values with Sokogbe having the highest maximum value of dust particulate in the atmosphere. This is due to the fact that Yormandu settlement is one of the largest and populated with significant movement of people and vehicles while Sokogbe is along a very busy and dusty road. The lowest average and maximum values are recorded in Swarray Town because of its small size and lower population with very limited activities.

5.4.4 Identification of Sensitive Receptors

All the residential areas in the vicinity of the proposed development should be regarded as containing sensitive population from the point of view of health impact. These include the town of Koidu located north of the site as well as the proposed resettlement area which is located in the east of the mining lease area. Given the location of the site and the wind direction distribution, both the sensitive receptors will have a lower probability of being impacted.

5.5 Noise

The approach used in investigating noise impacts for this project is based on guidelines provided by the IFC EHS. According to the IFC EHS guidelines, noise impacts should not exceed the levels presented in Table 13 below, or result in a maximum increase in background levels of 3 dBA at the nearest receptor location off-site.

Table 5.5-1: Acceptable rating levels for noise in districts (IFC EHS, 2007)

Noise level guidelines	One Hour LAeq (dBA)	
Receptor	Daytime 07:00-22:00	Night time 22:00-07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

Baseline noise measurements were taken at seven locations in Koidu village to measure the general noise climate in the village. The noise measurement locations are presented in Table 14 and illustrated on Plan 8.

According to the IFC EHS: 2007 guidelines, 'daytime' is defined as anytime between 07:00 to 22:00 and 'night time' between 22:00 to 07:00. As a result of these guidelines, measurements were taken once during the daytime and once during night time at each location. Monitoring was taken at a measurement of 1.5 meters above ground level, and for a minimum period of one hour.

Table 5.5-2: Noise measurement locations

ID	Description of location	GPS coordinates
N1	Measurements were taken at a residential area off of Mining road in the village of Koakoyima	8°37'13.62"N; 10°59'12.06"W
N2	Measurements were taken at a residential area in Koidu Town, near the north western boundary of Koidu Mine	8°37'58.91"N; 10°58'56.55"W

ID	Description of location	GPS coordinates
N3	Measurements were taken at a residential area in Koidu Town, on the northern side of Koidu Mine	8°38'31.60"N; 10°58'31.06"W
N4	Measurements were taken in Gbessengumbu street, at Ansuru boys primary school, Kiodu town	8°38'30.32"N; 10°57'59.63"W
N5	Measurements were taken in Bongalou village, Kiodu town	8°38'0.55"N; 10°57'28.60"W
N6	Measurements were taken in the new resettlement area on the eastern side of Kiodu Mine	8°37'31.67"N; 10°57'5.15"W
N7	Measurements were taken at a residential area 430 meters of the south eastern corner of Koidu Mine	8°37'1.52"N; 10°57'14.99"W

5.5.1 Daytime noise baseline results

The results from the daytime noise meter recordings for all the sampled locations as well as the rating limits according to the IFC guidelines are presented in Table 15. The results of the noise measurements taken of the ambient noise levels at relevant locations in Koidu Town, indicated that the baseline noise levels are below that of the IFC daytime guideline levels for residential districts, at N1, N2, N5 and N6.

Baseline levels measured above the daytime guidelines at N3, N4 and N7. The ambient noise levels at KN3, KN4 and KN7 were impacted on by the noise produced by vehicular activity, mostly motorbikes as well as the social activities by the local people.

5.5.2 Night time noise baseline results

The results from the night time noise meter recordings for all the sampled locations as well as the rating limits according to the IFC guidelines are presented in Table 15.The results of the noise measurements taken of the ambient noise levels at relevant locations in Koidu Town, indicated that the baseline noise levels are mostly above the IFC night time guideline levels for residential districts, the levels were only below the guidelines at KN5 an KN6.

The baseline levels measured above the night time guidelines at N1, N2, N3, N4 and N7. The night time ambient noise levels at N1, N2, N3, N4 and N7 were mostly impacted on by the noise produced by Gryllidae (crickets) and frogs. Additional noise producing sources included generators running throughout the night at KN3 as well as a cinema at KN4 near the Ansuru boys primary school which was screening local movies.

Noise that was audible during the baseline measurements and which was responsible for the day/night time measurements are summarised in Table 16.

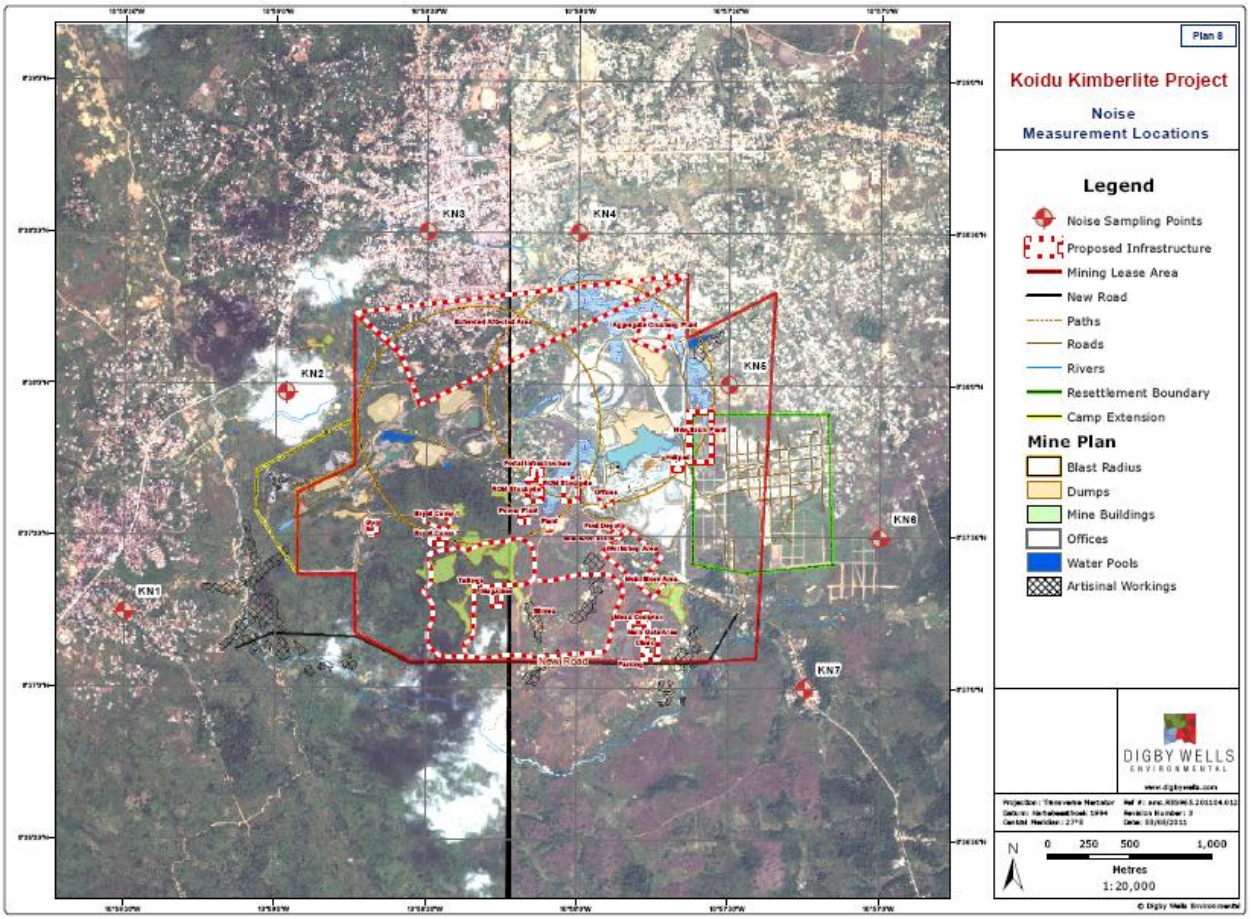


Table 5.5-3: Results of the baseline noise measurements taken at receptors located around Koidu Mine (DWA, 2010)

Sample	IFC rating limit			Measurement details		
	Type of district	Period	Acceptable rating level dBA	$L_{Areq,T}$ dBA	Maximum/Minimum dBA	Date/Time
N1	Residential	Daytime	50	39	53 / 32	03/02/2011; 09:00
		Night time	40	50	52 / 45	03/02/2011; 22:00
N2	Residential	Daytime	50	46	58 / 38	03/02/2011; 10:10
		Night time	40	54	56 / 50	03/02/2011; 23:10
N3	Residential	Daytime	50	51	69 / 41	03/02/2011; 11:20
		Night time	40	58	59 / 57	07/02/2011; 23:15

Sample	IFC rating limit			Measurement details		
	Type of district	Period	Acceptable rating level dBA	$L_{Areq,T}$ dBA	Maximum/Minimum dBA	Date/Time
N4	Residential	Daytime	50	56	78 / 44	04/02/2011; 09:10
		Night time	40	56	75 / 48	04/02/2011; 22:00
N5	Residential	Daytime	50	44	56 / 38	04/02/2011; 10:15
		Night time	40	39	49 / 35	04/02/2011; 23:10
N6	Residential	Daytime	50	49	74 / 33	04/02/2011;11:30
		Night time	40	35	48 / 32	04/02/2011; 22:00
N7	Residential	Daytime	50	55	81 / 35	07/02/2011; 11:05
		Night time	40	43	64 / 38	07/02/2011; 22:00
	Indicates LAeq,T levels above either the daytime rating limit or the night time rating limit					

Note: LAeq,T is the equivalent continuous A-weighted sound pressure level, in decibels, determined over a time period of not less than 30 minutes (the average noise level over the specified time period). The maximum/minimum is the highest/lowest reading during the specified time period over which the measurement was taken. 'A-weighted' is a standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.

Table 5.5-4: Summary of noise sources that were audible during the baseline measurements around the project site (DWA, 2010)

Noise source description				
ID	Day	Duration	Night	Duration
N1	Birdsong	Intermittent	Frogs	Continuous
	Villagers socializing	Continuous	*Gryllidae*	Continuous
N2	Birdsong	Intermittent	*Gryllidae*	Continuous
	Villagers socializing	Continuous	Frogs	Continuous
	Birdsong	Intermittent	*Gryllidae*	Continuous

Noise source description				
ID	**Day**	**Duration**	**Night**	**Duration**
N3	Villagers socializing	Continuous	Generators	Continuous
	Motorbikes	Intermittent	Frogs	Continuous
N4	Birdsong	Intermittent	*Gryllidae*	Continuous
	Villagers socializing	Continuous	Cinema	Continuous
	Motorbikes	Intermittent	Frogs	Continuous
N5	Birdsong	Intermittent	*Gryllidae*	Continuous
	Villagers socializing	Continuous		
	Motorbikes	Intermittent		
N6	Birdsong	Intermittent	*Gryllidae*	Continuous
	Villagers socializing	Continuous		
	Motorbikes	Intermittent		
N7	Villagers socializing	Continuous	*Gryllidae*	Continuous
	Motorbikes	Intermittent	Frogs	Continuous

5.6 Soils

Almost all the soils in the uplands and the swamps within the project lease area have been previously mined out by historical and illicit artisanal mining prior to initiation of operations in 2003. The mining operations conducted by Koidu Holdings in the K1 pit have had a minimal to negligible impact on the soils in the lease area, as the total area affected by ore extraction from the kimberlite pipe is less than 0.5 hectares.

The mainly illicit artisanal mining activities which have never been monitored or controlled have resulted in the previous loss of topsoil, a situation which the management of Koidu Holdings is attempting to reverse in the areas under its direct influence and control. Koidu Holdings recovers and stockpiles the topsoil prevalent in the area on which operations are focussed, which topsoil is earmarked for rehabilitation and the re-establishment of land suitable for agriculture. The topsoil is recovered from its own operations as well as during the rehabilitation of areas damaged by historic artisanal operations.

By continuing the soils management measures as currently implemented by Koidu Holdings management, the identified impacts of the Koidu Kimberlite Project on the soils within the mining lease area are of low significance.

The general description of the soils in the Project area is indicated in the following table.

Table 5.6-1: General description of the soils in the Koidu Kimberlite Project area

Soil map unit	Land form	Soils
A	Isolated hillcrests; short to medium length; almost flat with boulders and locally rocky.	Shallow soils to bedrock with pockets of deep soil over saprolite (> 100cm). Well drained, strongly acid
B	Isolated hill slope; short, straight; steep to moderately steep (15-30%), locally with boulders and rocks.	Deep, well drained. Sandy loam to coarse sandy clay loam over coarse sandy clay sub-soil
C	Dissected low uplands with interfluve crest, gentle slopes (1-2%)	Deep, well drained sandy clay to sandy clay loam over gravely sandy clay sub-soil
D	Irregular interfluve slopes; short to long undulating, very gentle-to-gentle slope (2-5%),	Deep, well drained gravely sandy clay loam over gravely sandy clay sub-soil
E	Inland valley swamps; level; 20-150 m wide; Locally channelled; previously mined out	Deep, very poorly drained silty clay loam to sandy clay loam over coarse sandy clay to clay sub soil
E1	Inland valley swamps nearly level; 20-150m wide; locally channelled; currently mined out	Deep to moderately deep, imperfectly to poorly drained, sandy clay loam to gravely sandy clay over coarse sandy clay.

Plan 9 contains the historic data as previously surveyed. Groups A and B represent isolated hill crests and isolated slopes. Soils are generally well-drained. Texture ranges between sandy loam and sandy clay loam overlying sandy clay to gravely coarse sandy clay sub soil.

Colours range between dark brown to brownish yellow in the topsoil to dark red in the subsoil.

Groups C and D represent low uplands (interfluves crest) and interfluves side slopes. Soils are generally well drained and of similar textures than groups A and B. Colours vary from greyish brown to dark yellowish brown in the topsoil over brownish yellow to strong brown subsoil. Reddish yellow and yellowish red mottles in the subsoil due to weathering of ironstone gravels.

Group E represents soils of the inland valley swamps. These soils are extensively disturbed by historical illegal mining activities prior to 2002. The soils are of gravelly texture but poorly drained and as a result permanently waterlogged. The soil colours are greyish brown to yellowish brown topsoil over light olive brown to dark greenish grey sub soils.

5.7 Geology

The Koidu kimberlite cluster comprises two main pipes and several small blows associated with four main sub-vertical to vertical kimberlite dyke zones that extend for approximately 5 km along strike. The dykes both pre-date and post-date the formation of the pipes that were emplaced into Archean granitoids of the Man craton approximately 146 million years ago. Significant quantities of high quality macro-diamonds have been recovered from the dykes, pipes and blows with grades ranging from 0.2 to 0.7 carats per tonne (cpt).

The main pipes, named K1 and K2 are smooth, steep sided pipes that are morphologically similar to those mined in the Kimberley area of South Africa (Class 1). Surface expressions of the pipes are approximately 0.3 ha for K1 and 0.5 ha for K2. The external morphology and infill present within the pipes is consistent with a diatreme setting and significant erosion of the pipes has occurred. The pipes are infilled by multiple phases of kimberlite characterised by contrasting textures due to different emplacement processes (highly explosive vs. intrusive). Texturally, the infill within the bodies is dominated by massive to locally bedded volcaniclastic kimberlite classified as tuffisitic kimberlite breccia (TKB).

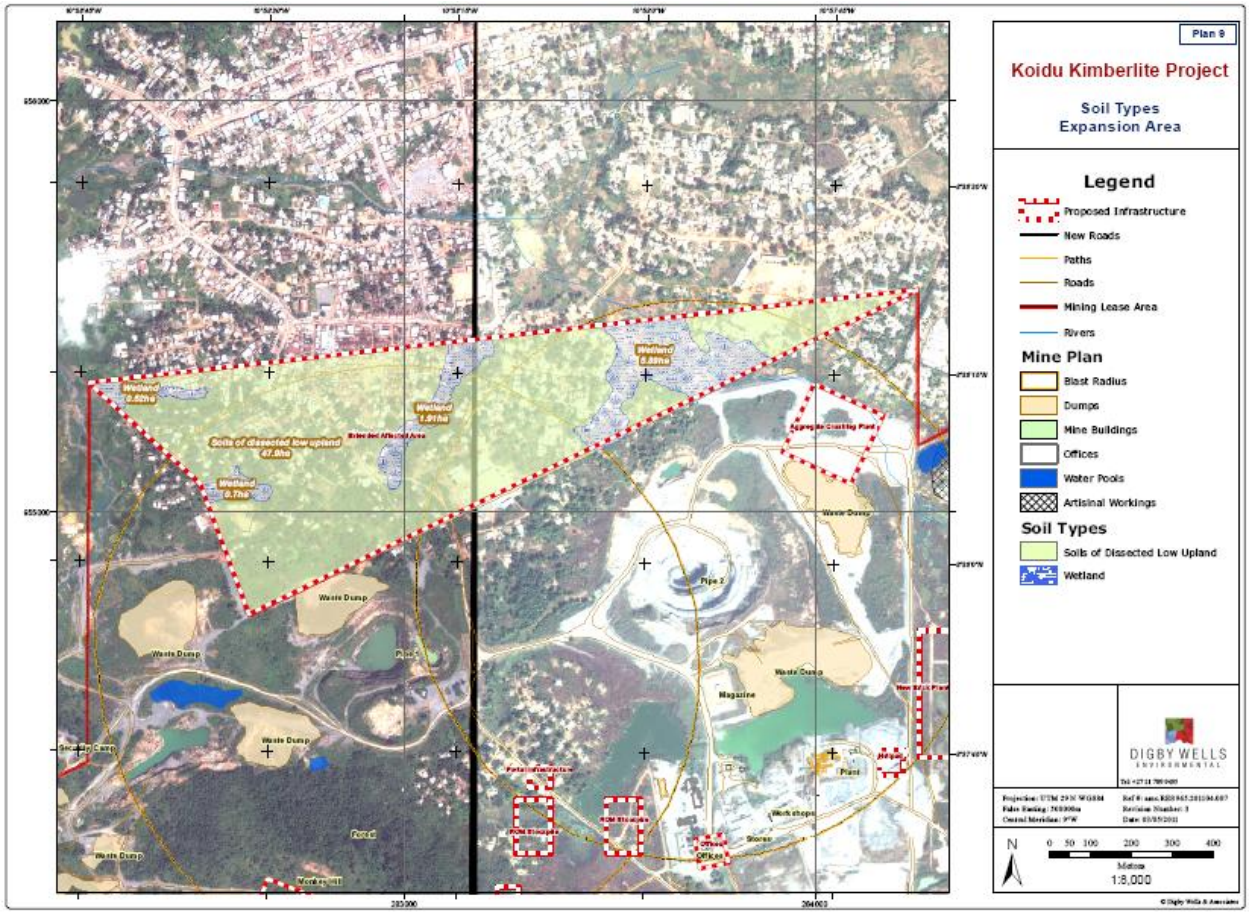
Volcaniclastic rocks are typically associated with a high proportion (15 – 90%) of fresh granite xenoliths and variable proportions of olivine, mantle derived indicator minerals and mantle xenoliths. Coherent kimberlite is less common but volumetrically significant within the pipes and occurs as main pipe infill, as well as late stage dykes and rare sills. The different rock types or phases of kimberlite present within the pipes are characterised by different grades.

In addition to the well-formed pipes, there are a number of blows that represent poorly developed, small, volcanically immature pipes. These bodies are named Blow A, Blow B1, Blow B2 and Blow B3. These bodies are characterised by more complicated external pipe shapes compared to K1 and K2 and are dominantly infilled with coherent kimberlite, textural transitional kimberlite (characterised by both coherent and volcaniclastic features) and less common, well developed, massive volcaniclastic kimberlite classified as TKB.

The four main dyke zones, termed DZA, DZB, DZC and DZD, were emplaced along a southwest to northeast structural trend and are classified as Group 1, macrocrystic, phlogopite (± calcite and monticellite) hypabyssal kimberlites. Structurally, the dykes consist of irregular, braided and en-echelon arrays typically made up of multiple segments each ranging in thickness from a few centimetres to over 4 m. Simple single segment dykes are less common. In addition to variations in external morphology, the dykes display considerable internal variation in the size and proportion of olivine macrocrysts, the type and abundance of mantle derived indicator minerals, mantle xenoliths and diamond grade. The dykes in general are characterised low proportions (<5%) of country rock xenoliths.

Associated with the main pipes and blows and less commonly with the dykes are locally extensive zones of leached granite (SiO_2 removed) and marginal (or contact) breccias that contain typically low proportions (<10%) of kimberlite. The development of these zones is interpreted to both predate and postdate the formation of the pipes and have been incorporated into the geological models. Concentric 'onion-skin' shells of altered granite surrounding rounded granite cores are also observed, as well as joints filled with pulverised, angular shards of country rock around many of the dyke exposures and pipe walls. Although these zones will in most cases not be considered as ore, these zones will have an impact on the mine

design.



5.8 Ecology (Fauna and Flora)

To achieve the aim of the study the characterisation of the fauna and flora present on site and along the road diversion route at this time was set as one of the objectives. This objective was accomplished by following accepted methodologies used to quantify the presence of the following habitat components:

- Vegetation, according to Braun-Blanquet (1964);
- Mammals (Visual, trapping);
- Birds (Visual);
- Reptiles (Visual, trapping); and
- Amphibians (Visual, trapping, auditory).

The above mentioned five measurable habitat components were measured according to the methodologies set forth in fauna and flora report contained in Volume 3. The survey was undertaken to gain insight into the current state of the habitat present on the project area. Furthermore, the delineation of habitat units was accomplished by noting the effect that landscape features and anthropogenic activities have on fauna and flora assemblages.

5.8.1 Flora

5.8.1.1 Regional natural environment

As a transitional habitat between the rain forests of the Guinean-Congolian region and the dry savannas of Sudan, the Guinean Forest-Savanna Mosaic ecoregion is home to a wide range of species. This area is a convergence zone for savanna and forest species. The predominantly savanna habitat is checked with forest patches that run along the rivers and streams and occasionally adorn hilltops, mountains, and ridges. Wetland areas of this ecoregion host a diversity of waterfowl and wading birds. These varied habitats are home to Ghana Worm Lizards, Emerald Starlings, hunting spiders, Patas Monkeys, and many other species.

5.8.1.2 Local natural environment

The tropical rainforest cover of Sierra Leone is characterised by seven different vegetation types: moist rain forest, semi-deciduous, montane, mangrove, wooded grassland, farm bush, and swamp forests (Maley 1994). Farm bush arises from slash-and-burn agriculture and is becoming the dominant vegetation type in Sierra Leone.

The vegetative cover for Sierra Leone (NAPA, 2007) indicates that the savannah woodlands are limited to the northern parts of the country. The savannah woodlands and wooded grasslands are increasingly being subjected to frequent fires, both man-made and natural. Most of the moist and semi-deciduous forests are located within protected areas, often on mountaintops and slopes (USAID, 2007).

The current vegetation cover for the project area comprises a limited coverage of secondary forest, forest regrowth, grass cover on mined-out uplands and hydromorphic/aquatic vegetation in swamps (Inland Valley Swamps).

5.8.1.3 Habitat/Vegetation types

A total of six vegetation and/or habitat types were delineated for the project area and are presented in Table 18 as well as Plan 10. Wetland habitats were investigated during an aquatic assessment conducted as part of the Koidu Kimberlite Project Environmental and Social Impact Assessment (ESIA).

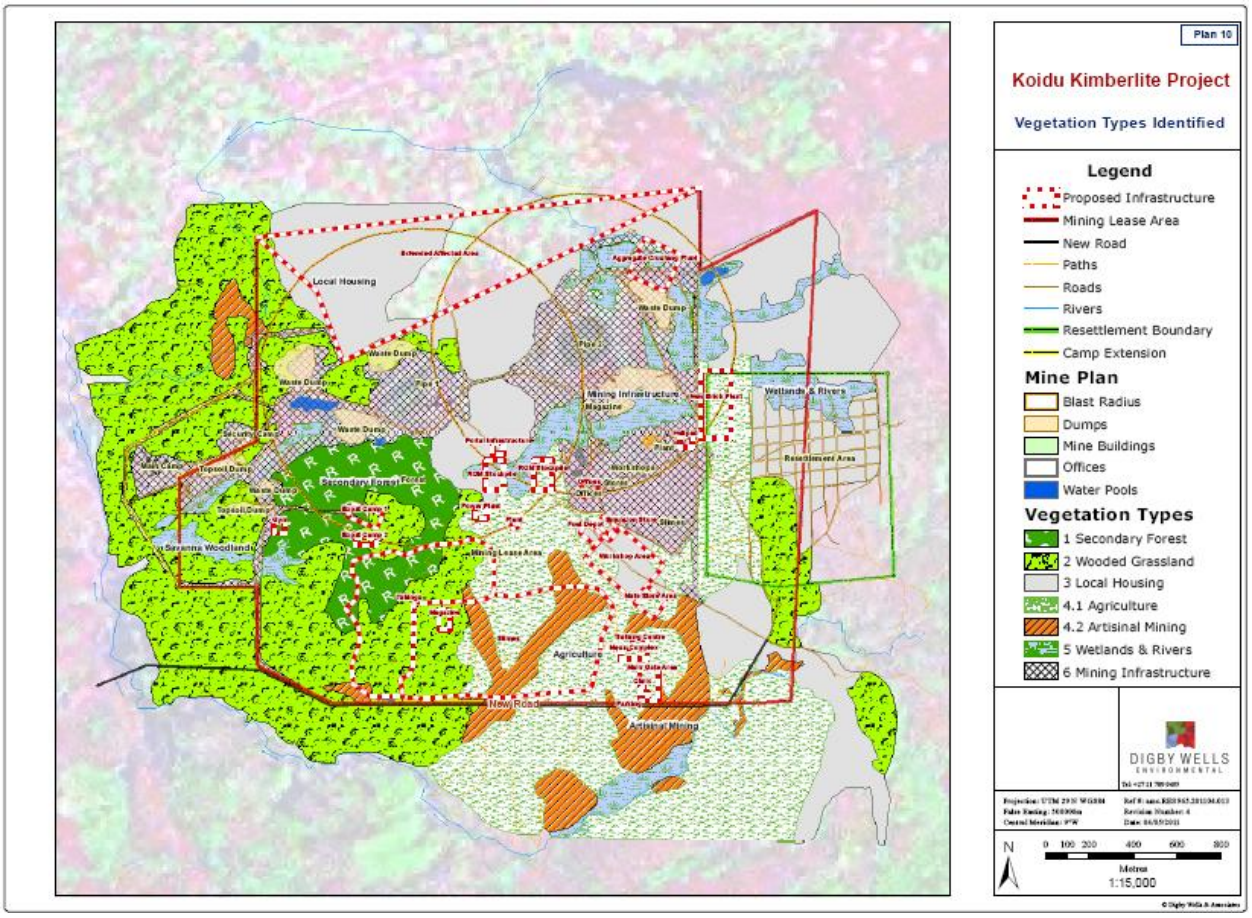
Table 5.8-1: Hectares of vegetation types

Name	Area in ha.	Percentage of total (%)
1. Secondary Forest	41.18	4.87
2. Wooded grassland	240.46	28.45
3. Villages/Local Housing	180.80	21.39
4. Degraded Areas	216.55	25.62
4.1. Agriculture	169.91	20.10

4. 2. Artisanal Mining	46.64	5.52
5. Mining Infrastructure	135.00	15.97
6. Aquatic Environments	Refer to Aquatic Study	

The degraded areas habitat type was sub-divided to illustrate the artisanal mining and agriculture subtypes. Topographic features were the primary consideration for the delineation of the various units. These features included the location of the habitat type in the landscape, influence of available soil type, influence of available moisture, gradient and aspect. The above mentioned factors have an effect on the habitat type in isolation and in conjunction with each other.

Secondly, anthropogenic activities were also considered to assist with the delineation of vegetative and/or habitat types. Owing to the settlement of rural communities within the area, plantations, previous and current artisanal mining and subsistence farming landscape features have formed in the area. As is the case with natural factors, anthropogenic factors could have an effect in isolation or in conjunction with other factors.



In the following table, the habitat types identified during the survey are summarized into individual topographic setting, ecological functioning, ecological integrity and ecological sensitivity. As can be seen, secondary forest and wetland cover the two smallest portions of the study area host the highest ecological integrity and therefore the highest ecological

sensitivity.

Table 5.8-2: Description of habitat types

Vegetative Unit	Size	Topographic	Ecological	Ecological	Ecological
Secondary forest	41.18	Lowland	Biodiversity	High	High
Wooded grassland	240.46	Lowland	Biodiversity	Medium high	Medium high
Villages/Household	180.80	Lowland flats	None	None	Low
Degraded Areas	216.55	Lowland flats	None	None	Low
Mining Infrastructure	135.00	Lowland flats	None	None	None
Aquatic Environment	Refer to Aquatic Study				

5.8.1.3.1 Secondary forest

Secondary forests are characterised by tall trees with a fairly closed canopy that provides the required shade for the underlying plantations. The extent of the forests that historically covered the lower lying areas have been reduced by subsistence farming activities with only isolated remnants occurring in sheltered areas. These secondary forests still contain many of the more hardy forest species found within the forest. However, the method of previous farming and previous artisanal mining practices have destroyed much of these species and created a patchwork of agricultural fields or farm bush and mining pits across the lower lying and bottom slope areas of hills throughout the project site. The natural factors that played a role in the formation of the original forest were also responsible for this vegetation type. However, the introduction of anthropogenic pressure in the form of subsistence agricultural has isolated many parts of the forest type, producing an attempted re-generation of the forests, which gives rise to the secondary forest vegetation

The secondary forest vegetation type is not common within the project area (4.8%). However, secondary forest cover is present within the project area and, is evident on the upper slopes and crest of Monkey Hill as a direct consequence of the efforts of mine management to maintain and protect it and the limited accessibility afforded to the general population by mine security.

The secondary forest type is also evident in Swarray Town where it has been used to shade cacao and coffee plantations. Other areas within the project area classified as secondary forest comprise the cluster of fruit trees that are usually found around settlements.

5.8.1.3.2 Wooded grasslands

The secondary forests and regenerating woodlands give way to expansive, wooded grasslands that characterize this ecoregion (Mayaux et al. 1999, Justice 1997) and covers 28.4% of the study area. Most of the tall grass savannas are fire-climax communities that generally grow on well-drained soils. Woody complexes regenerate on these grasslands when burning is halted and seed trees are available (White 1983). Savanna woodland (and shrubland) is more densely vegetated than Acacia savanna or wooded grassland, but not densely enough to form a closed canopy. The open canopy allows sunlight to reach the ground, allowing grass to grow and form a significant groundcover.

The wooded grassland areas are under constant threat from anthropogenic expansion in the form of two identified land uses. These are firstly agricultural, artisanal mining and plantation areas and secondly, human habitation, not necessarily in that order.

The natural factors responsible for the formation of this vegetation type has made it very attractive to humans in the sense that these areas are low lying, relatively flat, has medium clay content soil with good water holding capacity - this does not include the hill areas which also counts under this vegetation type. These flat areas are suitable for agricultural practices such as plantations and grazing areas. The hills in the study area is also partially covered with the wooded grassland vegetation type, however the gradient of these hills have made them un-attractive for farming and building. They do however suffer from the same uncontrolled burning regime as the lowland moist savannah.

5.8.1.3.3 Degraded, Agriculture and Artisanal Mining

The degraded areas encountered within the mine lease area consisted of areas where anthropogenic activities have impacted heavily on the natural occurring habitat types totalling 25.6%. The practice of artisanal mining and various stages of agricultural development were noted. The agricultural expansions consisted of uncontrolled burning that is used to clear vegetation and prepare areas for planting crops. These fires often spread further than the intended agricultural patch and therefore clear large areas not used for actual planting of crops.

The natural factors that was suitable for agricultural expansion, such as slope that is not to steep, or suitable but not excessive water accumulation, has resulted in the formation of this sub-habitat type. These areas are exclusively used for agricultural practices, with isolated huts being found. This land use has destroyed much if not all if the natural species in these areas. Agricultural and plantation areas were mostly encountered on the relatively flat lower lying areas, very similar to wooded grassland areas, except for more human disturbance.

As mentioned previously a correlation exists between habitat quality and animal species

present. The habitat quality in these areas was highly modified which has resulted in the loss of ecosystem functioning and services offered to wild animals, such as shelter and food.

Relying on this correlation, the species diversity within this vegetation type was not expected to be high.

5.8.1.3.4 Villages

Areas suitable for human habitation are reliant on natural features, these features are much the same as what is needed for agricultural activities, and they include relatively level surfaces, with minimal slope. The untransformed and natural vegetation type associated with these features are the wooded grassland and secondary forest habitat units, it therefore stands to reason that these two natural vegetation types made way for the areas of human habitation. This habitat type was identified as the most transformed of all six of the identified habitat types. Subsequently its ecosystem value in terms of services that are provided has been compromised and animal species that were reliant on these services are not expected to occur in these areas. This habitat type occurs predominantly to the north of the mine, with isolated areas occurring in the north east of the study area totalling 21.3%.

5.8.1.4 Conservation areas

5.8.1.4.1 Secondary forest

Isolated forest patches or secondary forest vegetation types were encountered where the natural factors made the area unsuitable for agriculture and housing. The secondary forest paths occur in areas similar to gallery forests, however as mentioned previously, these areas are isolated. The relationship between these vegetation types go further than this in that they share 42 % of the plant species encountered between them. Furthermore, the fact they share certain species, will mean that a number of principles that apply for one will apply for the other, such as gap formation. This vegetation type occupied 4.8 % of the total area of concern or 41.1 ha. Within this area, 59 % of the plant species encountered during the survey occurred here.

Once more, secondary forest occupies a relatively small area that harbours a large amount of plant species, indicating an important area for conservation. Tree species found in these areas included Ficus elastica, Klainedoxa gabonensis, Mitragyna stipulosa. With the shrub component consisting of Bridelia ripicola and Sida acuta.

5.8.1.4.2 Wooded Grassland

On flatter and drier areas that are higher lying, the wooded grassland vegetation type was encountered. Plant species encountered here were very often the re-growth of previous season burning practices mixed with oil palm trees, where only a small area was deliberately burnt but the fire spread to a larger part of the wooded grassland vegetation type.

Common grasses, many growing taller than two meters, include Andropogon spp.,

Hyparrhenia spp. and Loudetia spp. Fire-adapted woodland trees grow in varying densities, depending on fire frequency and current or previous land use.

Upper slopes and crests of many of the hills support wooded grasslands. The vegetation type includes trees and shrubs, such as Albizia ferruginea, Acacia sp. and Erythrina abyssinica with the undergrowth including species such as Trema orientalis, Spathodea campanulata and Harungana madagascariensis.

The herbaceous layer on drier ground is dominated by, Thaumatococcus daniellii, Marantochloa congensis, Aframomum sanguineum, A. laurentii, and Costus lucanusianus. Various grass species are also present. The herbaceous layer under woody vegetation is dominated by Olyra latifolia. Mainly due to unregulated and frequent fire occurrences only fire adapted plant species occur in these areas for more than one season.

5.8.1.4.3 Forest regrowth

Forest regrowth is considered to be the vegetation derived from the shifting cultivation pattern of farming common in Sierra Leone. It is generally found on both low and high uplands (hills of variable heights) throughout the country. Within the Koidu Kimberlite Project area, however, this vegetation type is mainly evident on the middle and lower slopes of Monkey Hill. This may be attributed to this area being about the only land area that presents cultivation viability following the shifting cultivation practice. Forest regrowth is scattered on these slopes and generally ranges from a mixture of low shrubs, grasses, herbs and crop remnants to thicket vegetation. Specific areas of forest regrowth are uncommon due to the previous intensive /extensive artisanal diamond mining which depleted the area of agriculturally viable lands, occurring over much larger areas.

The regrowth vegetation community with its undergrowth of shrubs, herbs and grasses such as the Scleria barteri (Sword Grass), is generally much more difficult to penetrate than the secondary forest. Tree species include Musanga cecropioides (Umbrella Leaf Tree), Morinda geminata (Brimstone), Elaeis guineensis (Oil Palm), Terminalia ivorensis (Ronko Tree) and Ceiba pentandra (Cotton Tree). Fruit trees such as Arisophillea laurina (Monkey Apple), Dialum guineense (Tamarind) and Magnifera indica (Mango) are also identified. The sensitive plant, Mimosa pudica is also evident in places helping to hinder penetration with its thorny creeping stem.

The various species comprising this vegetation type are not rated as threatened or endangered, because regrowth vegetation usually persists in areas where the forest was removed for the purpose of cultivation. Often such clearing does not involve much de- stumping and this makes it possible for the same species to regenerate when left to fallow.

Due to limited accessibility to the mining lease area, a positive impact on the vegetation cover and rehabilitation of previously disturbed areas is observed within the mining lease area.

5.8.1.5 Medicinal species

These plant species have properties that relieve or cure ailments and have been used by local people or foreigners alike. Various parts of a plant may contain the substance that possesses these properties, these include, roots, tubers, bark, stem, leaves, flowers or fruit. Plant species with medicinal properties are very often exploited which results in their populations and individuals being under threat and in need of conservation. The plant species identified during the field work yielded 20 medicinal species, 24 % of the total number of pants encountered. Of these medicinal species 50 % was exclusively found within the confines of the secondary forest, which, as discussed earlier only occupies 4.7 % of the total land area of the area of concern. This further emphasises the fact that forest habitat type is of importance and must be conserved.

5.8.1.6 Alien invasive species

Alien invasive plant species are non-specific in their habitat requirements, which is one of the characteristics that make them successful. A complete list of alien invasive species can be found in Table 23.

The secondary forest habitat type contained one alien invasive species Chromolaena odorata. According to the ISSG (Invasive species specialist group) database Chromolaena odorata, species that was encountered in this vegetation type is a fast-growing perennial shrub, native to South America and Central America. It has been introduced into the tropical regions of Asia, Africa and the Pacific, where it is an invasive weed. Also known as Siam weed, it forms dense stands that prevent the establishment of other plant species. It is an aggressive competitor and may have allelopathic effects. It is also a nuisance weed in agricultural land and commercial plantations. It ranks no. 23 on the worst invasive species in the world (ISSG.com).

Furthermore the secondary forest contained the alien invasive, Bambusa vulgaris which occurs spontaneously or naturalised mostly on river banks, road sides, wastelands and open ground; generally at low altitudes. In cultivation it thrives best under humid conditions up to 1000m altitude, but tolerates unfavourable conditions as well. Plants may become completely defoliated during the dry season, the plants can survive low temperature (grows up to 1200 m altitude, survives -3 degrees C) and also tolerates a wide range of soil types (Ohrnberger 1999).

Bambusa vulgaris forms extensive monoculture stands where it occurs, excluding other plant species. B. vulgaris colonises along streams into forest (Blundell et al. 2003).

Bambusa vulgaris is used for construction of houses, huts, boats, fences, props and furniture; as raw material for paper pulp; shoots are rarely used as a vegetable or as livestock fodder (Ohrnberger 1999; Quatrocchi 2006).

The plantation habitat type contained three exotic plant species and one invasive plant species, with the exotic plants not necessarily being aggressive invaders. It was expected that this area contained high numbers of exotic or alien plants as this vegetation unit is actively stocked by any plant species that are edible by the local population, with no regards given to ecological

status of these plants.

5.8.1.7 Protected species

Albizia (Albizia ferruginea) is considered to be of conservation significance and has to be protected and conserved. This tree was encountered in secondary forest only. It is listed as being Vulnerable by the IUCN (www.IUCN.org). It is described as a widespread and often common timber species, which has suffered heavy exploitation. The IUCN descriptive code for Albizia ferruginea is VU A1cd.

Protected plant species that could also occur in the mining concession is Entandrophragma cylindricum (VU A1cd), Entandrophragma angolense (VU A1cd), Milicia excels (Lower Risk/near threatened), Terminalia superba. None of the aforementioned species were identified within the vegetation types delineated.

5.8.2 Fauna

5.8.2.1 Mammals

Table 5.8-3 lists the mammals that were identified and found to occur within the project area:

Table 5.8-3: Mammals that occur on the project area

Scientific name	Common name
Cephalopus rufilatus	Red flanked duiker
Cercopithecus sabaeus	Green monkey
Felis serval	Serval cat
Ichneumia albicauda	White tailed mongoose
Mus setulosus	Peter's mouse
Paraxerus poenis	Green squirrel
Sylvicapra grimmia	Bush duiker
Tragelaphus scriptus	Bushbuck

Of the mammals found on site, none have a Red Data status according to IUCN red species list and are not protected. However, it is recommended that the mammals that do occur on site be given protection.

The fact that no Red Data species occur on site can also be related to the high anthropogenic pressure present. Although forested areas occur on the concession area, it is freely accessed by the local community that utilise it for firewood and food, unsustainably. Further, the site has been severely impacted by previous and current illegal artisanal mining activities.

However, although these species are not listed, they play a very important role in the ecology of the site and without protection will become extinct within the area. Predatory animals such as Serval found on site play an important role in ecological systems. The Serval is not a commonly found species in Africa, but only a few countries protect it due to a lack in a protected species lists/legislation in some countries such as Sierra Leone. It has not been evaluated specific to Sierra Leone, so its status locally is unknown.

Due to the lack of background information, any of the species found can be keystone species that play vital part in the ecological system of the site and may need a protective status within the country. When consultation occurred with the local community, they indicated that they have not seen any predatory animals and that they are hard to find, indicating the necessity to conserve where possible specifically for the predatory Felidae and Canidae. Currently the probability that Red Data species might occur on site is seen as low, but with conservation efforts of forest and sensitive areas, habitat availability for Red Data species can increase to moderate to high probability.

5.8.2.2 Avifauna

The following birds were identified to occur on the project area as seen in Table 5.14-4.

Table 5.8-4: Avifauna that occurs on the project area

Scientific name	Common name
Actophilornis africanus	African jacana
Andropadus virens	Little greenbul
Apus affinis	Little swift
Ardea cinerea	Grey heron
Ardea goliath	Goliath heron
Batis senegalensis	Senegal batis
Bubo cinerascens	Greyish eagle owl
Bycanistes fistulator	Piping hornbill
Campephaga phoenicea	Red-shouldered cuckooshrike
Campethera maculosa	Little green woodpecker
Caprimulgus inornatus	Plain nightjar
Centropus senegalensis	Senegal coucal
Ceryle rudis	Pied kingfisher
Columba unicincta	Afep pigeon
Corvus albus	Pied crow
Crinifer piscator	Western grey plantain-eater
Cuculus solitarius	Red-chested cuckoo
Cynnyris cupreus	Copper sunbird

Scientific name	Common name
Cynnyris minullus	Tiny sunbird
Cypsiurus parvus	African palm swift
Dendrocygna viduata	White-faced duck
Dendropicos fuscescens	Cardinal woodpecker
Dyaphorophyia castanea	Chestnut wattle-eye
Egretta ardesiaca	Black heron
Egretta garzetta	Little egret
Egretta intermedia	Yellow-billed egret
Elminia longicauda	African blue flycatcher
Estrilda melpoda	Orange-cheeked waxbill
Gallinula chloropus	Common moorhen
Gymnobucco calvus	Naked-faced barbet
Gypohierax angolensis	Palmnut vulture
Halcyon leucocephala	Grey-headed kingfisher
Hirundo rustica	European swallow
Hirundo semirufa	Red-breasted swallow
Indicator minor	Lesser honeyguide
Ispidina picta	African pygmy-kingfisher
Lagonosticta rubricata	African firefinch
Lanius collaris	Common fiscal
Macrodipteryx longipennis	Standard-winged nightjar
Merops pusillus	Little bee-eater
Milvus aegyptius	Yellow-billed kite
Milvus migrans	Black kite
Muscicapa striata	Spotted flycatcher
Necrosyrtes monachus	Hooded vulture
Nettapus auritus	African pygmy goose
Numida meleagris	Helmeted guineafowl
Onychognathus hartlaubi	Chestnut-winged starling
Ploceus cucullatus	Village weaver
Podica senegalensis	African finfoot
Polyboroides typus	Gymnogene
Psalidoprocne nitens	Square-tailed saw-wing
Pteronetta hartlaubii	Hartlaub's duck
Pycnonotus barbatus	Common bulbul
Quelea erythrops	Red-headed quelea
Scopus umbretta	Hammerhead

Scientific name	Common name
Serinus canicapillus	West african seedeater
Serinus mozambicus	Yellow-fronted canary
Spermestes cucullata	Bronze mannikin
Streptopelia semitorquata	Red-eyed dove
Streptopelia senegalensis	Laughing dove
Tauraco persa	Guinea turaco
Tchagra minuta	Marsh tchagra
Tchagra senegalus	Black-crowned tchagra
Terpsiphone viridis	African paradise-flycatcher
Tockus erythrorhynchus	Northern red-billed hornbill
Tockus hartlaubi	Black dwarf hornbill
Treron calvus	African green pigeon
Tutur afer	Blue-spotted wood-dove

None of the birds found have a Red Data status or are protected within Sierra Leone, however this does not mean that the species do not need protection. The lack of protection is due to the lack of environmental studies and legislation. Sierra Leone does not have a protected species list indicating sensitive species and by the rate that the environment is being impacted, such an effort is urgent.

Bird habitat on the concession area included open areas, forests, ridges and wetlands. More species were expected to be found, but the species found were very well established communities. Common bulbuls, swallow, turacoes and bee-eaters were found to dominate the ridge area. In the more forested sites, hornbill, woodpeckers and sunbirds were abundant. Open areas were dominated by doves and crows, and finally wetlands and rivers included birds dependant on these systems such as herons, kingfishers and ducks. Vultures and kites were found feeding on kitchen waste around a dump site on the concession area. The current probability that Red data species might occur is seen as medium, but with the conservation of sensitive areas and limiting impacts and pollution, this could be increased to a high probability.

5.8.2.3 Herpetofauna

Snakes are commonly occurring and abundant in Sierra Leone. Although the site is impacted, it is suggested by Menzies (1966) that this will allow for the penetration of Savannah species into impacted forested areas, whereas forest snake species are becoming less common and only locally occurring. Reptile and amphibians found on site are presented in Table 22. None of these species have a Red Data status. The frog species found was abundantly represented in all the aquatic habitats on site. Species were found by more than one ecological specialist during the field survey; also local people assisted in mentioning

species they have seen. Due to the impacted nature of the site, the occurrence of Red Data Herpetofauna is seen as medium to low.

Table 5.8-5: Herpetofauna that occur on the project area

Species Name	Common Name
Agama agama	Agama lizard
Arthroleptis sp.	Squeaker
Mehelya poensis	Forest file snake
Naja nigricollis	Spitting cobra
Natriciteres variegata	Forest marsh snake
Philothamnus heterodermus	Variable green snake

5.8.3 Conclusion

The summary of the habitat types and the fauna associated with the habitat types, as per the field work, is shown in Table 23. The number equals the amount of individuals found during the field survey and the value is seen as ecological value linked to species richness.

Table 5.8-6: Summary of Fauna and Flora

Habitat Type	Flora	Mammals	Birds	Amphibians	Reptiles	Value
Secondary	39	5	43	-	2	High
Woodland	20	2	12	-	1	High
Wetlands	16	-	19	1	-	High
Degraded	16	2	4	-	-	Low
Village	12	-	3	-	-	Low
Mine	3	-	6	-	2	Low

From the results discussed above, it is evident that the area of concern is under anthropogenic pressure, most notably from the surrounding communities and to an extent the effects of previous and current mine workings. It is largely due to human actions that the degree and type of differentiation between vegetation types has taken place. The identification of these vegetation types were on the basis of presence, absence and assemblages of plant species and the effect of natural and human factors. The subsequent habitat types created smaller niches where animals were adapted to survive.

A major threat to natural habitat types, and subsequently wild animals, was informal subsistence agriculture practiced by locals, in these instances a piece of natural habitat is burnt to remove vegetation. Thereafter, the area is ploughed and planted. The effect of this action is far reaching, firstly the natural vegetation is removed which decreases the amount of

available graze and browse, thereafter a fallow piece of land will provide good habitat for alien and invasive species to colonise. If an area is cleared and receives a large amount of rainfall before planting has commenced, the surface runoff will be much greater because of the reduced infiltration, this in turn will cause erosion and a loss of valuable topsoil. A second major threat is the practice of illegal artisanal mining within the boundaries of the mining concession. This not only destroys the vegetation present on the footprint but also the vegetation where the discarded soil is dumped. The frequency of these small pits and not their size is the major contributing factor in the destruction of the vegetation type.

The subsequent reduction in natural habitat has meant that adaptable animal species have remained in the area, with sensitive species having moved away to more suitable habitat. However, availability of habitat is not the only driving force in the emigration of animal species, frequent small scale hunting for bush meat has reduced the numbers of wild animals even further. The presence of many homemade snares found during the field work was evidence of this.

As mentioned previously the proliferation of informal subsistence farming and the accompanied slash and burn practice has created favourable conditions for alien and invasive plant species.

The size and condition of the habitat types identified in the area revealed an advancing degraded land which consists of agricultural/artisanal mining (216 ha) and village (180 ha) habitat types driven by human expansion. This expansion is as a result of the need for natural resources to support natural as well as anthropogenic activities in Koidu Town, resulting in a shrinking or declining secondary forest and wooded grassland type. Furthermore, monitoring how the interfacing ecosystems advance and retreat can offer insight into the nature and rate of environmental change over time, and into the causes of this change (Furley 1992). Such changes between domination by secondary forest or savanna woodland habitats are believed to have occurred many times over the past few million years (Kingdon 1989, Maley 1994). However, the introduction of the anthropogenic factor has changed the dynamics of the ecosystem to a large extent.

During the field survey no Red Data or protected fauna species were found. Not only is this due to the already impacted environment and the hunting pressures of the community, but also due to the fact that no locally protected species lists exist. This is due to the fact that there are no environmental studies defining species in Sierra Leone, no funding to conduct such needed studies and no legislation protecting current occurring species, apart from international legislation. Also, little is known on the ecological processes and any of the species that were found can be keystone species in the ecological functioning of the system. This study did confirm there is a continuing decline of species within the study area, specifically predatory species, and for this reason all species and its habitat need protection before they become locally extinct. At this point the concession area is providing a form of protection to fauna species. The Project will further promote the protection of fauna and flora by placing infrastructure in already disturbed or degraded areas.

In addition, a perimeter wall is currently being constructed for security purposes and to

comply with Kimberley process requirements. Access control due to the wall will also aid in protecting fauna and flora from poaching, fires and logging.

A solid wall may result in ecological impacts by secluding the concession area from the outside environment, and may lead to:

- Seclusion of species from other species (system limitations);
- Seclusions of food resources from included species, such as predatory animals will have limited feeding options and will not be able to seek food outside of the concession area; and
- Limitation on mating/reproducing opportunities (genetic limitations).

This seclusion from the outside environment will need continual, human interference, accurate management and studies of the concession ecosystem. This is in line with Koidu Holdings' current rehabilitation and environmental management carried out in support of their intention to establish a nature conservation area within the concession.

5.9 Aquatic Environment

The water resources considered for this study included the associated wetland areas as well as the local rivers/streams. In order to assess the current status of these two systems, different methodologies were applied.

5.9.1 Water quality (in situ)

The overall in situ water quality of the Meya River was in an acceptable state, with no water quality parameters being considered a limiting factor for aquatic biota. The in situ water quality results for the system are presented in Table 24.

Table 5.9-1: The in situ water quality results for the Meya River

Parameter	Acceptable Range	Meya River
Temperature (˚C)	5 - 30	21.6
pH	6.5 - 9.0	7.2
Dissolved Oxygen Saturation (%)	80 - 120	119.6
Dissolved Oxygen Concentration (mg/l)	> 5	
Total dissolved solids (mg/l)	< 1000	

Note: denotes water quality parameter measured to be within a desired range

According to the South African Water Quality Guidelines for Aquatic Ecosystems (DWAF, 1996), the temperature of water plays an important role for aquatic ecosystems by affecting

rates of chemical reactions and, therefore, also the metabolic rates of organisms. The rate of development, reproductive periods and emergence time of organisms are all affected by temperature. The temperature of 21.6˚C recorded for the survey was within the desired range.

According to DWAF (1996) both geology and the atmosphere has an influence on the pH of natural waters. Fresh water systems are mostly well buffered and more or less neutral, with a range from 6.5 to 8.5. Most species will tolerate and reproduce successfully within a pH range of 6.5 – 9.0 (DWAF, 1996) and as result, this is the adopted range for the study. As a result of the presence of bicarbonates of the alkali and alkaline earth metals most fresh water systems are slightly alkaline (Bath, 1989). A pH of 7.2 was recorded for the system which is close to natural but slightly alkaline. This value is within the required range described.

The target water quality range for an aquatic ecosystem is between 80 – 120% of DO saturation (DWAF, 1996). The minimum allowable values for sub-lethal and lethal DO saturation is greater than 60% and 40%, respectively. The in situ DO saturation for the Meya River was recorded as 119.6% and this is within the desired range.

According to Mason (1991), dissolved oxygen (DO) is possibly the most important measure of water quality, especially for aquatic life. Both the survival and functioning of aquatic biota is dependent on the maintenance of aquatic DO concentrations because it is required for the respirations of all aerobic organisms. Thus, it may be stated that DO concentrations provide a useful measure of ecosystem health (DWAF, 1996). The median guideline for DO for the protection of aquatic biota is >5.0 mg/l (Kempster et al., 1980). The DO concentration recorded for the Meya River (10.11 mg/l) was double this minimum limit, indicating a suitable concentration of dissolved oxygen within the system for aquatic biota.

Macro-invertebrate fauna appear to be sensitive to salinity, with acute toxic effects likely to occur in most of the sensitive species at salinities in excess of 1000 mg/l. The TDS concentration for the Meya River (25.0 mg/l) was considerably below this level.

The overall in situ water quality of the Meya River adjacent to the mining area is in a good state, with none of the assessed water quality variables being a limiting factor for aquatic biota. This is important to note, considering the activities such as washing, bathing, ablutions and artisanal mining which are abundant. It appears that the current activities and mining operation are not having an impact on the in situ water quality of the Meya River.

5.9.2 Index of habitat integrity

The scores pertaining to the IHI assessment for the Meya River are presented in Table 25. This index assesses the severity of any damage inflicted to the instream and riparian habitats of the system caused from anthropogenic perturbations.

Table 5.9-2: The scores of the IHI assessment for the Meya River

Instream habitat integrity	Score	Riparian habitat integrity	Score
Water abstraction	0	Vegetation removal	15
Flow modification	18	Alien encroachment	12
Bed modification	23	Bank erosion	13
Channel modification	17	Channel modification	18
Water quality	3	Water abstraction	3
Inundation	8	Inundation	8
Exotic macrophytes	3	Flow modification	13
Exotic fauna	2	Water quality	18
Solid waste disposal	4		
Integrity score	**43**	**Integrity score**	**23**
Integrity class	**Largely modified**	**Integrity class**	**Seriously modified**

Note: No impact (0), Small impact (1-5), Moderate impact (6-10), Large impact (11-15), Serious impact (16-20), Critical impact (21-25)

The overall instream habitat has been "largely modified" and this may be largely attributed to the artisanal mining activities within the system. These artisanal mining activities have caused serious impacts to the system, modifying the flow and channel structure. Additionally, artisanal mining activities have also imposed a critical impact on the Meya River due to bed modification. Similarly, the riparian habitat has been "seriously modified" due to the artisanal mining activities. These activities have had a serious impact due to channel modification and altered water quality. Additional impacts which are considered to be large resulting from the artisanal mining activities are the removal of vegetation, alien vegetation encroachment due to the placement of fields in the riparian areas, bank erosion and modifications to flow. The findings of the habitat integrity assessment indicate that the current artisanal mining activities are having a considerable impact on the habitat integrity of the Meya River.

5.9.2.1 Habitat assessment for low gradient stream

The results of the habitat assessment for the Meya River as per the USEPA (2006) guidelines are presented in Table 26. Based on these findings, the quality of habitat suitable for aquatic biota was determined to be "moderate" for the system. None of the assessed habitat parameters were determined to be optimal for the system. Vegetative protection and epifaunal substrate were determined to be the most intact and important for the system. This component includes the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna. It was evident from the study that the surrounding artisanal mining activities are impacting on the habitat integrity of the system with the majority of the habitat parameters determined to be

suboptimal in state. These activities have resulted in excessive sedimentation of the system, resulting in the decrease in habitat quality and a loss in habitat diversity.

Table 5.9-3: The habitat parameter scores for the low gradient Meya River

Habitat Parameter	Score
Epifaunal substrate/Available cover	14
Pool substrate characterization	11
Pool variability	8
Sediment deposition	4
Channel flow status	6
Channel alteration	12
Channel sinuosity	11
Bank stability (L) & (R)	11
Vegetative protection (L) & (R)	15
Riparian vegetative zone width (L) & (R)	7
Total score	**99**
Habitat percentage (%)	**49.5**
Habitat description	**Moderate**

5.9.2.2 Benthic macroinvertebrates

In order to assess the macroinvertebrate community structure of the Meya River, a variety of biotopes are sampled. These biotopes consist of various water velocities and depths, as well as habitat structures. A total of 13 macroinvertebrate taxa were sampled during the survey and a total of 505 individuals were sampled from the Meya River. The abundances of the sampled macroinvertebrate taxa and the respective sensitivities are presented in Macroinvertebrates with different tolerances to poor water quality were sampled from the Meya River. Ten of the taxa sampled are considered to be highly tolerant (1-5) to poor water quality and three of the taxa are considered to be moderately tolerant (6-10) to poor water quality. No taxa which are sensitive to poor water quality were sampled during the survey.

The total number of families within the three insect orders Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and Trichoptera (Caddis flies) identified for the project was three. This metric gives an indication of the variety of the more pollution sensitive orders. Thus, this provides a confirmation that very few taxa considered to be sensitive to poor water quality were sampled for the study.

Macroinvertebrates with different tolerances to poor water quality were sampled from the Meya River. Ten of the taxa sampled are considered to be highly tolerant (1-5) to poor water

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Table 5.9-4: The abundances of the sampled macroinvertebrate taxa and associated sensitivities for the Meya River as well as the respective EPT scores

Family	Taxon	Sensitivity	Abundances
ANNELIDA	Hirudinea	3	11
CRUSTACEA	Potamonautidae	3	7
ODONATA	Coenagrionidae	4	13
	Gomphidae	6	9
	Libellulidae	4	23
HEMIPTERA	Gerridae	5	49
	Nepidae	3	5
TRICHOPTERA	Hydropsychidae	6	96
EPHEMEROPTERA	Leptophlebidae	9	3
DIPTERA	Ceratopogonidae	5	6
	Chironomidae	2	228
	Simuliidae	5	47
GASTROPODA	Planorbinae	3	8
Number of Individuals			
Number of Taxa			13
Ephemeroptera, Plecoptera, Trichoptera (EPT)			3

5.9.3 Invertebrate habitat assessment system

The IHAS assesses the quality and availability of habitat suitable for macroinvertebrate communities. The results of the IHAS assessment for the Meya River are presented in Table 28. Based on these results, the quality and diversity of habitat for the system was determined to be in a moderately suitable state. This is an indication that a large variety of biotopes are absent from the system. Additionally, the quality and quantity of the available habitat types and flow scenarios may be limited. These impacts are largely attributed to the local water uses and in particular to the artisanal mining activities. The reach of the Meya River considered for the study was largely unimpacted on by artisanal mining and agricultural activities.

Table 5.9-5: The scores of the IHAS assessment for the Meya River

Biotope		Meya River
IHAS	Stones in current	14
	Vegetation	8
	Other habitats	12
	Stream condition	22
	IHAS score percentage (%)	56
	Classification	**Moderate**

5.9.4 Ichthyofauna assessment

In this assessment 164 individual fish were collected representing 9 types or species (known and unknown) of fishes from five families. This included a single species from the Characidae family, five Cichlidaens, one Clariidae species, one Mastacembelidae species and a single Mochokidae species. The identified genus and species as well as the associated quantities sampled for each are presented in Table 29.

Table 5.9-6: The fish species sampled for the study area and associated quantities

Family	Genus	Species	Local name	Quantity
Characidae	*Brycinus*	*nurse**	Shiny fish	43
Cichlidae	*Hemichromis*	*faciatus*	Ngog	12
Cichlidae	*Oreochromis*	*niloticus*	Ngog	45
Cichlidae	*Pelmatochromis*	*buettikoferi**	Ngog	32
Cichlidae	*Sarotherodon*	Unknown	Ngog	17
Cichlidae	*Tilapia*	*louka **	Ngog	12
Clariidae	*Clarias sp*	Unknown	Slippery fish	1
Mastacembelidae	*Mastacembelus*	*cryptacanthus**	Snake fish	1
Mochokidae	*Chrysichthys*	*nigrodigitatus**	Spiny fish	1
Total abundance				**164**

Note: (*) denotes relatively uncertainty to identify to species

In addition, the preferences or sensitivities for each of the sampled fish species to water quality, habitat and flow and combined or total sensitivities are presented in

Table 5.9-7: A brief review of the families of fishes collected is provided as well as considerations of taxa sensitivities

Family	Genus	Species	Water quality	Habitat	Flow	Sensitivity
Characidae	*Brycinus*	*nurse**	Moderate	Moderate	Low	33%
Cichlidae	*Hemichromis*	*faciatus*	Low	Moderate	Low	17%
Cichlidae	*Oreochromis*	*niloticus*	Low	Low	Low	0%
Cichlidae	*Pelmatochromis*	*buettikoferi**	Low	Moderate	Low	17%
Cichlidae	*Sarotherodon*	Unknown	Low	Moderate	Low	17%
Cichlidae	*Tilapia*	*louka **	Low	Moderate	Low	17%
Clariidae	*Clarias sp*	Unknown	Low	Low	Low	0%
Mastacembelidae	*Mastacembelus*	*cryptacanthus**	High	High	High	100%
Mochokidae	*Chrysichthys*	*nigrodigitatus**	Moderate	High	Moderate	67%
Note: (*) denotes relatively uncertainty to identify to species						

Table 5.9-7: Overview of the types and abundances of fishes collected in the study including preferences or sensitivities of types to water quality, habitat and flow and combined or total sensitivities with species scoring 100% considered to be extremely sensitive types (blue), 83% representing very sensitive types (turquoise), 67% representing sensitive types (green), 50% representing tolerant types (yellow), 33% representing very tolerant types (orange) and 0-17% extremely tolerant species (red).

5.9.4.1 Characids represented by the Brycinus nurse collected in the study

This is a large family of African and South American freshwater fishes (Skelton, 2001). The Characidae family is identified by having sharp teeth and a small adipose fin. According to Skelton (2001) there are 18 genera and over 100 species of African characins confined to tropical water. They are considered to be a shoaling species.

5.9.4.2 Cichlidae family or Cichlids of which four were collected in the study

Cichlids form a very large family of fishes found throughout Africa, in South and Central America, Madagascar, Arabia and India (Skelton, 2001). They are considered to be an important source of food throughout the region and are an attractive aquarium fish that is cultured and relocated to all regions of the world. There are over 800 known species of Cichlids in Africa specifically from the great lakes in Africa.

5.9.4.3 Clariids represented by the one Sharptooth catfish collected in the study

Clariids are found in Africa and Asia and are very important as aquaculture and fisheries species and as a targeted angling species. They are very hardy or tolerant and can often outlast many other fish in desiccating environments. They have a distinct bony helmet-like head and an elongated body with long dorsal and anal fins (Skelton, 2001). In Africa 12 genera and 74

species are known. In this study, a single Sharptooth catfish (Clarias sp) was collected from the Meya River system. These fish are extremely tolerant and are able to take advantage of adverse environmental conditions.

5.9.4.4 Mastacembelidae or Spiny eels represented by one species in the study

This slender eel like fish has an unusual rostral appendage and a series of detached spines along the back in front of the soft dorsal fin (Skelton, 2001). They are found in various freshwater environments in tropical Africa and Asia with two genera and about 45 species found in Africa (Skelton, 2001). In this study one species of Spiny eel (Mastacembelus cryptacanthus) was collected from the Meya System. These Spiny eels are known to be sensitive to modified water quality and have specialist habitat requirements. The occurrence of this fish suggests that habitat availability and diversity as well as water quality states are suitable in the Meya River to maintain an acceptable fish community.

It is important to note that M. cryptacanthus has not been recorded in this region of West Africa and the presence of this species is indicates this to be a considerable range extension (SAIAB, 2011) which should be further investigated.

Mochokideans are endemic to Africa where 10 genera and approximately 170 species have already been identified. Distinct features of this family include their complex mouths and tough spines in the dorsal and pectoral fins. They can be difficult to identify due to the wide variation in features like colour patterns, teeth and barbells (Skelton, 2001). These species are known to be habitat specialists and were collected within riffle, rapid areas of the sites considered. In this study, only Chrysichthys nigrodigitatus was sampled from the Meya River system.

5.9.4.5 Considerations of the sensitivities of fishes obtained in the study

In this study a simple scoring system was used to score the possible sensitivities or preferences of the fishes collected to impaired water quality states, modified habitats and flow regimes. Results in Table 5-5 show that the fishes collected in the study have been determined to have a wide range of sensitivities to water quality modifications with all of the Cichlidae species and the Clarias sp having a "low" preference or determined to be insensitive to water quality and only the Mastacembulus sp being allocated a "high" score, determined to be a sensitive species. The habitat assessment revealed that only O. nilotcus and Clarias sp were determined to have a "low" score for habitat, while the Mastacembulus sp and C. nigrodigitatus received "high" scores. Most of the Cichlidae species and B. nurse received "moderate" scores. B. Nurse, Clarias sp and all of the Cichlidae species received "low" scores for flow preference. C. nigrodigitatus received a "moderate" score and Mastacembulus sp received a "high" score. The "high" sensitivity scores recorded for the flow component are surprising when considering the extreme low flow conditions experienced during the survey. No clear relationships between sites and these ecosystem components (water quality, habitat and flow) were observed.

In consideration of overall sensitivities, findings in Figure 10 initially reveal the total dominance of tolerant to extremely tolerant species for the Meya River system. In spite of this, a "sensitive" species as well as an "Extremely Sensitive" species was also sampled from the system. The abundances of the two sensitive species was extremely low with only a single species of each being sampled which constituted less than 1% of the sample population. In spite of this, it is encouraging to note that species considered to be sensitive to various driving components are present within the system in spite of the impacts on the system.

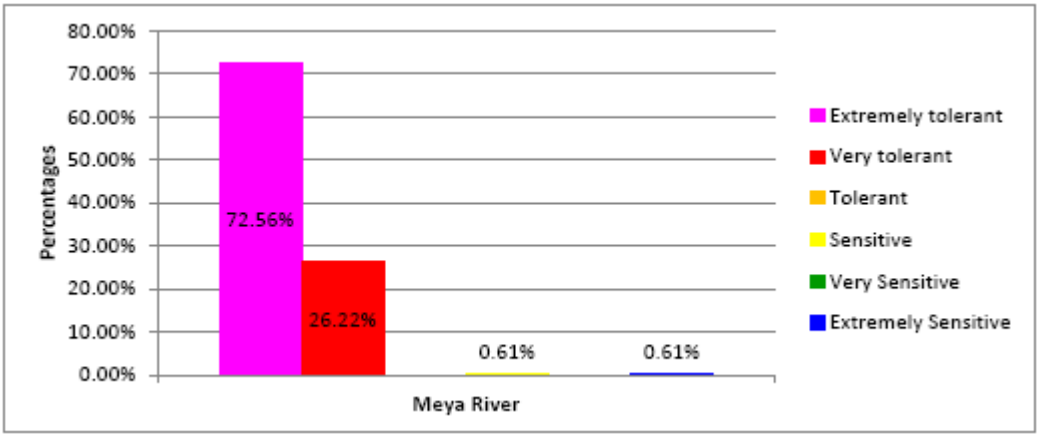


Figure 5.9-1: Percentage contribution of total sensitivities of fishes collected at each site

5.9.5 Conclusion

The water resources associated with the project area are in a largely impacted state when compared to natural reference conditions. This is in accordance with findings published by the US AID (US AID, 2007) stating that the water resources of Sierre Leone have been impacted on by rudimentary farming techniques and artisanal mining activities. The impacted water resources are largely representative of the adjacent and surrounding areas which have also been impacted on by local users.

The Koidu Kimberlite Mine has not impacted directly on the integrity of the Meya River with impacts most notably originating from the local water users and artisanal miners. In spite of this and in light of the proposed KOIDU KIMBERLITE PROJECT expansion project, the Meya River should be considered for future monitoring objectives.

The wetlands associated with the project area have largely been formed due to mining activities and profiling in the area extending over a 70 year period. Thus the wetlands are not necessarily representative of historical natural reference conditions. In addition to this, the delineated wetland areas have been considerably impacted on by historic mining activities as well as by local artisanal mining operations. The placement of agricultural fields by locals within the wetlands has also impacted on the systems, but the severity is considered to be less severe than that of the artisanal mining operations.

The construction and placement of a perimeter wall and road for the Project have had a direct negative impact on the integrity and functioning of the wetland system but the severity

of this impact is considered to be negligible, owing to the poor state of the systems inherited by the Project.

The study component conclusions pertaining to each of the specialist study components are presented separately in the subsequent sections.

5.10 Wetland systems

5.10.1 Wetland delineation

The wetland area was delineated whereby features such as soil, vegetation, topography and hydrology were collectively considered (Plan 10). The extent of the artisanal mining and agricultural activities within the system is a concern.

5.10.2 Wetland unit characterisation

The wetland unit associated with the Koidu mining project area was initially identified at desktop level and then ground truthing was conducted to confirm these findings. The wetlands in the study area are linked to both perched groundwater and surface water. A single HGM type of natural wetland system occurs within the area assessed. The HGM unit identified for the project area is an unchanneled valley bottom wetland system.

5.10.3 Wetland unit setting

The identification of various wetland units is often characterised by the position of the units in the landscape and the general topography of the survey area. A schematic diagram of how the identified wetland unit for the project area is positioned in the landscape and the general topography of the study area is illustrated in Figure 11. A description based on the setting of the identified HGM unit in the landscape and the associated hydrologic components is presented in Table 5.10-1.

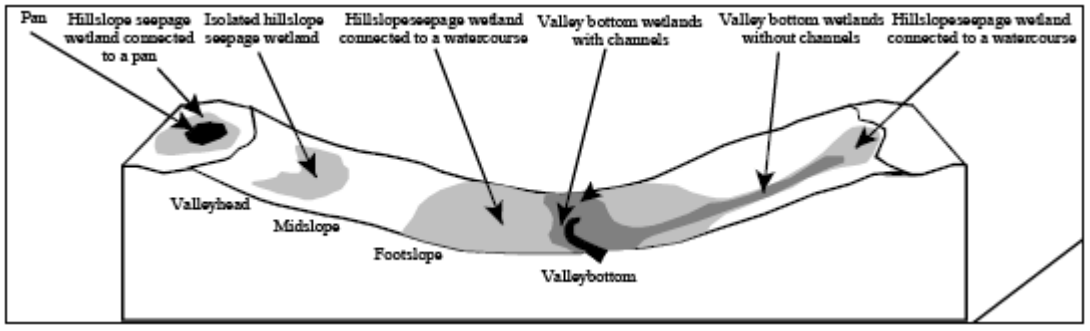


Figure 5.10-1: A schematic illustration of the HGM wetland types identified for the study area

Table 5.10-1: The definition of the different HGM wetland types occurring in the study area [based on the system first described by Brinson (1993) and modified by Marneweck and Batchelor (2002), and further developed by Kotze, Marneweck, Batchelor, Lindley and Collins (2004)]

	TOPOGRAPHIC SETTING	DESCRIPTION	
Valley bottom wetlands without channels	Occur in the shallow valleys that drain the slopes	Valley bottom areas without a stream channel. Are gently or steep sloped and characterized by the alluvial transport and deposition of material by water.	
	HYDROLOGIC COMPONENTS		
	Inputs	Throughputs	Outputs
	Receive water inputs from adjacent slopes via runoff and interflow. May also receive inputs from a channelled system. Interflow may be from adjacent slopes, adjacent hillslope seepage wetlands if these are present, or may occur longitudinally along the valley bottom.	Surface flow and interflow.	Variable but predominantly stream flow.

5.10.4 Description of Unchanneled Valley Bottom Wetlands

This type of wetland resembles a floodplain in its location and gentle gradient, with potentially high levels of sediment deposition (Kotze et al., 2007). Extensive areas of these wetlands remain saturated as stream channel input is spread diffusely across the wetland even at low flows (Kotze et al., 2007). These wetlands also tend to have a high organic content. Facultative wetland indicator plant species, comprising a mixture of grasses and sedges, are evident as longitudinal bands within a relatively narrow zone along the valley bottoms. Facultative wetland plant species usually grow in wetlands (67-99% of occurrences) but occasionally are found in non-wetland areas. Lateral seep zones form part of the adjacent hillslope seepage wetlands, this is a characteristic for all the valley bottom wetlands. The primary drivers for these systems, owing to the shallow gradients along the valley bottoms are diffuse horizontal surface flow and interflow. There is generally a clear distinction in the transition in the vegetation structure between the mixed grass-sedge meadow zones that characterise these wetlands to the more intermittently wet grassland habitats associated with the adjacent hillslope seepage wetlands (Kotze et al., 2007).

5.10.5 General wetland functional description

Valley bottom wetlands without channels also offer a service in the enhancement to the quality of water. This is with respect to the removal of toxicants and nitrates. This removal is higher than in valley bottom wetlands with channels owing to the greater contact of the wetland with runoff waters, particularly if there is a significant groundwater contribution to the wetland (Kotze et al., 2007). According to Cronk and Siobhan Fennessy (2001) and Keddy (2002) the phosphate retention levels may be lower because a certain amount of phosphate may be re-mobilized under prolonged anaerobic conditions. These wetlands provide an additional service in trapping and the retention in the wetland itself of sediment carried by runoff

waters. Valley bottom wetlands without channels reduce the flooding potential as a result of diffuse flows over the surface of the wetland, thereby reducing the severity of floods downstream. This depositional environment is created by the surface roughness caused by the vegetation. The depositional environment is enhanced through the presence of dams. These wetlands provide valuable grazing ground during winter periods and early spring as a result of extended periods of wetness

5.10.6 Ecological functional assessment

The general features of the wetland unit were assessed in terms of functioning and the overall importance of the hydro-geomorphic unit was then determined at a landscape level. The level of functioning supplied by the hydro-geomorphic unit for various ecological services for the project area is presented in Table 32. The result from the "WET- EcoServices" tool for the respective wetland unit is presented below in Figure 5.10-2.

Table 5.10-2: A listing and scoring of ecological services offered by the HGM unit identified for the project area

Ecological service	Valley bottom wetland without a channel Overall Score
Flood attenuation	1.3
Streamflow regulation	0.9
Sediment trapping	1.1
Phospahte trapping	1.2
Nitrate removal	1.1
Toxicant removal	1.0
Erosion control	0.8
Carbon storage	0.9
Maintenance of biodiversity	0.5
Water supply for human use	1.0
Natural resources	0.8
Cultivated foods	3.3
Cultural significance	1.0
Tourism and recreation	0.3
Education and research	0.1

Note: Moderately high importance (3 – 4)

Intermediate importance (2 – 3)

Moderately low importance (1 – 2)

Low (0 – 1)

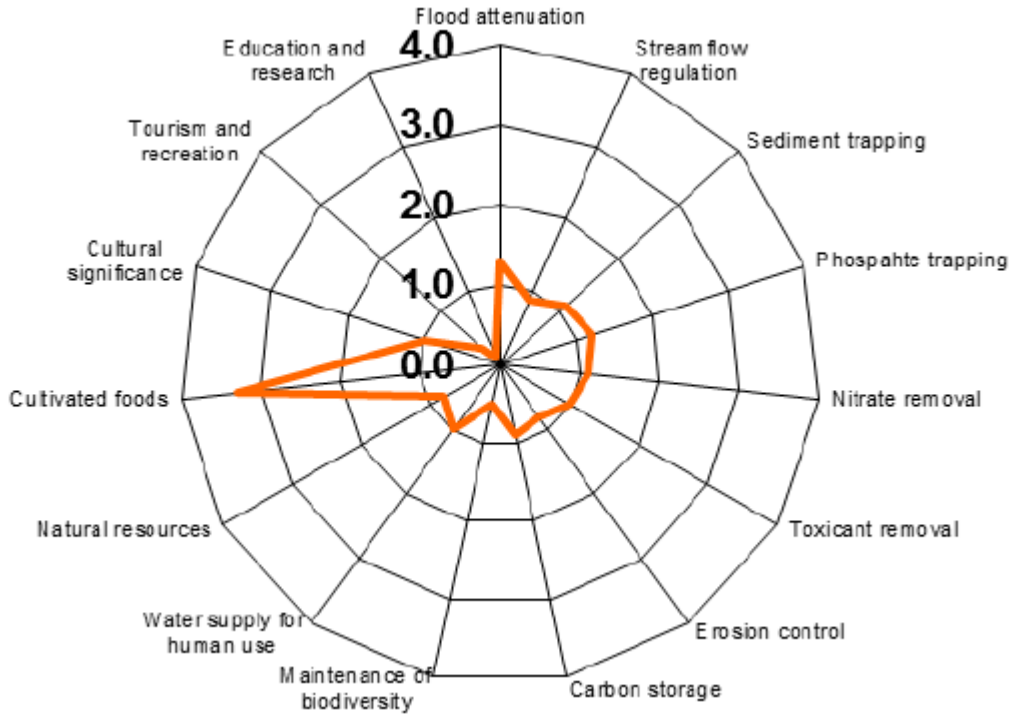


Figure 5.10-2: Radial plot of functions performed by the identified wetland unit

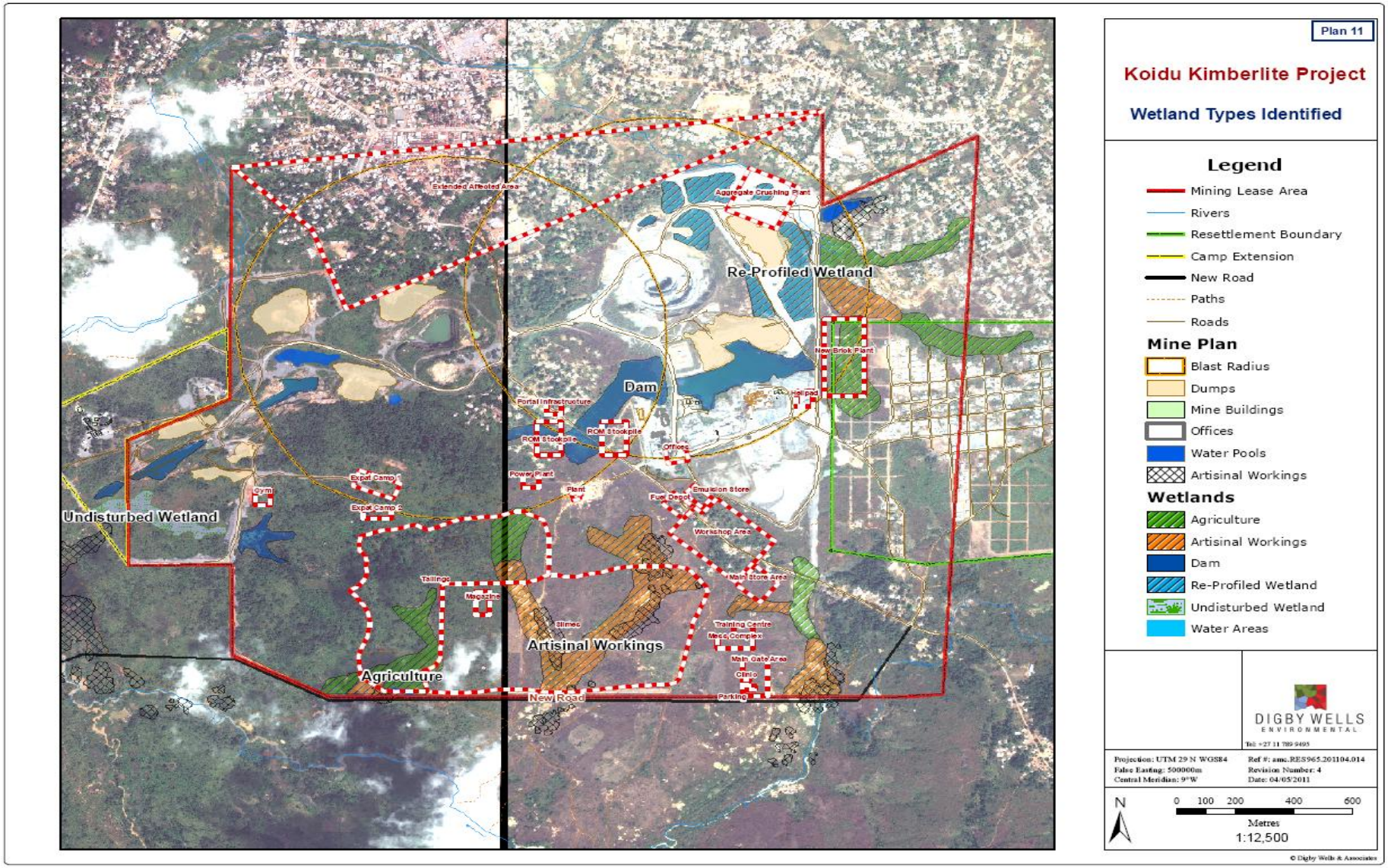
The identified wetland unit provides a variety of ecological services of varying importance. The majority of the services provided were determined to be of low ecological importance. Some of the assessed services considered for water quality enhancement such as phosphate trapping and nitrate removal were determined to be of moderately low importance. This is important to note due to the fact that unchanneled valley bottom wetlands contribute considerably to the improvement of water quality for such a system. The provision of "cultivated foods" by the system was determined to be of moderately high importance. This may be attributed to the dependence of local villages on these systems for their potatoes and rice plantations. It may be concluded that the placement of these plantations into the system has affected the ability of these systems to enhance water quality and this may provide an opportunity for the KOIDU KIMBERLITE PROJECT to rehabilitate these areas in order to restore ecological functioning to the catchment.

5.10.7 Conclusion

The wetland system assessed for the project area has largely been formed due to extended periods of commercial and artisanal mining as result of artisanal pit creation and profiling. In addition to this, the current land uses, namely artisanal mining and agricultural activities have impacted considerably on the functioning and integrity of this system. Thus important ecological services pertaining to the enhancement of water quality and the maintenance of biodiversity have been lost. The severity of the associated impacts is considered to be severe.

The prevention of agricultural and artisanal mining activities within the wetland systems

within the Project area would provide an opportunity for these systems to potentially recover. Thus, long term objectives would need to be defined for these systems in order to ensure that none or limited future impacts are imposed onto these systems so as to assist the recovery of ecological integrity and functioning for the catchment. The Koidu Kimberlite Project would therefore be afforded the opportunity to contribute to the rehabilitation of these wetland areas.



5.11 Surface Water

5.11.1 Rainfall

The Koidu area is extremely wet with about 2 600 mm of rain falling during the year. Approximately 2 400 mm falls within an eight month period from April to November with five of the months exceeding 300 mm. The rainfall measurements between 2005 and 2010 that were recorded at the project site are summarised Table 33.

Table 5.11-1: Rainfall measurements at the Koidu Kimberlite Project, 2005 – 2010

Month	Rainfall (mm)						Monthly statistics			
	2005	2006	2007	2008	2009	2010	Mean	1 σ	CV	% of total
January	-	0	0	0	0	0	0	0	-	0%
February	-	0	9	105	95	20	46	50	109.4%	1.7%
March	-	68	0	126	124	97	83	52	62.7%	3.2%
April	93	159	113	229	80	178	152	58	38.1%	5.8%
May	178	218	147	145	158	315	197	30	15.4%	7.5%
June	153	309	246	219	333	402	302	73	24.1%	11.5%
July	153	481	430	361	500	150	384	142	36.9%	14.6%
August	150	402	571	590	550	321	528	86	16.2%	20.1%
September	290	36	629	402	363	-	465	244	52.6%	17.6%
October	325	482	327	307	416	-	383	81	21.2%	14.5%
November	229	72	85	59	156	-	93	43	46.6%	3.5%
December	7	0	0	3	2	-	2	2	237.7%	0%
Total	-	2 655	2 556	2 545	2 776	1 161	2 632	-	-	100%

The evapo-transpiration for the area is approximately 1 400 mm and therefore there is significantly more rainfall than there is runoff at the mine and spillages and discharges will occur (UNDP/FAO- TR5, 1980).

5.11.2 Rainfall statistical analysis

A statistical analysis was done on rainfall data for the last 4 years, as well as 1 day data, that were available for the Koidu site in Sierra Leone. The mean annual precipitation for the study areas was determined from the rainfall data as 2 600 mm for the catchments. The adopted 1 day rainfall depths of the respective areas for the various return periods are given in Table 34.

Table 5.11-2: Adopted design rainfall

Duration	Return Period Rainfall (mm)						
	1:2	1:5	1:10	1:20	1:50	1:100	1:200
1 day	122	155	181	209	251	288	330

5.11.3 Catchment description

As outlined in the 2003 EIA, the project area lies within the Meya stream sub-catchment covering an area of about 188 km2, which is a tributary of the Bafi River.

Monkey Hill forms a watershed, with the northern tributaries draining into the Woyie River and those to the south joining up with the Meya River. Both of these rivers merge into the Moinde River which flows in a north westerly direction along the Meya-Moinde Fault.

The bulk of the water supply in the area comes from rivers, streams and swamps. The pH of the water in the major rivers in Sierra Leone ranges between 6.5 and 7 in the wet season and 6.2 and 6.5 in the dry season. The pH of water in the swamps ranges between 5.2 and

6.0. The pH for samples selected in the project area ranges between 6.4 and 7.6 with a mean value of 6.9.

The mine area has been divided into nine areas and each of the areas is described in more detail below. Figure 13 indicates the catchment boundaries while Figure 14 indicates the proposed and existing layout of the mine. Included in the mitigation measures are initial thoughts on the clean and dirty water diversions that will be updated during the next few weeks as more information is made available.

The catchments are summarised as follows:

- Catchment A includes the catchment to the south of the mine area. The catchment is presently minimally impacted upon by mining and the river flows to the south. In the future expanded mine this catchment will include the tailings dump, plant, offices, change houses, clinic and workshops and will form the hub of the mining;
- Catchment B includes the existing K1 pit and the water drains to the North West of the mining area;
- Catchment C in an area to the north west of the site and the river from catchment B flows into catchment C;
- Catchment D is to the west of catchment A and presently is not impacted upon by the mine but is in a catchment that is a possible site for the tailings dump. The river in this catchment flows to the south of the mine;
- Catchment E includes the present day plant area and main dam and the water exits the site to the east; and
- Catchment F G, H and I and smaller catchments presently flowing into the K2 pit.

5.11.4 Catchment characteristics

A catchment area is defined as the total area drained by a river or stream, measured from the mouth of that particular water body. Assuming an evenly distributed rainfall event, a bigger catchment in area will collect, and based on its slope, feed its water body with more water than a small catchment. This is one, amongst others, of the catchment characteristics such as, slope, vegetation cover, soil type, hydraulic length, etc that affect the volume of water running in a river given the type and duration of rain falling. The catchment sizes, their hydraulic lengths, and average slopes (measured from 10-85% of hydraulic length) are given in Table 35 below. Refer to Figure 15 for the delineated catchment areas.

Table 5.11-3: Catchment characteristics

Catchment name	Incremental area (km^2)	Longest watercourse (m)	10:85 slope (m/m)	Tc (hrs)	C-Factor
A	0.395	925	0.0076	0.37	0.401
B	0.638	1120	0.0339	0.24	0.401
C	0.034	350	0.0486	0.08	0.396
D	0.230	916	0.0677	0.16	0.396
E	0.573	1288	0.0023	0.74	0.421
F	0.011	158	0.0823	0.04	0.365
G	0.022	243	0.0206	0.09	0.417
H	0.3	248	0.0323	0.08	0.395
I	0.675	1 704	0.0017	1.03	0.378

Please note:

- These catchment characteristics were determined using 1m contour detail and aerial photographs in GIS.
- 10-85 slopes denote the slope of the catchment from a point 10% from the end point and 85% of the distance to the furthest point.
- Time of concentration denotes the length of time it takes for a raindrop to travel from the furthest point of the catchment to the outlet point.
- The runoff factor was adopted to describe the runoff response of the specific catchment to the design rainfall.

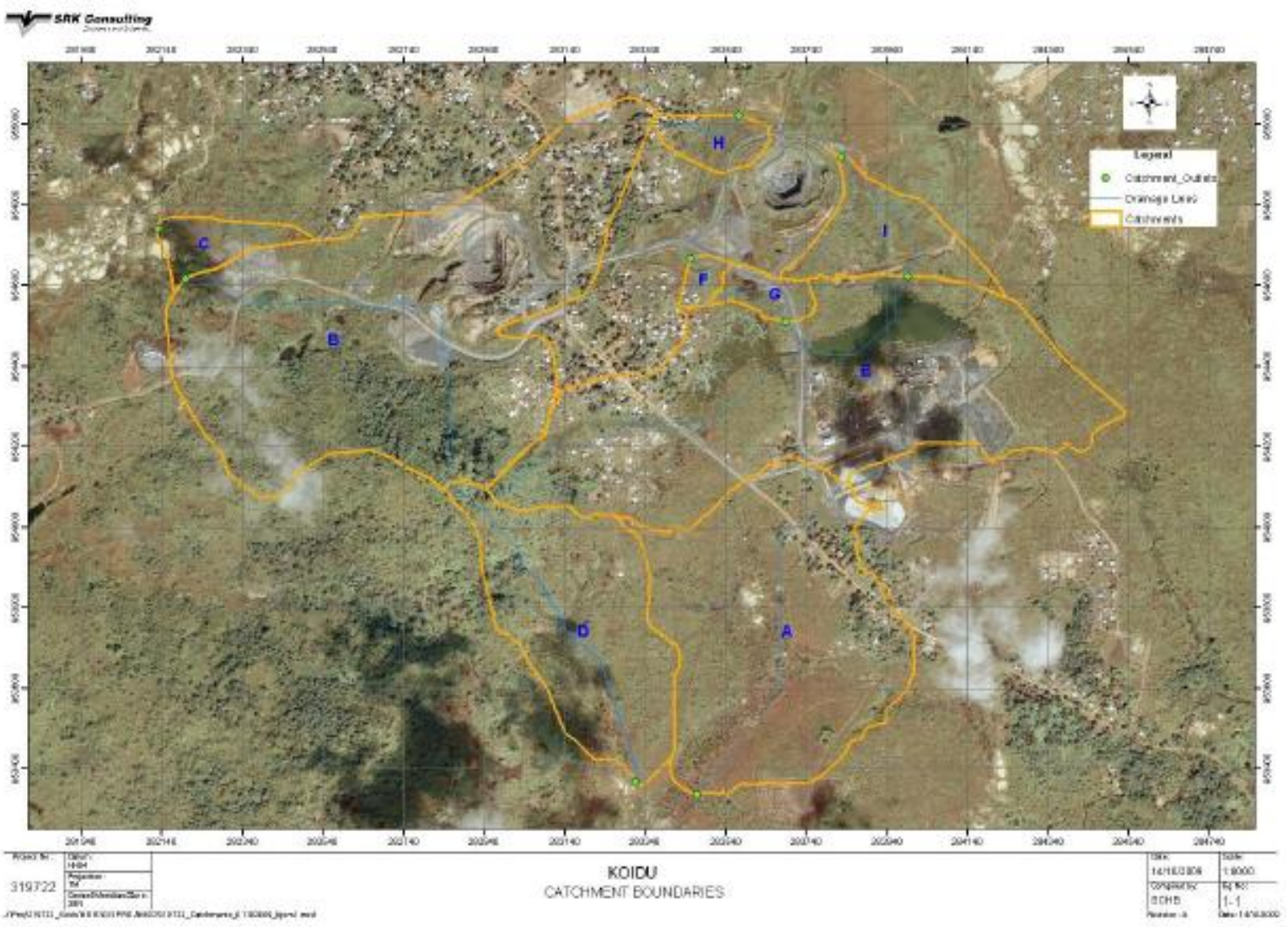


Figure 5.11-1: Catchment Boundaries for Water Course Outlets (SRK, 2009)

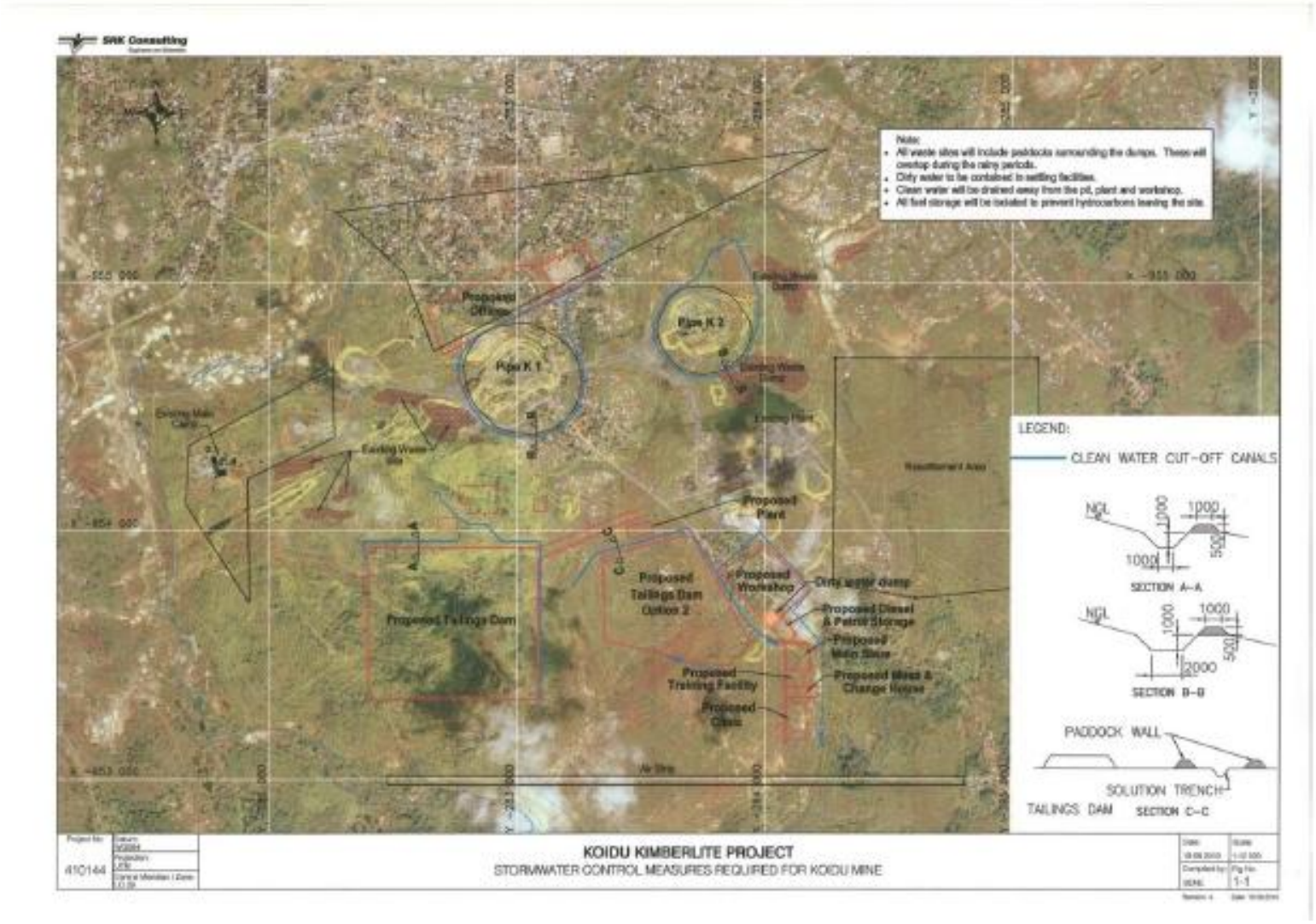


Figure 5.11-2: Existing and proposed mine layout (SRK, 2010)

5.11.5 Flood hydrology

Flood hydrological methods used in this study include the Rational method and the SCS method. These models are suited for a catchment of these size ranges. The Universal Programs for Discharge software incorporates the Rational method and the VisualSCS software incorporates the SCS method. These programs were therefore used by SRK Consulting to model the flood peaks.

Table 36 below gives a summary of the 1:50 and 1:100 year flood peaks calculated using the methods described above.

Table 5.11-4: Summary of flood peaks

Catchment name	Area (km^2)	Return period years (m^3/s)						
		2	5	10	20	50	100	200
A	0.395	6.60	9.10	11.30	13.80	17.50	20.80	24.50
B	0.638	13.60	18.70	23.30	28.30	35.90	42.60	50.30
C	0.034	14.00	19.0	24.0	29.0	36.0	43.0	51.0
D	0.230	6.00	8.20	10.30	12.50	15.80	18.80	22.00
E	0.573	6.20	8.60	10.70	13.10	16.60	19.80	23.40
F	0.011	0.80	1.10	1.40	1.70	2.10	2.50	3.00
G	0.022	0.80	1.10	1.40	1.70	2.10	2.50	3.00
H	0.030	1.20	1.70	2.10	2.60	3.20	3.90	4.50
I	0.675	5.90	8.10	10.20	12.40	15.80	18.80	22.20

The adopted peak selected for all the catchments is based on the SCS TC Method. This method produced the most conservative results and is a preferred method for catchments of these sizes.

5.11.6 Pit inflows

The runoff into the K1 pit has will be substantial during a storm event to about 38,000 m^3 for a 1:50 year storm (see Table 38 below). An in-pit sump will be required to cater for the 1:5 year, 1 hour storm rather than the 50 year event. This will mean that during larger storms water might be lying at the bottom of the pit for 8 to 10 days. Mining could continue on the higher benches but it will mean more water will seep into the underlying material.

5.11.7 Water quality

Surface and groundwater samples were at five locations within the Koidu mining lease area

(Table 37). The hydrochemical analysis was undertaken by M&L Laboratories in Johannesburg and included major ions, pH, EC, TDS and an ICP scan for dissolved metals following filtering of the sample on site.

Table 5.11-5: Surface and groundwater monitoring points within the mining lease area

Sampling Point	Description	Co-ordinates
SW1	Near proposed new tailing dump	953299.227 283360.703 378.633
SW2	Discharge from dam below plant	▪ 954467.7 284120.21 382.549
SW3	Discharge from dam slurry dams	954553.43 284240.128 382.95
SW4	Stream down-gradient of pit	955141.481 283862.204 374.75
BH1	Borehole at main accommodation	954252.652 281810.302 386.821
BH2	Borehole at office complex	▪ 954221.822 283763.263 390.721
BH3	Borehole at resettlement	954597.873 284513.472 388.31
WBH2	Piezometer at K1 Pit	▪ 954563.462 282867.562 375.38
WBH5	Piezometer at K1 Pit	954748.97 283086.94 383.2

The following water quality results were obtained:

- Camp water supply (BH 1): The water quality is reflective of recent recharge with a calcium/bicarbonate signature, and no evidence of chemical contamination that might affect its use as drinking water (although it should always be disinfected for drinking). The water is moderately saline (as indicated by the Total Dissolved Solids – TDS) and moderately hard (as indicated by the calcium concentration). All constituents analyzed including dissolved metals and metalloids comply fully with the WHO Drinking Water Quality Guidelines (2008);
- BH 2, Near Plant: Low TDS and hardness, without indication of chemical contamination, and fully compliant with the WHO Guidelines (2008).
- BH3, Background groundwater quality: Water quality is reflective of recent recharge (calcium / bicarbonate signature), with moderately high TDS and acceptably low hardness, and fully compliant with WHO Guidelines (2008);
- SW 1, Background Surface Water Quality: Low TDS dominated by calcium and bicarbonate with other constituents at trace levels. The cation-anion imbalance at -8% is slightly high but explained by the trace levels of many of the cation and anions, analyzed at concentrations close to their analytical detection limits. Dissolved metals and metalloids are generally close to detection limits, apart from iron probably derived from suspended soil particles in a slightly acid water;
- SW 2 and SW 3, Water discharged from dam below the Plant (SW 2) and from slurry dumps

(SW 3): These waters are essentially similar in composition with pH values slightly in the alkaline range and moderately high TDS values showing evidence of slightly elevated sulfate and nitrate values indicative of contact with mining wastes. The cation-anion imbalance for SW 2 is higher than desirable (orange shading) indicating minor under-recoveries of calcium and magnesium during analysis, although these are not considered significant. Despite these minor alterations to the background water quality, these analyses remain fully compliant with the WHO Drinking Water Quality Guidelines (2008);

- SW 4, Surface water down-gradient of the Pit: Neutral water moderately low in TDS and hardness with no evidence of chemical contamination. Metals and metalloids remain in compliance with WHO Guidelines except for iron soluble iron and manganese which are widespread in these geological formations and probably leached from the suspended soil particles in the watercourse. At these levels the iron and manganese have nuisance value but no adverse health connotations. It is likely that the Fe and Mn in solution interfered slightly with the cation and anion analysis resulting in the rather high cation-anion imbalance, which is not considered significant; and
- WBH 5 and WBH 2, Piezometer holes adjacent to the Pit: This water complies with the WHO Guidelines except for elevated iron and manganese in WBH 5 and (of more concern) elevated dissolved lead at levels non-compliant with the WHO Guidelines (2008). The soluble lead indicates the presence of lead in the mineralogy around the Pit, and this should be noted in follow-up sampling of groundwater in the area.

Table 5.11-6: Runoff into the K1 Pit

Return period	Runoff into K1 pit (24-hr storm)						
	2	5	10	20	50	100	200
Curve number	84.18	84.18	84.18	84.18	84.18	84.18	84.18
24 hour design rainfall (mm)	124.30	159.50	190.30	224.40	276.10	323.40	378.40
Runoff depth (mm)	85.41	118.24	147.56	180.41	230.73	277.11	331.29
Runoff from external catchment	7 119	9 856	12 299	15 037	19 231	23 097	27 614
Runoff from haulroads	6 038	8 359	10 431	12 754	16 311	19 589	23 420
Direct pit area volume	1 287	1 652	1 971	2 324	2 860	3 350	3 919
Total inflow into pit	14 444	19 866	24 701	30 115	38 402	46 036	54 953

Table 5.11-7: Runoff into K2 Pit

Return period	Runoff into K2 pit (24-hr storm)						
	2	5	10	20	50	100	200
Curve number	84.18	84.18	84.18	84.18	84.18	84.18	84.18
24 hour design rainfall (mm)	124.30	159.50	190.30	224.40	276.10	323.40	378.40
Runoff depth (mm)	85.41	118.24	147.56	180.41	230.73	277.11	331.29
Runoff from external catchment	4 473	6 193	7 728	9 449	12 084	14 513	17 351
Runoff from haulroads	3 794	5 252	6 554	8 014	10 249	12 309	14 716
Direct pit area volume	809	1 038	1 238	1 460	1 797	2 105	2 463
Total inflow into pit	9 076	12 483	15 521	18 923	24 130	28 926	34 529

5.12 Groundwater

A hydrogeological investigation was conducted in 2009-2010 in the Koidu mine area to define the hydrogeological framework of the area, to predict the groundwater conditions that will most likely be encountered during proposed mining, and to predict the potential impacts of mining and dewatering on groundwater resources in the vicinity of the mine. The field investigation included hydraulic testing in three coreholes drilled in the granite country rock adjacent to the K1 and K2 pits and a 3-day pumping test of the leached granite adjacent to the K2 kimberlite. The primary analytic tool for making the predictions was a 3-dimensional groundwater flow model.

The geohydrology is divided into the two main aquifer types present in the area, the upper weathered aquifer and the underlying fractured aquifer. The weathered aquifer consists of in- situ weathered host rock as well as transported material. The underlying fractured aquifer can be subdivided into the various geological units from which they are derived.

5.12.1 Hydrogeological Framework

The K1 and K2 pits and their planned underground extensions are within slightly fractured to massive granites with a bulk hydraulic conductivity ranging from 3 x 10-3 to 2 x 10-2 m/day. Hydraulic testing conducted in 2009 (HCItasca, 2009) indicate that the near-surface sub- horizontal (exfoliation) joints and the NNW-SSE striking high angle joints observable in the ramp to Blow A do not extend to depth, and thus have no hydrologic significance with respect to future mining.

The only hydrogeologic unit of significance is the so-called leached granite that forms an altered 10- to 30-m wide rind with a hydraulic conductivity of about 6 x 10-1 m/day around the K2 kimberlite.

5.12.2 Dewatering

The peak amounts of inflow, the approximation duration of the inflows, and the total volumes of water to be managed for the 50- and 100-year rainfall events (using data provided by SRK) are summarised in the following table for various stages of the mine.

Table 5.12-1:

Recurrence frequency(yrs)		50			100		
Mine	Depth interval (mamsl)	Peak inflow (m^3/hr)	Approx Duration (hrs)	Total Volume (m^3)	Peak inflow (m^3/hr)	Approx duration (hrs)	Total Volume (m^3)
K1	above 0	4,500 - 8,000	48	38,000	5,500 - 13,000	48	46,000
	-40 to -100	8,000- 15,000	24		10,000- 17,000	24	
	-120 to -160	12,000 - 16,000	12		17,000 - 12,000	12	
K2	above -30	1,800 4,500	72	24,000	4,500 – 9,000	48	42,000
	-70 to 130	2,000 - 5,000	48		3,000 – 6,500	48	29,000
	below -150	2,800 - 5,200	48		3,500 – 6,200	48	

These are quite large inflows and volumes of water. Koidu will need to design an optimal amount of pumping capacity and temporary storage to manage this water.

As a result of the overall low hydraulic conductivity of the granite country rock, the predicted mine inflows will be managed passively (i.e., without any active dewatering) with two exceptions:

- The water contained in the near surface joints around the K1 kimberlite that was intercepted by wells installed by Aqua Earth in 2006 to help minimise inflow to the K1 vertical pit will be captured by a series of underground drainholes drilled from a dewatering ring at about the 250 mamsl level; and
- The leached granite will be pre-drained by a series of underground drainholes drilled into it from a dewatering ring around the K2 kimberlite at about the 150 mamsl level in order to depressurise the leached granite to improve slope stability in the pit, and to minimise inflow to the underground mine.

5.12.3 Depth of water table

It is expected that a difference in water table is present between the weathered and fractured aquifers. Eighteen water level measurements were taken in March 2003 and the level varied between 0.8 meter below ground level (mbgl) and 6.5 mbgl (CEMMATS, 2003). All these measurements were taken in hand dug wells and are therefore believed to be indicative of the weathered aquifer water levels.

Within the No. 2 pipe the water levels is 378.7 mamsl according to the levels surveyed on site. This is expected to be an indication of the water levels within the kimberlite aquifer and the fractured granitic aquifer is expected to have a similar level.

5.12.4 Presence of boreholes, wells and springs and their estimated yields

Twenty two wells in the study area were investigated by CEMMATS (2003), but this represents a sample of the wells and not the total number. The only indication of yield is the daily abstraction volume, which varies between 100 l/day and 2 500 l/d. These yields could also be a function of the number of people utilising the wells and test pumping is required to establish the yields.

The formations of springs are governed by the geology and are generally associated with a pinching out of the weathered aquifer by an impermeable layer, e.g. the underlying rock bed. No springs were recorded by CEMMATS but surface water-groundwater interaction does occur in low-lying areas as is evident from the numerous low-lying areas that are marshland or are flooded. The weathered aquifer is expected to discharge in low lying areas, but this discharge may occur below the water level of the receiving body thereby not appear as a spring.

5.12.5 Groundwater quality

During a study conducted in 2009, the quality of potable water in the Koidu Holdings mining lease area was sampled and analysis. During this study the following parameters were measured:

- Physical parameters consisting of temperature, turbidity, conductivity and residual chlorine;
- Chemical parameters consisting of Iron, Manganese, Nitrogen, Sulphate, Copper, Aliminium, Magnesium, Ammonia, Bromine, Nitrate, Phosphate, Silicone, Sulphide and Clorine; and
- Bacterial parameters consisting of faecal coliforms.

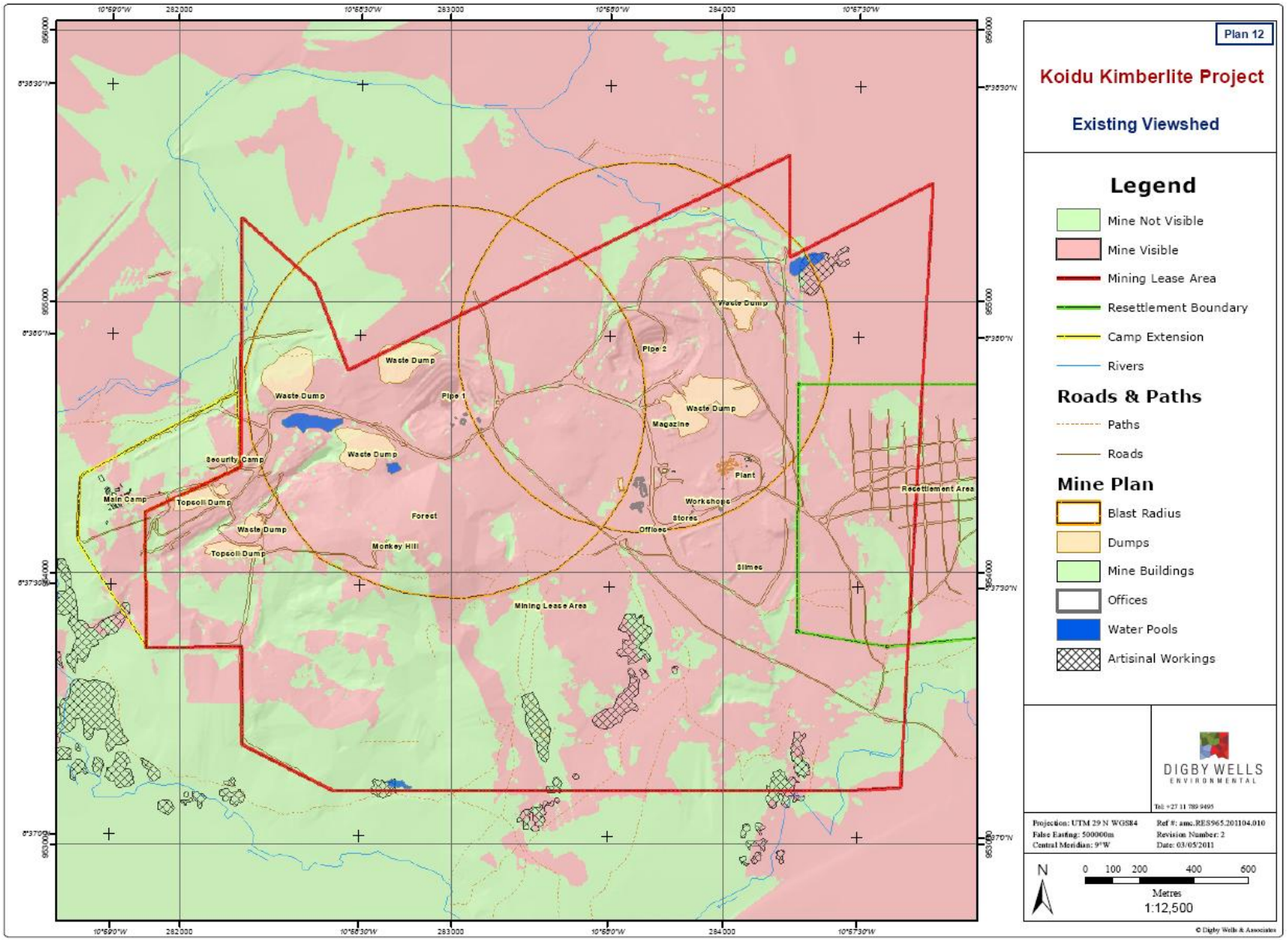
The analysis indicated that the measurements of the parameters tested were all within the permissible limits recommended by the World Health Organisation (WHO). It also indicated that the water had high chemical bacteriological qualities and is good for human consumption.

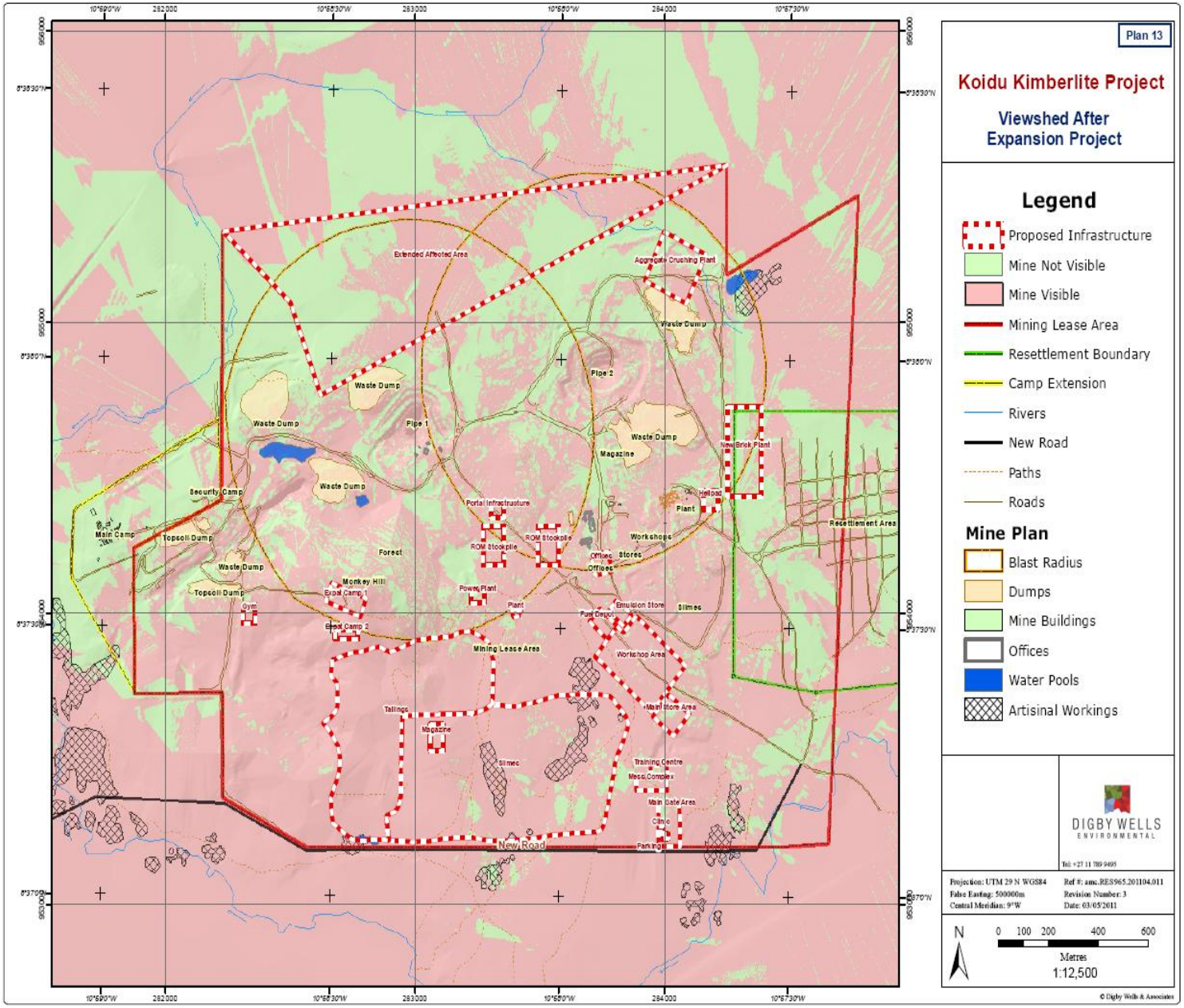
5.13 Visual

In order to assess the visual disturbance of the site, Viewshed modelling was employed. Within a Geographical Information System (GIS), a Digital Terrain Model (DTM) was created from contour information to digitally display the relief of the topography surrounding the proposed mine. This DTM was then used to create a theoretical viewshed model which is the total area that theoretically has a direct visual connection with the project based on topographical features. The theoretical viewshed model does not take into account aspects such as vegetation and atmospheric conditions such as haze or fog.

Plan 12 depicts the extent of the viewshed of the current mining activities, it is evident that the mine does have a high visibility within the local area already and that the area is already largely disturbed from an aesthetic point of view, largely as a result of mining activities conducted pre-2002.

Plan 13 depicts the viewshed model based on the proposed additional infrastructure in addition to the existing infrastructure The area surrounding Koidu Town is already historically aesthetically disturbed. This, together with the existing rehabilitation of vegetation within the mining lease area, reduces the potential visual impacts of the Koidu Kimberlite Project. The mine is also compatible with the area as there are mining operations all around and it is not near any historical or scenic site.





5.14 Archaeology

5.14.1 Archaeological resources at the Koidu Kimberlite Project

As part of the environmental and social investigations required for the Koidu Kimberlite Project (Koidu Project), an Archaeological Impact Assessment (AIA) was conducted. The overall objective of the archaeological study was to use internationally recognised measures to identify, document and assess potential sites of archaeological and heritage significance in the project area in order to conserve, mitigate and manage heritage sites and artefacts according to the recommendations and criteria of the relevant heritage authorities and legislation.

Three sites were identified during the fieldwork (Plan 14):

- A possible residential settlement on a low hill to the south-west of Monkey Hill. Potsherds found in close association with settlement deposit. There is evidence of potential vegetable gardens and house mounds that may be related to sites RES967/002 and 003.
- A metalworking site on the southern slope of Monkey Hill. Evidence of metalworking, especially iron reduction and smithing found. Artefacts include fragments of pottery vessels, tuyérè pipes (blow pipes), iron slag, bloom and ore. May be related to sites RES967/001 and 003. The site is at least 100 m2 in extent. The site has been partly damaged and altered by agricultural activities, illegal woodcutting and other informal impacts by the local community.
- A metalworking site and possible residential settlement on the crest and upper slopes of Monkey Hill. Evidence of metalworking, especially iron and copper reduction found. Artefacts include fragments of pottery vessels, tuyérè pipes (blow pipes), iron slag, bloom and ore. May be related to sites RES967/001 and 002. The site seems to occupy the entire hilltop of Monkey Hill, and possibly also the upper 360° slopes of the hill. The site has been partially destroyed by bulldozer clearing activities. It may represent a type of fortified site as described by DeCorse (1981, 1983).

In order to assess the significance of the identified sites, a literature review and additional research were undertaken. This determined that a) there are known archaeological sites in the project area, and b) these sites may be significant in terms of the archaeological history of the area, as well as providing an understanding of the expansion and influence of West African cultures southwards. All potential impacts will occur during the construction phase, thus, no additional impacts are expected during the operational and decommissioning phases. Subsequent to the mitigation of the sites, the three sites were reassessed. Potential impact on sites 1 and 3 were considered to be neglible. Excavations at site 2 provided evidence to support the initial impact assessment finding that the site represented a metalworking site, where extensive reduction of iron took place. Impact to the mitigated are of the site will be low, although high potential for further subsurface artefacts and archaeological features were identified.

This site and evidence of potential sites on and around Monkey Hill further highlighted the possibility that the hill may have represented a fairly large metalworking centre in the cultural landscape. Thus, impacts on Monkey Hill as a site was rated as medium following the mitigation of the three sites, although impacts on individual sites were rated as low (site 2) to negligible (sites 1 and 3).

Table 40 outlines the three archaeological sites found within the Koidu Kimberlite lease area.

All potential impacts will occur during the construction phase, thus, no additional impacts are expected during the operational and decommissioning phases. Subsequent to the mitigation of the sites, the three sites were reassessed. Potential impact on sites 1 and 3 were considered to be neglible. Excavations at site 2 provided evidence to support the initial impact assessment finding that the site represented a metalworking site, where extensive reduction of iron took place. Impact to the mitigated are of the site will be low, although high potential for further subsurface artefacts and archaeological features were identified.

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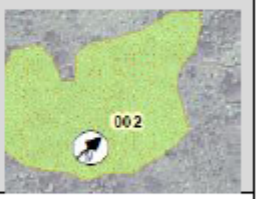
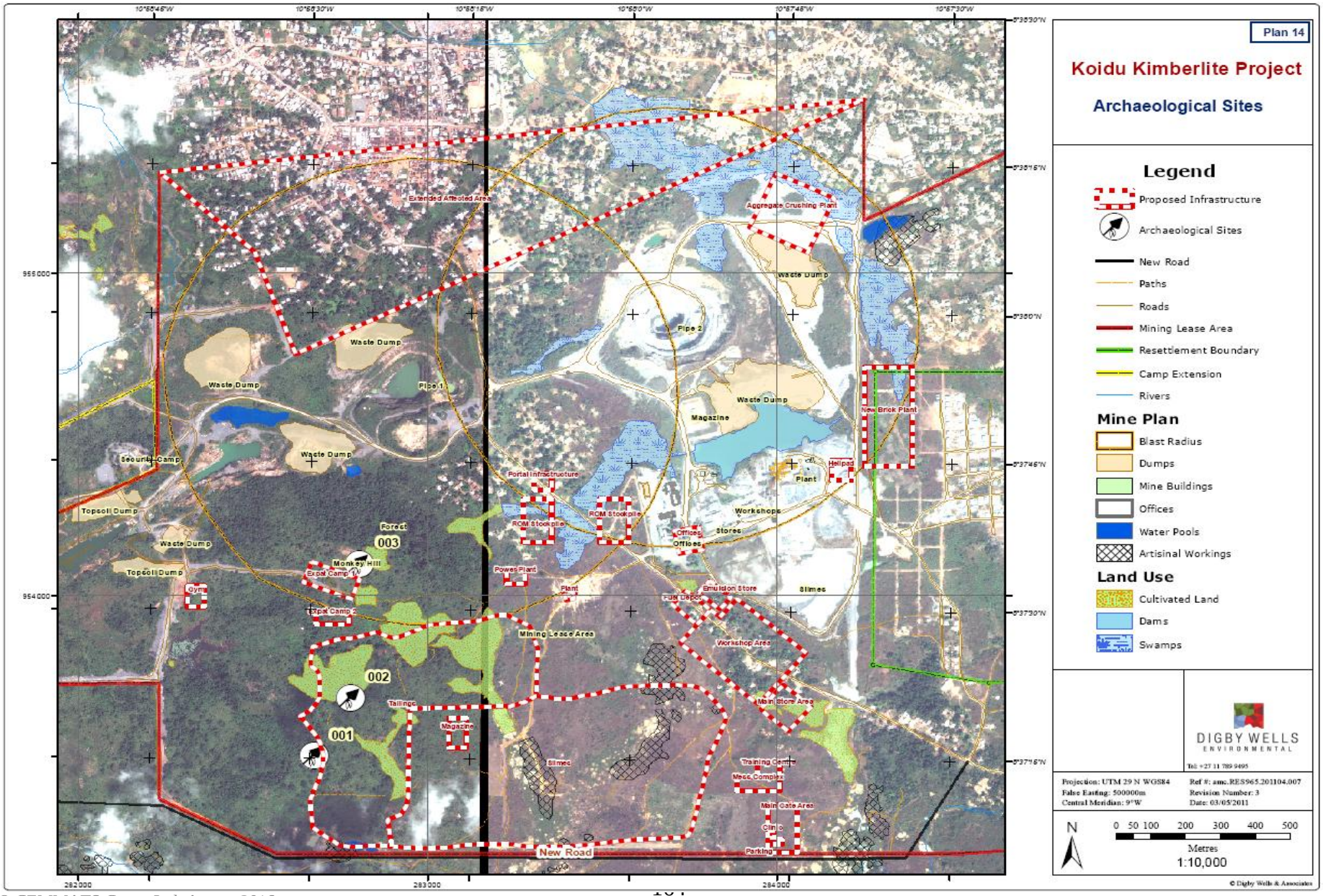
Table 5.14-1: Archaeological sites found within the mining lease area

Site ID	GPS Location	Description	Illustration
RES967/001	*N8.62090 W10.97485*	A settlement - probably small homestead - on a low hill.	
RES967/002	*N8.62254 W10.97391*	Metalworking, notably iron, and possible settlement	
RES967/003	*N8.62631 W10.97370*	Metalworking, evidence of both iron and copper, and possible fortification.	



6 Description of Current Environmental Condition

This section describes the current environmental conditions at the site, providing data, details and descriptions of the project site covering the first half of 2016.

6.1.1 Climate

Koidu Limited monitors climate/meteorological conditions through its on-site Geonica S.A weather station. Data collected on winsdpeed, rainfall and relative humidity is downloaded and analysed, with detail presented in quarterly monitoring reports submitted to EPA-SL. Rainfall data is also collected through rain gauges installed at different locations throughout the facility.

Figure 5.14-1: Rain Gauge

Figure 5.14-2: Weather Station

Monthly averages for windpeed, rainfall and relative humidity from January to June 2016 are presented in the following table:

Table 5.14-1: Meteorological Data for Jan - June 2016

	Relative Humidity (%)	Windspeed (m/s)	Rainfall (mm)
January	76.628	1.199	-
February	37.803	0.837	-
March	79.097	0.948	-
April	88.450	1.390	0.177
May	70.407	0.849	1.203
June	-	-	10

6.1.2 Air Quality

The Tactical Air Sampler measures dust levels at the facility over 24hour periods, collecting data for $PM_{2.5}$ or PM_{10} depending on what it has been set to record.

Figure 5.14-3: Installation of Tactical Air Sampler at Charlie 4 Gate

Filter paper inserted into the sampler is weighed before insertion, and again after the 24 hour sample period, in order to determine the total dust gathered. The weight of the dust collected on the filter paper is inserted into a formula which is used to calculate the dust concentration.

Figures obtained are compared to the WHO thresholds for $PM_{2.5}$ or PM_{10} dust levels. During the first half of 2016, dust measurements were taken in January, February, April and May; results are shown below:

Table 5.14-2: PM2.5 Measurements in January

Field data log	Charlie 4 ($PM_{2.5}$)
Date/Time Installed	08:45 12/01/ 2016
Date/Time completed	08:45 12/01/ 2016
Elapsed 'Start time	625.4
Elapsed 'End' time	649.4
Flow adjustment	6lpm
Weight of filter before sampling	0.0002g (200µg)
Weight of filter after sampling	0.0004g (400µg)
Final weight of filter paper	0.0002g (200µg)
PMact	22.8µg/m^3

Table 5.14-3: PM2.5 Measurements in February

Field data log	Charlie 4 (PM2.5)
Date/Time Installed	08:45 12/02/ 2016
Date/Time completed	08:45 12/02/ 2016
Elapsed 'Start time	723.3
Elapsed 'End' time	747.3
Flow adjustment	6lpm
Weight of filter before sampling	0.0002g (200µg)
Weight of filter after sampling	0.0005g (500µg)
Final weight of filter paper	0.0003g (300µg)
PMact	34.2µg/m^3

Table 5.14-4: PM10 Measurements in April

Field data log	Charlie 4 (PM_{10})
Date/Time Installed	09:30 07/04/ 2016
Date/Time completed	09:30 08/04/ 2016
Elapsed 'Start time	749
Elapsed 'End' time	773
Flow adjustment	6lpm
Weight of filter before sampling	0.0002g (200µg)
Weight of filter after sampling	0.0006g (600µg)
Final weight of filter paper	0.0004g (400µg)
PMact	45.62µg/m^3

Table 5.14-5: PM2.5 Measurements in May

Field data log	Charlie 4 ($PM_{2.5}$)
Date/Time Installed	10:30 08/05/ 2016
Date/Time completed	10:30 09/05/ 2016
Elapsed 'Start time	773
Elapsed 'End' time	797
Flow adjustment	6lpm
Weight of filter before sampling	0.0002g (200µg)
Weight of filter after sampling	0.0005g (500µg)
Final weight of filter paper	0.0003g (300µg)
PMact	34.21µg/m^3

The WHO air quality standards stipulate the following 24-hourly mean levels as maximum thresholds:

PM_{10} - 50µg/m^3

$PM_{2.5}$ - 25µg/m^3

Results indicate that $PM_{2.5}$ thresholds were exceeded in February and May. Mitigation measures implemented include site watering and enforcement of respiratory PPE usage in dusty areas.

6.1.3 Noise

Noise generated at the facility is as a result of blasting (seismic activity) and general operational activities (machinery, etc).

Seismic Monitoring

Seismic monitoring is conducted whenever a blasting exercise is carried out. The seismic monitoring system consists of four Nomis mini Seismographs, each assigned to a definite seismic monitoring station to record Peak Particle Velocity (PPV in mm/s) and airblast in decibels (dBL).

Three (3) monitored blasting events occurred during March 2016, of which the most intense recorded vibration indices were:

PPV: 7.82 mm/s (14th March) – Below Safe Level of Vibration (SMS1)

Airblast: +127dBL (14th March) - Below Threshold (SMS1)

No damages as a result of blast induced seismicity were recorded.

Operational Noise Monitoring

Occupational noise levels are measured using a 4-in-1 Environmental Test Meter which also measures relative humidity, temperature and light. This equipment was recently acquired and data collection commenced in April.

Table 5.14-6: Noise Measurements in April

		Week 1				
		Parameter				
No.	Location	dB-A	dB-A Hi	dB-C Hi	dB-C Lo	Ave Total
1	Camp/ Dyke zone A-N1	64.7	71.7	65	64.8	68.2~64.9
2	Area D/ Canteen-N2	56.6	65.8	70.1	70.7	61.2~70.4
3	Plant- tyre cycle-N3	89.9	63.9	78.9	70.6	76.9~74.8
4	Charlie-1-gate-N4	75.3	66.8	87.1	67.7	71.01~77.4
5	Post office/Opera- N5	69.2	84.4	95	84.3	76.8~89.7
6	Bricks Plants-N6	76.8	65.9	67.3	73.1	71.35~70.2
7	Kimbadu-N7	59	65.5	84.8	66.7	62.3~75.8
		Week 2				
		Parameter				
No.	Location	dB-A Lo	dB-A Hi	dB-C Lo	Db-C Hi	Ave Total
1	Camp/ Dyke zone A-N1	77.1	82.2	82.2	94.3	79.7~88.2
2	Area D/ Canteen-N2	55	58.5	68.9	70	56.8~69.5
3	Plant- tyre cycle-N3	61.1	78.1	78	91.2	69.6~84.6
4	Charlie-1-gate-N4	49.3	66.4	66.4	86.3	57.9~76.5
5	Post office/Opera- N5	86.3	107.5	107.4	111.5	96.9~109.5
6	Bricks Plants-N6	77.5	59.5	60.9	68.5	68.5~64.7
7	Kimbadu-N7	50.9	70	69.9	84.3	60.5~77.1
		Week 3				
		Parameter				
No.	Location	dB-A Lo	dB-A Hi	dB-C Hi	dB-C Lo	Ave Total
1	Camp/ Dyke zone A-N1	75.8	88.9	89.9	77.8	82.4~88.3
2	Area D/ Canteen-N2	67	69	70	55.9	68~62.95
3	Plant- tyre cycle-N3	90.7	76.8	88.9	98.5	83.8~93.7
4	Charlie-1-gate-N4	77	85	80	74	81~77
5	Post office/Opera- N5	100	99	101	120	99.5~110.5
6	Bricks Plants-N6	60	68	59	68	64~63.5
7	Kimbadu-N7	50	55	53	45	52.5~49

Table 5.14-7: Noise Measurements in May

			Week 1			
					Parameter	
No.	Location	dB A-Lo	dB-A Hi	dB-C Lo	dB-C Hi	Ave Total
1	Camp/ Dyke zone A-N1	47.6	68.9	86.7	88.4	58.3~87.6
2	Area D/ Canteen-N2	50	68.8	68.8	84.7	59.4~76.8
3	Plant- tyre cycle-N3	70.2	81	80.9	93.3	76~87.1
4	Charlie-1-gate-N4	58.4	77.4	77.4	91.6	68~85
5	Post office/Opera- N5	91.2	93.3	93.2	104.4	92.3~99
6	Bricks Plants-N6	48.3	70.4	70.4	75.9	59.4~73.2
7	Kimbadu-N7	69.7	76.2	76.2	87.3	74.8~81.8
		Week 2				
				Parameter		
No.	Location	dB-A Lo	dB-A Hi	dB-C Lo	Db-C Hi	Ave Total
1	Camp/ Dyke zone A-N1	55	66.5	86.7	88.4	60.8~87.6
2	Area D/ Canteen-N2	45	66.4	68.8	84.7	57~76.8
3	Plant- tyre cycle-N3	75	80.5	80.9	93.3	80.7~87.1
4	Charlie-1-gate-N4	54	77	77.4	91.6	65.5~84.5
5	Post office/Opera- N5	94	90	93.2	104.4	92~98.8
6	Bricks Plants-N6	52.5	69.8	70.4	75.9	61.2~73.2
7	Kimbadu-N7	66.8	77.8	76.2	87.3	72.3~81.8
			Week 3			
			Parameter			
No.	Location	dB-A Lo	dB-A Hi	dB-C Hi	dB-C Lo	Ave Total
1	Camp/ Dyke zone A-N1	40.9	68.7	88.7	86	54.8~87.4
2	Area D/ Canteen-N2	40.8	55.8	55.4	80.5	48~68.9
3	Plant- tyre cycle-N3	66.8	80.9	78.5	90	79.7~84.3
4	Charlie-1-gate-N4	49.9	78.7	77.5	90	64.3~83.8
5	Post office/Opera- N5	89.5	88.8	90.5	104.9	89.2~97.7
6	Bricks Plants-N6	55.5	66.8	69.9	70	61.2~70.8
7	Kimbadu-N7	68.9	70.4	76	80	69.7~78

The maximum prescribed safe noise level in industrial areas is 85dB. Noise levels in most areas measured are within safe limits for workers. Consistently high readings above the recommended levels were however recorded in the Post Office/Opera - N5 area. Workers in this area should always use noise protective PPE and exposure to these levels should not exceed 8 hours per day. The upper ranges of measurements taken in other areas such as Camp/Dyke zone A - N1 and the Plant - tyre cycle - N3 also exceeded recommended limits.

6.1.4 Ecology (Fauna and Flora)

The partial degradation of natural vegetation and habitat for animal life had already taken place within the surrounding environment due to current land use practices which include artisanal mining and slash and burn farming practices. The destruction of the areas with remaining natural wooded grassland and secondary forest areas initially resulted in the permanent reduction of natural habitat of reptiles, birds, frogs, insects and mammals present within the areas. The secondary forest, wooded grassland and

surrounding vegetation had offered habitat to certain birds, reptiles, frogs, insects and mammals that could be present.

Some of the ecological system was impacted by the initial site clearance. Biodiversity was thus reduced and the total ecological system changed.

The placement of the tailings dump and slimes dam resulted in the direct loss of wetland areas which had been severely degraded by agriculture, historical commercial and artisanal mining activities, as well as current illegal artisanal mining.

The general ecological situation is now much improved. Currently the monkey hill forest is regenerating itself since the completion of the mine enclosure 3 meter high 10 kilometres gabion wall which was completed in 2012. There are no more illegal tree falling /charcoal burning activities within the mine concession and hunting wild life. There has been a significant increase in the population of resident wild life of the Monkey Hill like monkeys, antelope, deer, pythons, cobra's, black and green mamba's, bush cats, wild Guinea fowls ,local predators (birds of prey), monitor lizards, and common cutting grass.

The water lakes within the concession are now teaming with local verity of fish and this is a good indicator that the waters are clean and productive to support the growing wild life.

The green forest and the abundance of wild fruits and old banana and mangos/oranges left from the farms are now supporting the wild life.

Killing of any wildlife either snakes, fish, birds or animal is prohibited and if caught is the sack from the mine. This is KL's way of protecting the environment and wildlife for the future generation to see and enjoy as part of our living heritage.

6.1.5 Aquatic Environment

Assessments of the aquatic environment are carried out periodically as part of the company's Bio-monitoring plan.

The surveys usuall involve the use of indicators, indicator species or indicator communities; generally benthic macro invertebrates, fish, and/or algae are used. Areas investigated during this exercise include:

Name/site	X-Coords	Y-coodrs	Z-coords
Dyke zone A	281896	954076	320
Dyke zone B	282513	954490	371
Habitat at wokshop	283694	954212	329
Slime dam	283617	953301	346
Habitat back of dyke zone A	281764	953940	350
Habitat close to monkey hill mesh	282260	9538000	322

Monitoring equipment and instruments used include:

- ✓ Fishing hook and line
- ✓ Digital camera

Results of the aquatic assessment conducted in the January to March 2016 quarter is given in the following table:

Table 5.14-8: Results of Fish Species Caught during Aquatic Assessment

Site Name	Date/Time identified	Scientific name	Common name	Range in length (cm)	Range in width(cm)
Slimes Dam	19/01/2016-08:40:00 AM	tilapia zilli	Tilapia	22cm	9cm
Slimes Dam	19/01/2016-08:50:00 AM	tilapia zilli	Tilapia	22cm	9cm
Slimes Dam	19/01/2016-08:50:00 AM	tilapia zilli	Tilapia	22cm	9cm
Slimes Dam	19/01/2016-08:30:00 AM	tilapia zilli	Tilapia	22cm	9cm
Slimes Dam	19/01/2016-09:10:00 AM	tilapia zilli	Tilapia	21cm	9cm
Slimes Dam	19/01/2016-10:35:00 AM	tilapia zilli	Tilapia	21cm	9cm
Slimes Dam	19/01/2016-10:45:00:AM	tilapia zilli	Tilapia	21cm	9cm
Slimes Dam	19/01/2016-10:50:00 AM	tilapia zilli	Tilapia	21cm	9cm
Slimes Dam	19/01/2016-11:00:00 AM	tilapia zilli	Tilapia	24cm	7.9cm
Slimes Dam	19/01/2016-11:35:00: AM	tilapia zilli	Tilapia	24cm	9.9cm
Slimes Dam	19/01/2016-11:40:00: AM	tilapia zilli	Tilapia	21cm	8cm
Slimes Dam	19/01/2016-11:45:00: AM	tilapia zilli	Tilapia	20cm	8cm
Slimes Dam	19/01/2016-11:50:00 AM	tilapia zilli	Tilapia	17cm	8cm
Slimes Dam	19/01/2016-11:55:00 AM	tilapia zilli	Tilapia	17cm	8cm
Slimes Dam	19/01/2016-12:10:00 AM	tilapia zilli	Tilapia	17cm	8cm
Slimes Dam	19/01/2016-12:20:00 AM	oreochromis urolepis	Wami Tilapia	16cm	5cm
Slimes Dam	19/01/2016-12:30:00 AM	oreochromis urolepis	Wami Tilapia	16cm	5cm
Slimes Dam	19/01/2016-12:35:00 AM	oreochromis urolepis	Wami Tilapia	16cm	4cm
Slimes Dam	19/01/2016-12:40:00 AM	oreochromis urolepis	Wami Tilapia	16cm	4.5cm

Site Name	Date/Time identified	Scientific name	Common name	Range in length (cm)	Range in width(cm)
Slimes Dam	19/01/2016-12:50:00 AM	tilapia zilli	Tilapia	10cm	6cm

Figure 5.14-4: Fish Survey Exercise (Tilapia Zilli Catch)

6.1.6 Hydrology and hydrogeology

The general water table in the area which before u/g mining was close to the surface as evidenced by the numerous swamps in the vicinity will be affected by the draw down in the water table caused by the cone of depression. A zone to enhanced hydraulic conductivity between dykes A and B is situated to the east and west of the k1 pipe (elevation between 250 and 300 meters asl). Water is pumped out of boreholes around pipe K2 have been supplied to Township residents for Domestic use. The water quality is good as evidenced by the various tests carried out on the water quality by accredited labs.

6.1.7 Surface Water

Surface water quality monitoring is carried out in the artificial lakes and streams within the KL concession. Insitu measurements are taken using the Oaklon Waterproof Meter to measure the parameters temperature, pH and conductivity. Data is collected to create a database for reference purposes, so that any change in normal values can be easily identified and its cause traced. Data collected from January to June 2016 are presented in the following tables:

Table 5.14-9: January Surface Water Quality Data

		Week 1			Week 2			Week 3		
		Parameter			Parameter			Parameter		
No.	Location	Conductivity(µS)	PH	Temp (Ĉ)	Conductivity(µS)	PH	Temp (Ĉ)	Conductivity(µS)	PH	Temp (Ĉ)
1	Slimes dam	128	7.4	29.9	120	7.8	28.7	170	7.8	29.9
2	Monkey Hill stream	146.5	8.1	30	144	8.4	27.5	156	8.4	30
3	Dyke Zone B	713.4	7.9	29.7	711.2	8	28	701	8	29.7
4	Waste dump	211	6.9	30.2	213	7.2	29.5	215	7.2	30.2
5	Canteen	121	8	28.8	116	7.9	30.7	161	7.9	26.8
6	Brick Plant	19.9	8.2	28.3	20.4	8.2	29.5	30.8	8.2	28.3
7	Lake at Training	under construction					under construction			
8	Old camp	359	8	27.5	335	8	27	376	8	27.5
9	Office	77.7	6	27.5	80.4	6.6	30.5	81.4	6.5	28.5
10	Koidu maitenance	125	6.18	26.5	135	6.5	26	128	6.5	28.5

Table 5.14-10: Febraury Surface Water Quality Data

		Week 1			Week 2			Week 3		
		Parameter			Parameter			Parameter		
No.	Location	Conductivity(µS)	PH	Temp (Ĉ)	Conductivity(µS)	PH	Temp (Ĉ)	Conductivity(µS)	PH	Temp (Ĉ)
1	Slimes dam	442	7.4	27.4	554	7.27	25.4	450	7	27.5
2	Monkey Hill stream	150	8.1	30.5	200	6.45	26.5	200	7.5	28.9
3	Dyke Zone B	721	7.12	29.7	712	7.9	27.8	713	7.4	27.8
4	Waste dump	200	6.9	30.2	148	8	27.8	150	6.8	28
5	Canteen	121	8	28.8	108	6.8	29.9	122	6.8	28.9
6	Brick Plant	197	8.2	30.2	177	6.8	26.3	190	6.5	27.8
7	BME	308	7.62	27.7	300	7.42	27.6	315	7.5	27
8	Old camp	122	8	26.9	132	8.6	27.5	120	6	28.8
9	Office	77.7	6	30.1	71	6.38	26.8		7	28.5
10	Koidu maitenance	122	6.18	26.5	98	6.25	27.3		6.9	27.8

Table 5.14-11: April Surface Water Quality Data

Koidu Limited Conductivity,Temperature and PH values for April, 2016.

Week 1				Week 2			Week 3		
	Parameter			Parameter			Parameter		
Location	Conductivity(µ	PH	Temp (Ĉ)	Conductivity(µS)	PH	Temp (Ĉ)	Conductivity(	PH	Temp (Ĉ)
Slimes dam	130	7	30	155	8	28	198	7	27.6
Monkey Hill stream	146.5	8.1	25	156	8.2	27.8	145	8.4	26
Dyke Zone B	713.4	7.9	29.4	650	8	28.9	713	8	26
Waste dump	190	6.9	24.5	177	7	7.2	168	7.2	29.5
Canteen	120	8	7	121	8	27.5	131	8	30
Brick Plant	19.9	8.2	26.4	30.8	8	26.9	198	8.2	28.5
BME	212	8.3	28.5	220	8.3	30	250	8.3	26.7
Fuel yard	120	8	28.9	125	7.9	28.8	122	8	25
Office	77	7.9	28.7	74.5	8	27.8	77.7	6.5	27.5
Koidu maitenance	123	8	26.8	133	8.5	28	122	7.5	26.8

Table 5.14-12: May Surface Water Quality Data

Koidu Conductivity,Temperature and PH values for May, 2016.									
	Week 1			Week 2			Week 3		
	Parameter			Parameter			Parameter		
Location	Conductivity(µS)	PH	Temp (Ċ)	Conductivity(µS)	PH	Temp (Ċ)	Conductivity(µS)	PH	Temp (Ċ)
Slimes dam	125	7	27	140	7.5	30.3	450	7	27.5
Monkey Hill stream	140	8.1	26	140	8,5	26	200	7.5	28.9
Dyke Zone B	712	7.9	31	710	8	26	713	7.4	27.8
Waste dump	185	6.9	25.8	160	7.2	29.5	150	6.8	28
Canteen	122	8	8	121	8	30	122	6.8	28.9
Brick Plant	19	8.2	26.4	188	8.2	28.5	190	6.5	27.8
BME	222	8.3	28.5	212		26.7	315	7.5	27
Fuel yard	120	8	28.9	121	8.8	25	221	7	28.8
Office	76	7.9	28	78	7	27.5	81	8	28.5
Koidu maitenance	125	8	27.8	122	7.5	26.8	100	7	27.8

Table 5.14-13: June Surface Water Quality Data

Koidu Conductivity,Temperature and PH values for June, 2016.									
	Week 1			Week 2			Week 3		
	Parameter			Parameter			Parameter		
Location	Conductivity(µS)	PH	Temp (Ċ)	Conductivity(µS)	PH	Temp (Ċ)	Conductivity(µS)	PH	Temp (Ċ)
Slimes dam	125	7	27	122	7.5	28	125	8	26.7
Monkey Hill stream	140	8.1	26	138	8	27	144	7.75	27.5
Kitchen	712	7.9	31	710	7	28	355	29.3	7.12
Waste dump	185	6.9	25.8	177	7	25	266	6.85	30
Canteen	122	8	8	121	6.8	29	75.4	6.05	25.6
Brick Plant	19	8.2	26.4	18	7.98	25	242	7.3	27
BME	222	8.3	28.5	200	26	27	377	7.34	27.8
Fuel yard	120	8	28.9	198	7	28	373	7.5	28.1
Office	76	7.9	28	77	8	29	65.6	6.52	29.5
Koidu maitenance	125	8	27.8	120	6	25	90.3	6.78	25

6.1.8 Groundwater

Groundwater quality and quantity monitoring is carried out monthly on boreholes within the concession and neighbouring communities.

Water samples are collected from these boreholes and sent the Salwaco Laboratory in Freetown for testing.

Water levels are monitored using the dip meter sensor which has a sensor fitted to the end of the tape which beeps when contact is made with water.

Figure 5.14-5: Dip Meter with Sensor

Figure 5.14-6: Dip Meter in Use

6.1.8.1 Groundwater Quality

Water samples are taken periodically from various boreholes within the mine concession and from the community, and sent to the SALWACO Laboratory in Freetown for physical, chemical and bacteriological testing. Details of tests carried out in June 2016 are given below.

Laboratory Analyses

Water Bacteriology:

The determination of faecal coliforms on both samples was done by the membrane-filtration technique using the POTA Lab Kit. Samples bottles for water collection were washed clean with laboratory detergent and rinsed with tap water, Three volumes of water samples (10ml, 20ml, 50ml,) were measured and filtered through Millipore filter pads with pore size 0.45µm in the pre-sterilized filtration unit assembly. These filter pads will trap any bacteria present in the water samples. These pads were then removed with forceps and placed on top of a filter membrane soaked in membrane faecal coliform broth in pre-sterilized Petri dishes. The Petri dishes were later incubated for 18 – 24 hr at 44^{o}C in the incubator of the Oxfam DelAqua Kit after 60min resuscitation period. Faecal coliforms were identified by the formation of blue colonies on the filter pads while non-faecal coliforms formed pink colonies. These colonies are counted methodically and results expressed per 100ml water sample.

Physical Water Analysis:

This was done using portable laboratory instruments. The HACH Multi-portable conductivity meter (CO150) and pH meters (EC!) were used to test for water conductivity, pH, DO, TDS and Temperature. These instruments had been calibrated prior to taking measurements in the field. The probes of these instruments were dipped into the water samples according to the instruments manuals and measurements taken. These readings were also saved in the instruments memory. Turbidity measurement was done using the Turbidity meter, Readings were taken directly and values entered into the monitoring forms provided.

Chemical Analysis:

Chemical analysis was done by Spectrophotometric method using the HACH DR/2800 Spectrophotometer. Analytical procedures were in accordance with procedures outlined in the HACH Water Analysis Handbook, 4th Edition.

Ferrous iron was determined quickly on spot using the 1,10 Phenanthroline method to prevent the oxidation of ferrous to ferric iron which is not determined. The Spectrophotometer was prepared for measurement by entering the stored programme number of 255 for dissolved iron and adjusting the light wavelength to 510nm. The HACH ferrous iron reagent powder pillow was added to about 10ml water sample in the sample cuvet. A blank sample also prepared without the iron reagent powder. After a 5-min reaction time, the blank sample was placed into the cell holder of the spectrophotometer for zeroing the instrument. This was removed and replaced with the prepared sample. Test result were recorded in mg/l.

Copper was determined using the bicinchoninate method at light wavelength 560nm. The spectrophotometer was prepared for analysis by using the stored programme number of 135. No prior digestion of the water sample was necessary since the sample was analysed immediately after collection on the spot. The content of one CuVer 1 copper reagent powder pillow was added to about 10ml water sample in the sample cell and swirled to mix. A two-minute reaction time was allowed. A blank sample cell containing deionsed water was used to zero the Instrument after which the prepared sample was measured. Results were recorded in mg/l.

The Periodate Oxidation method was used to determine manganese in solution at light wavelength of 525nm. About 10ml water samples were put into the sample cell and the contents of one buffer powder pillow, citrate type, added. This was swirled to mix. Next was added the contents of one sodium periodate powder pillow into the sample cell and swirled to mix thoroughly. After a two-minute reaction time, a blank sample cell with deionised water was used for zeroing before the prepared sample was measured in mg/l.

Nitrate-nitrogen was determined using the cadmium Reduction method at light wavelength of 400mm. A 10ml sample cell was filled with the water sample and another sample cell with deionised water. This was used as the sample blank. The contents of one Nitra Ver 5 nitrate reagent powder pillow were added to the cell with the water sample. After a total of five minutes reaction time, the sample cell with deionised water was used for zeroing the Instrument before the prepared sample was measured in mg/l N-N.

Sulphide was determined using the Sulfi Ver 4 method at light wavelength of 450nm. A clean sample cell was filled with about 10ml of the filtered water sample. The contents of Sulfi Ver 4 reagent powder pillow was added to this cell and swirled to mix. After a five-minute reaction time, a second sample cell was filled with 10ml water sample and used as the blank for zeroing. The prepared sample was than measured in mg/l.

Fluoride was determined using the SPADNS method at light wavelength of 580nm. About 10ml water sample was measured into one sample cell and 10ml deionised water into the second sample cell. About 2ml of SPADNS solution was measured into each sample cell and a one-minute reaction time allowed.

The cell with the deionised water was used for zeroing before the prepared sample was measured in mg/l F^-.

The DPD Method was used to determine residual or free chlorine in the water sample at light wavelength of 530nm. About 10ml water samples were filled into two 10ml sample cells. One was used as blank and into the other cell was added the contents of one DPD free chlorine powder pillow and mixed for 5min. The blank cell was for zeroing the Instrument before the prepared sample was measured sample was measured in mg/l CI_2.

Calcium hardness was determined using the titration method of 10nm. Sample, was used to fill the sample cell and calval 2 reagent was used, the results were then extrapolated from a calibration chart provided.

6.1.9 Results

The laboratory results are highlighted in the following tables:

			Analyte Name	Temperature	pH	Turbidity	D O	Conductivity	T D S
			Units	oC	mg/L	NTU		µS/cm	mg/L
			Detection Limit WHO	No Value	6.5 - 8.5	5		<450	<248
Description	**Sample Date**	**Matrix by Product**	**Source**						
KLB 001	15/06/2016	WATER	x	27.4	7.4	1.4	1.1	260	130
KLB 002	15/06/2016	WATER	x	27.4	6.4	2.4	0.9	262.	131.
KLB 005	15/06/2016	WATER	x	27.1	6.3	0.4	1.3	67.6	33.8
KLA 006	15/06/2016	WATER	x	27.2	6.4	1.	1.3	193.4	967.
KLA 007	15/06/2016	WATER	x	27.2	6.3	6.8	1.1	208.	104.
KLA 008	15/06/2016	WATER	x	27.	6.5	0.4	1.	306.	153.

			Analyte Name	Suspended Solids	Flouride	Chloride	Nitrate	Nitrat/Nitrogen	Nitrite
			Units	mg/l	mg/L	mg/L	mg/L	mg/L	mg/L
			Detection Limit WHO		<1.5	<250	<10	10	3
Description	**Sample Date**	**Matrix by Product**	**Source**						
KLB 001	15/06/2016	WATER	x	0.06	1.24	10.	1.	0.23	2.
KLB 002	15/06/2016	WATER	x	4.	1.32	10.	15.	3.41	2.
KLB 005	15/06/2016	WATER	x	0.06	0.83	5.	15.	3.41	0.1
KLA 006	15/06/2016	WATER	x	0.01	1.11	7.	2.	0.45	0.2
KLA 007	15/06/2016	WATER	x	5.	1.	8.	15.	3.41	1.45
KLA 008	15/06/2016	WATER	x	0.06	0.64	15.	12.	2.73	3.

			Analyte Name	Phosphate	Bicarbonate	Potassium	Calcium Hardness	Ammonia	Silica
			Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
			Detection Limit WHO	20	No.value	6	250	No.value	15
Description	**Sample Date**	**Matrix by Product**	**Source**						
KLB 001	15/06/2016	WATER	x	0.06	0.	0.	10.	0.	0.11
KLB 002	15/06/2016	WATER	x	0.	0.	0.1	9.	0.	0.
KLB 005	15/06/2016	WATER	x	0.25	0.	0.02	5.	0.	0.
KLA 006	15/06/2016	WATER	x	0.13	0.	0.01	6.	0.	0.03
KLA 007	15/06/2016	WATER	x	0.47	0.	0.3	9.	0.	0.
KLA 008	15/06/2016	WATER	x	0.18	0.	0.1	13.	0.	0.

			Analyte Name	Aluminium	Iron	Copper	Zinc	Arsenic	Manganese
			Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
			Detection Limit WHO	0.2	0.3	2	5	0.01	0.4
Description	**Sample Date**	**Matrix by Product**	**Source**						
KLB 001	15/06/2016	WATER	x	0.11	0.04	0.01	0.13	0.	0.
KLB 002	15/06/2016	WATER	x	0.12	0.02	0.06	0.11	0.	0.02
KLB 005	15/06/2016	WATER	x	0.15	0.	0.05	0.12	0.	0.05
KLA 006	15/06/2016	WATER	x	0.12	0.	0.09	1.17	0.	0.03
KLA 007	15/06/2016	WATER	x	0.12	0.02	0.06	1.5	0.	0.
KLA 008	15/06/2016	WATER	x	0.17	0.	0.03	2.21	0.	0.06

			Analyte Name	Magnesium	Cyanuric Acid	Free Chlorine	Total Chlorine	Chromium	Bromine
			Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
			Detection Limit WHO	200		0.3-0.5		0.05	No Value
Description	**Sample Date**	**Matrix by Product**	**Source**						
KLB 001	15/06/2016	WATER	x	9.	0.	0.	0.	0.06	0.1
KLB 002	15/06/2016	WATER	x	9.	0.	0.	0.	0.02	0.1
KLB 005	15/06/2016	WATER	x	4.	0.	0.	0.01	0.	0.
KLA 006	15/06/2016	WATER	x	7.	0.	0.	0.	0.	1.2
KLA 007	15/06/2016	WATER	x	11.	0.	0.	0.01	0.06	1.4
KLA 008	15/06/2016	WATER	x	20.	0.	0.	0.01	0.05	1.6

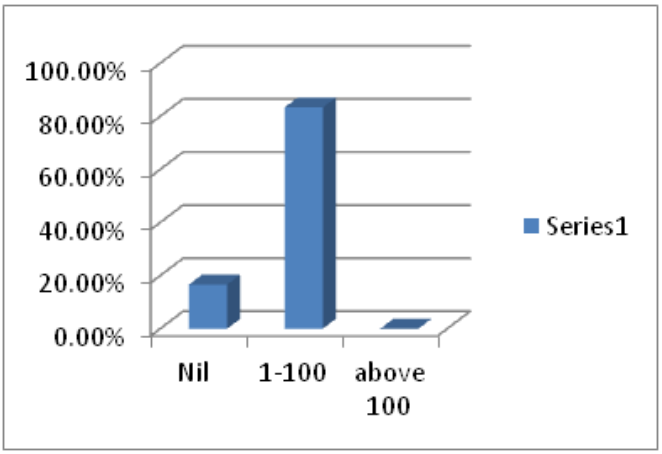
			Analyte Name	Molybdate	Sulphate	Sulphide	Molybdenum	E-Coli	Faecal Coli	Non-Faecal
			Units	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l
			Detection Limit WHO	0.25	<400	0.5	0.25	zero	zero	10
Description	**Sample Date**	**Matrix by Product**	**Source**							
KLB 001	15/06/2016	WATER	x	0.06	5.	0.07	0.05	0.	80.	20.
KLB 002	15/06/2016	WATER	x	0.04	4.	0.04	0.03	0.	40.	16.
KLB 005	15/06/2016	WATER	x	0.03	8.	0.03	0.02	0.	4.	16.
KLA 006	15/06/2016	WATER	x	0.06	5.	0.05	0.05	0.	Nil	Nil
KLA 007	15/06/2016	WATER	x	0.15	14.	0.03	0.12	0.	TNTC	Nil
KLA 008	15/06/2016	WATER	x	0.05	20.	0.03	0.03	0.	Nil	TNTC

Discussion of Results

Faecal indicator Bacteria: Faecal coliforms are a group of intestinal tract microbes and their presence in drinking water sources is an indication of faecal contamination. According to the World Health Organization (***WHO***), these bacteria should not occur repeatedly in drinking water and therefore recommended **zero** faecal coliforms counts per 100-ml water sample. Although data in this report were obtained from single analysis of water samples, they are nevertheless useful indicators of the chemical and bacteriological quality of drinking water sources monitored thus far.

Details of faecal coliforms detected in samples taken are as follows:

Faecal Coliforms counts per 100ml water sample	Percentage of water sources
Nil	16.6%
1 -100	83.33%
Above 100 (NTU)	0%
Total percentage	100%

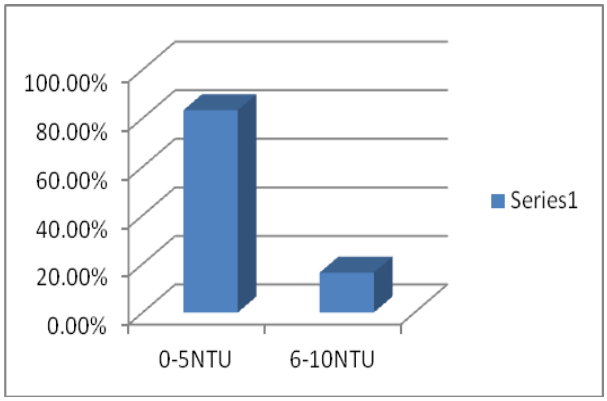


Turbidity

This is caused by suspended particles as clay, silt, organic and inorganic matter, plankton and other micro organisms in water. Turbidity is thus a measure if water clarity. Although turbidity does not have a direct effect on health, it reduces the effectives of disinfection procedures. Micro- organisms can be shielded from disinfections by suspended matter. Highly turbid water can lead to user rejection of water source purely for aesthetic reasons. According to **WHO**, the threshold at which at turbidity can be detected in water by the naked eye is above **5 NTU**.

Sample KLA 007 had water turbidity above 5NTU. All the other sources were clear. The table below shows the percentage of water sources with clear water:

Turbidity	Percentage of water sources
0 - 5NTU	83.33%
6 – 10NTU	16.6%
Above 10NTU	0%
Total percentages	100%



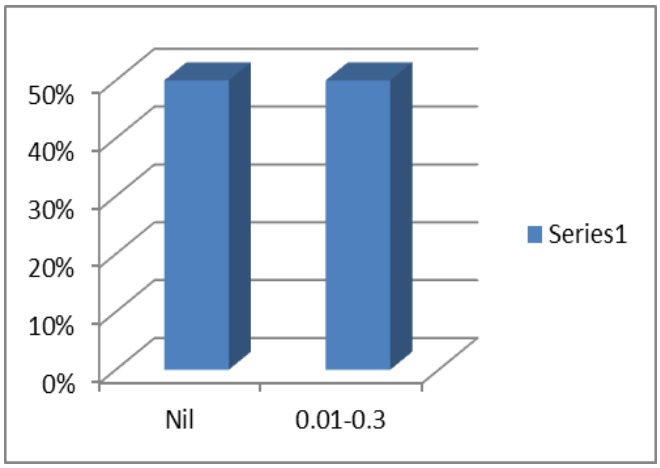
Dissolved Chemicals

Iron: This is present in natural water in the form of ferrous or soluble or state, which is easily oxidized to ferric. Iron in domestic supply stain cloths and gives a stringent taste to water causing more of a nuisance than health hazard. Although iron needed for blood formation, very high levels can impact negatively on the liver.

Taste threshold of iron water is 0.3mg/l according to the WHO. Above this, staining and taste conditions will lead user to reject water.

Low iron content was discovered in all the water sources monitored.

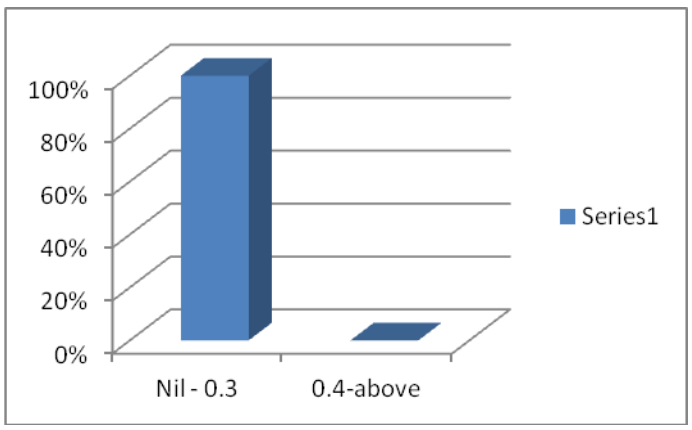
Iron concentration (mg/l)	Percentage of water sources
Nil	50%
0.01 – 0.3	50%
Above 0.3	0%
Total percentage	100%



Manganese: This is present in groundwater as the divalent ion (Mn^{2+}). High concentration of manganese in water cause dark stains in laundry and plumbing fixtures. It imparts an objectionable taste to beverage and tea. Manganese presents more of an economic problem than health hazard. In nature waters manganese rarely exceeds **1.0mg/l,** but levels above **0.1 mg/l** are sufficient to cause taste and staining problems. Maximum allowable limits in groundwater is therefore 0.4mg/l with total iron plus manganese content not to exceed **0.3mg/l.**

All the sources had low concentration of manganese.

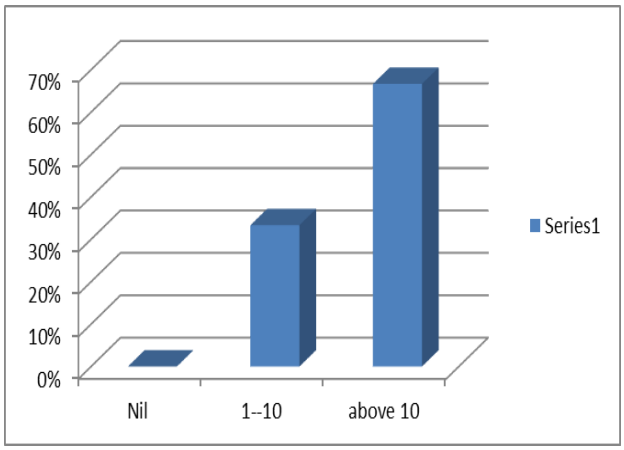
Manganese concentration (mg/l)	Percentage of water sources
Nil –0.3	100%
0.4 – above	0%
Total percentage	100%



Nitrate: Nitrate represents the oxidized form of nitrogen commonly found in water. High level of nitrate is indicative of biological waste in stages of stabilization from heavily fertilized fields. Drinking water containing high amounts of nitrate can cause infant methemoglobenaemia (blue babies). Thus the maximum allowable limit is ***10mg/l Nitrate –***

Nitrogen ion concentrations in all the water sources were far above the threshold. Only KLA 001 and KLB 006 had low nitrate.

Nitrate concentration (mg/l)	Percentage of water sources
Nil	0%
1-1–	33.33%
above	66.66%
Total percentage	100%



Fluoride: Fluoride in drinking water sources has a direct effect on human health. Excess of it can lead to dental or skeletal fluorosis and its deficiency can cause dental caries. The maximum allowable limit is 1.5 mg/l. Fluoride ion concentrations were very minimal and within the permissible limits in all the Samples monitored. The Standard well at the health center had no fluoride.

6.1.9.1 Groundwater Quantity Results for January to June 2016

Readings taken at the various boreholes for the first part of this year are as follows:

Table 5.14-14: Groundwater Quantity Data - January

No.	Location	Week 1(m)	Week 2(m)	Week 3(m)	Week 4(m)
1	Old camp	27.90	25.40	30.2	26.50
2	Dyke zone	DRY	DRY	DRY	DRY
3	New camp	26.21	26.31	25.45	26.87
4	BME	6.00	5.00	5.45	4.89
5	New log	8.90	8.67	8	7.90
6	New clinic	8.89	7.00	7.9	6.75
7	Waste dump	5.00	5.80	6	5.00
8	Office	8.00	8.00	7.98	7.78
9	Brick plant	5.00	5.50	5.87	5.00
10	Fuel yard	7.00	7.50	7	7.50

Table 5.14-15: Groundwater Quantity Data - February

No.	Location	Week 1(m)	Week 2(m)	Week 3(m)	Week 4(m)
1	Old camp	37.45	40.20	45.52	46.00
2	Dyke zone	0.00	0.00	0.00	Dry
3	New camp	28.00	35.00	38.88	41.7
4	BME	7.00	7.92	8.4	8.80
5	New log	9.87	11.35	11.45	12.00
6	New clinic	9.00	9.15	10.8	10.00
7	Waste dump	6.00	7.54	8.4	8.90
8	Office	9.90	10.36	10.45	10.50
9	Brick plant	6.90	4.96	5.8	6.00
10	Fuel yard	7.80	7.78	8	8.50

Table 5.14-16: Groundwater Quantity Data - April

April-2016 water level in meters					
No.	Location	Week 1(m)	Week 2(m)	Week 3(m)	Week 4(m)
1	Fuel yard	7.92	7.50	8	7.89
2	Old camp	26.00	25.40	22.00	29.00
3	Brick Plant	7.50	7.00	5.5	7.00
4	New logistics	10.00	8.67	9.8	9.99
5	Waste dump	8.00	6.00	8	7.88
6	New clinic	9.62	10.00	9.9	9.47
7	Office	10.20	8.00	8	10.48
8	BME	7.45	5.00	6.5	8.74
9	New main camp	32.5	33.00	33.8	32
10	Dyke zone B	0.00	0.00	0.00	0.00

Table 5.14-17: Groundwater Quantity Data - May

May-2016 water level in meters					
No.	Location	Week 1(m)	Week 2(m)	Week 3(m)	Week 4(m)
1	Fuel yard	7.99	7.89	7	6.87
2	Old camp	25.00	24.50	21.00	21.00
3	Brick Plant	6.50	6.00	5.6	5.00
4	New logistics	9.00	8.99	8	7.88
5	Waste dump	8.50	8.45	8.2	8.00
6	New clinic	9.50	9.00	8.99	8.55
7	Office	9.00	9.25	9	9.10
8	BME	6.00	6.88	6	6.50
9	New main camp	30	30.50	29	29.46
10	Dyke zone B	0.00	0.00	0.00	0.00

Table 5.14-18: Groundwater Quantity Data - June

June-2016 water level in meters					
No.	Location	Week 1(m)	Week 2(m)	Week 3(m)	Week 4(m)
1	Fuel yard	8.00	7.00	7.69	7.00
2	Old camp	25.00	24.50	24.25	24.00
3	Brick Plant	5.60	5.50	5.25	5.00
4	New logistics	8.00	8.00	8.1	8.60
5	Waste dump	7.90	8.20	8	8.80
6	New clinic	8.50	8.80	8.27	8.20
7	Office	7.00	7.50	10.1	9.00
8	BME	6.70	5.00	4.43	4.00
9	New main camp	29	31.60	30	30.1
10	Dyke zone B	0.00	0.00	0.00	0.00

6.1.10 Subsidence

Worldwide, underground mining operations present land subsidence risks generally via the following mechanisms:

1. The creation of accommodation space at depth from the extraction of earthen material.
2. Possible re-activation of fault zones due to redistribution of stresses due to mining and
3. Sinkholes due to mine dewatering

Koidu Limited has considered all the above subsidence mechanisms and has simulated geotechnical scenarios under which subsidence could possible occur and the physical limits of subsidence were also statistically evaluated.

The most likely mechanism to initiate subsidence at Koidu Limited is ***mechanism 1*** and is not expected to extend beyond a 50m buffer from the current open pit limits.

6.1.11 Geotechnical considerations

All geotechnical investigations were concluded as part of the 2010 Koidu Limited Feasibility study by SRK South Africa and are still deemed valid for the proposed Koidu Limited underground mine design.

Country Rocks on the Koidu Limited mine property are predominantly granitic gneiss and exhibits an unconfined compressive strength of 133MPa which presents a reasonable factor of safety with regard to supporting the underground infrastructure. Joint planes are considerably cohesive with a negligible joint alteration index and minimal infilling hence the rock mass has been considered as competent to support underground infrastructure (This conclusion is based on an in depth geotechnical investigation).

Kimberlite ore is well known to have a high weathering index resulting in mud rushes in many underground mines around the world. The Koidu Limited hosted Kimberlite ore bodies are relatively competent and exhibits an unconfined compressive strength of 65MPa which is generally higher when compared on a global scale. The Kimberlite ore body is considered to be virgin ground at depth hence

no weathering or insitu decomposition is expected, this is evident from core recovered during the 2014 exploration drilling protocol carried out at Koidu Limited.

Rockmass behaviour during mining will be monitored using a micro-seismic monitoring system which is an early warning and predictive monitoring system which is sophisticated with regard to identifying high risk areas with a high level of accuracy and incorporates various alarm mechanisms ranging from and audible alarm system to automated sms and email alert protocols.

6.1.12 Major conclusions on the state of the receiving Environment

Most of the observations and measurements recorded in the Digby Wells ESIA have been borne out by quarterly monitoring tests.

The presence of the boundary wall or fence has eliminated any encroachment by artisanal miners.

The climate in the area is still typical of wet tropical monsoon with a single wet season each year between mid-May and mid-November. The average rainfall is still approximately 2 540 mm and the wettest months are still as predicated. Noise levels are mainly high in operational areas but steps are being taken to reduce levels to tolerable levels. Noise levels are highest during the blasting phase but this only lasts for a short period. Dust levels are high in residential areas close to operations but these are mitigated against by several measures undertaken.

there are still areas of soils in the uplands and the swamps within the project lease area that were previously mined out by historical and illicit artisanal mining prior to initiation of operations in 2003. The mining operations conducted by Koidu Limited. in the K1 pit have had a minimal to negligible impact on the soils in the lease area, as the total area affected by ore extraction from the kimberlite pipe is less than 0.5 hectares.

The rsults of the water quality monitoring indicate acceptable results and groundwater level reading show minimla influnce of operations on ground water levels.

7 DESCRIPTION OF SOCIAL ENVIRONMENT

7.1 Background

The Koidu Kimberlite Project was re-established in 2003, during which Sierra Leone was recovering from a brutal civil war. The war caused widespread destruction of infrastructure, dwelling structures and agricultural land particularly in the diamond rich Kono District. Kimberlite pipes near Koidu Town were left relatively untouched during this time; the exploitation of these requires considerable capital resources and technical expertise.

However, all mining equipment and infrastructure left on site at the beginning of the civil war were completely destroyed.

The resettlement of a significant number of households residing in the 2003 mining lease area required the development of a Resettlement Action Plan (RAP) for implementation prior to and during the exploitation of the deposits. A detailed RAP was developed in 2003, which was in line with the World Bank Standards at the time. In support of the RAP, a household and agriculture survey was undertaken with directly affected households and construction of replacement houses for affected households commenced in 2004.

From 2003 to 2007 the Koidu imberlite Project experienced various challenges in managing the impacts of the mine on surrounding communities. This was compounded by the need to maintain security, access control and a safe working environment in line with international norms for the diamond industry. In December 2007, mining operations were suspended for several months following civil unrest in the project area. The Sierra Leonean government subsequently reviewed the then mining lease agreement and after extensive consultation between stakeholders, a formal agreement between Koidu Holdings (KH) the Government of Sierra Leone, directly affected parties and the Tankoro Native Administration was signed in 2008. When mining activities resumed in 2008, a second household survey of the lease area was undertaken to ensure that all households within the 250 meter blasting buffer zone were surveyed. At present, all the households within the 2010 confirmed mining lease area have been surveyed and they form part of the 2003 RAP as amended and agreed upon in August 2009. A total of 144 replacement houses have been constructed between January 2004 and April 2011. Construction delays have plagued the resettlement process since 2004, with the result that 112 households still have to be resettled. Koidu Holdings has now adopted stringent measures in order to finalise the resettlement process. All replacement houses are provided with Ventilated Improved Pit latrines (VIPs) and shower facilities on the residential stand. All affected households have also been compensated for the loss of economic trees. Community facilities in the resettlement village include community taps, a market and a recreational field.

7.2 Political Context

The Republic of Sierra Leone is situated in West Africa. It is bordered by Guinea to the north and east, Liberia to the south-east, and the Atlantic Ocean to the west and south-west. The country covers a total area of 71,740 km2 and had an estimated population of 4.9 million in 2004 (Sierra Leone Population

and Housing Census, 2004) but according to the 2015 Housing and Population Census result, the population had increased to 7,075,641.

The British entered Sierra Leone in 1787 in search of natural resources and land for repatriated and shipwrecked slaves from Great Britain and the United States of America The country was established in 1792 and became a British colony in 1808. Under British colonial rule Sierra Leone became a major trading site, as well as a source of resources such as iron, palm kernel, diamonds, gold and chromites. Diamonds were unearthed in the Kono District of Sierra Leone since the 1930s.

During the mid 1950s, British rule gradually diminished as Great Britain handed over government responsibilities to the Sierra Leoneans. The country became independent in 1961.Over time, the government became increasingly centralised which resulted, amongst other factors, in the neglect of rural communities. Corruption, deprivation and the abuse of power have led to political instability and poor economic growth. This has led to the brutal and destructive civil war between 1991 and 2001. The war officially ended in 2002.

Sierra Leone held successful elections in 2007 and 2012 and is a pluralistic democracy.

7.3 Project Location

The Koidu Kimberlite Project is located in the Kono District of Sierra Leone. Kono District is situated in the eastern part of Sierra Leone. The administrative capital is Koidu Town. The District is bordered by Kenema and Kailahun districts to the south, Tonkolili and Koinadugu districts to the east and Koinadugu District to the north respectively. It has a land size of about 5,641 km² and is densely populated.

The Koidu Kimberlite Project is located near Koidu Town in the Tankoro Chiefdom of the Kono District. The project area is surrounded by six settlements, namely, New Sembehun, Saquee Town, Sokogbe, Swarray Town, Yormandu and Manjamadu (the resettlement site). These settlements fall within or border on the existing mining lease area. Other neighbouring settlements are Old Meama, Wordu and Kanya.

7.4 Administrative Framework

Administratively, Sierra Leone is divided into four distinct areas; the Northern Province with its headquarters in Makeni, the Southern Province with Bo as its headquarters, the Eastern Province with Kenema as its headquarters and the Western Area comprising the Freetown Peninsular with Freetown as its headquarters.

7.4.1 Provincial government

Provincial administration is governed by the Ministry of Local Government and Rural Development. The Minister is assisted by a Resident Minister in each of the provinces whose offices are in the respective provincial headquarter towns. The resident ministers are assisted by

provincial secretaries. Provinces are divided into districts which are divided into chiefdoms headed by Paramount Chiefs.

7.4.2 District government

The Kono District capital is Koidu Town (also referred to as Koidu-New Sembehun City in order to include more recent township additions). The District comprises 14 chiefdoms, 70 sections, eight parliamentarian constituencies and 29 wards and 36 townships. They are responsible for the overall management of the districts including the provision of critical social services to the population.

Local administrators assist the councils.

7.4.3 Local Government

Koidu Town is administered by the Koidu-New Sembehun City Council. The Council is one of 19 councils in the country constituted by the provision of the Local Government Act of 2004. Generally, mining surface rent payments are made to local authorities as compensation. Cash compensation is also paid for housing and cultivation within the surface rent area, should relocation of these be necessary.

7.4.4 Chiefdom

Districts are divided into chiefdoms. Each of the chiefdoms in Sierra Leone is headed by a Paramount Chief who is ultimately responsible for the administration, maintenance of law and order, and the development of his chiefdom. The Paramount Chief inherits custodian rights over the land within his chiefdom.

Chiefdoms are administered by chiefdom councils with the Paramount Chief as chairman. Paramount Chiefs are assisted by Chiefdom Speakers. Paramount Chiefs are elected for life-long terms by Chiefdom Councillors, who in turn are selected by the residents of their chiefdoms. The Paramount Chief is assisted by a Chiefdom Committee, Council of Elders and a Native Administration. Tankoro Chiefdom comprises three sections. Each section is headed by a Section Chief and each town by a Town Chief. Sections are further divided into areas.Socio-Economic Baseline Conditions.

7.5 Socio-Economic Baseline Conditions

7.5.1 National Socio-Political Context

Sierra Leone covers a total area of 71,740 km^2 and had an estimated population of 4.9 million in 2004 (Sierra Leone Population and Housing Census, 2004) but according to the 2015 Housing and

Population Census result, the population has increased to 7,075,641. Political instability and poor economic growth led to the brutal and destructive 10 year civil war which officially ended in 2002.

Sierra Leone continues to be one of the poorest nations on earth despite recent accounts that the country is among the fastest growing economies in the world (Abdelrasoul, et al. 2013). The country's Human Development ranking slightly improved from the bottom in 2008 (178 out of 178 countries) to 177 out of 186 countries in 2013 (HDI, 2013). Equally, Sierra Leone's poverty headcount has declined from 66.4 percent in 2003 to 52.9 percent in 2011 (World Bank and Statistics Sierra, 2013). However, the country's human development and social indicators including illiteracy, primary school enrolments, life expectancy, maternal deaths, malnutrition, and child mortality rates, are among the worst in the world. Table 7.5-1 presents some of these gloomy socio-economic indicators.

Table 7.5-1: Information on National Social Indicators

Key Social Indicators	Rate	Source
GDP per capita	$435.41 in 2012	http://www.tradingeconomics.com/sierra-leone/gdp-per-capita
Economic growth rate	15.2% in 2012	World Bank, 2013
Infant mortality rate (IMR)	76.64/1000	(MoHS, 2012)
Life expectancy at birth	48.1 years	HDI, 2013
Maternal Mortality ratio	860/100,000	(MoHS, 2010)
Population Growth rate	2.277%	(SSL, 2012)
Adult literacy	30%	(MEST), (WAEC, 2008/2010)
Illiteracy rate	70%	(MEST), (WAEC, 2008/2010)
Primary school enrolment	1,353,723	(MEST), (WAEC, 2008/2010)
Net primary enrolment rate	70%	(MEST, 2012)
Gender parity in primary school enrolment for boys and girls	1.1 : 1	(MEST, 2012)

Basic water and sanitation facilities for the majority of Sierra Leoneans is extremely limited due to the limited functional infrastructure for water supply as well as the increase in population in Freetown and provincial cities over the past decade as a result of the civil conflict (PSRP II, 2008).

From surveys done from the PRSP II document prepared by the Government of Sierra Leone, about 70% of the population live in absolute poverty, with expenditure below US$ 1/ day. The average person's total consumption falls short of the minimum consumption level, by 27.5% of the poverty line. (PRSP II, 2008)

The most recent poverty profile prepared by The World Bank and Statistics Sierra Leone (2013) puts the incidence of poverty at 52.9 percent in 2011. The rural population which is about 70% (GoSL, 2012) is hardest hit with poverty headcount of 66.1 percent in 2011 (Ibid, 2013). Agriculture is the largest economic sector in the country. Nearly two-thirds of the population depends on it for their livelihood and it is responsible for almost half of the country's GDP. There has been a steady increase in domestic food production. For instance, for rice, which is the staple food and the most common crop cultivated by majority of Sierra Leoneans, production increased at an annual rate of 17.8% between 2000 and 2010 compared to -7.1% between 1990 – 1999 (FAO, 2013). Nonetheless, the living conditions continue to be difficult especially for rural villagers who struggle to remain at subsistence levels. Poor health indicators reflect the lack of access among the population to basic service notably - health. Endemic diseases, especially malaria and HIV/AIDS, loom as a threat; in 1997, UNAIDS estimated the HIV prevalence among adults to be 3.2%. In 2002, a national prevalence survey estimated the rate at 5% while the survey in 2010 revealed an increase of 1.5% (UNDP, 2013).

Sanitary conditions are very poor as sewage and refuse disposal systems do not function effectively in most places. Urban living conditions are extremely difficult; (PRSP II, 2008).

Less than 10% of Sierra Leone's total population has access to electricity, compared to 49% in Ghana, 46% in Nigeria, 96% in North Africa, 73% in Asia, 99% in China and 76% global average. Only around 1% of the rural population in Sierra Leone has access to electricity.

Of the 11,300km of classified roads in the country, 8,148km are classified in the national road system. The remaining roads consist of urban roads, community roads, local roads and farm tracks. With respect to the regional distribution of roads, the Northern Province accounts for 41% of the roads followed by the Southern Province with 33% and the Eastern Province with 23%. The Western Area accounts for only 3% (PRSP II, 2008).

7.5.2 Summary of Regional Context at time of Digby Wells ESIA

The Kono District is located in the North Eastern part of Sierra Leone. It covers an area of approximately 5,641 km2 and is densely populated. The District's capital is Koidu New Sembehun City. The Kono District borders with the Republic of Guinea to the east and Koinadugu, Tonkolili, Kenema and Kailahun Districts to the north, west, and south respectively. The district comprises 14 Chiefdoms, 70 Sections, eight Parliamentarian Constituencies, 29 Wards and 36 Townships (Digby Wells Focus Group Meeting with Township Chiefs, 16 April 2011).

7.5.2.1 Environment: Natural and mineral resources

The main natural resources of the district comprise arable land base clay and sand deposits.

Sand and clay mining are carried out along streams sides and swamps, which have led to the degradation of soil fertility (Kono District Development Plan, 2010 – 2012).

A large part of the district population depend on natural resources from forests and rivers for the use of foodstuff, fuel (fuel wood and charcoal), construction materials, crafts, medicinal plants and recreational materials (raffia, ornaments). The wildlife population has, however, been significantly reduced during the civil war and through hunting practices. Although fishing is not predominantly undertaken in the district, it is undertaken at inland rivers in the country (Kono District Development Plan, 2010 – 2012).

According to the Kono District Development Plan (2010 – 2012), major threats to biodiversity and the environment include subsistence agriculture, livestock farming, forest exploitation, energy exploitation, mining, transportation, urbanization and waste disposal.

The main mineral resources found in the district are diamonds and gold. Mining activities have also contributed to the degradation of the environment, causing air and water pollution as well as food contamination.

7.5.2.2 Population

Kono has had one of the highest population displacements in the country as a result of the civil war. According to the Sierra Leone Population and Housing Census (2004), the population for the Kono District was 335, 401 in 2004. The census was however affected by a large number of immigrant miners from northern Sierra Leone moving out of the Kono District at the time when the census was undertaken in search of alternative resource deposits in the country (Kono District Development Plan, 2010 – 2012).

The district has a low population density of approximately 30 persons per km2. The low population density in the district can be attributed to the decrease in the availability of mining resources and the damage to housing and community infrastructure as a result of the civil war. The 2004 population and household census show that the average household size for the district is 5.7. Family planning is not commonly practiced in the district (Kono District Development Plan, 2010 – 2012).

7.5.2.3 Ethnicity

Ethnic affiliation in the district is largely homogeneous with the Konos constituting 55% of the population. The other ethnic groups in the district are the Kissis, Kurankos, Mandigos and Temne.

7.5.2.4 Health

According to the Kono District Development Plan (2010 – 2012) the main illnesses and diseases affecting the residents in the district are: malaria, diarrhoea, skin diseases, hypertension, pneumonia, anaemia, intestinal worms, rheumatism, ear infection and

onchocerciasis. The main causes of the above-mentioned diseases include the breeding of mosquitoes in stagnant pools of water, poor sanitation facilities, improper refuse disposal, the use of contaminated water, unhealthy dietary habits and the lack of personal hygiene.

The Kono District Development Plan (2010 – 2012) also reported that teenage pregnancy is a source of concern in the district. Most residents in the district showed some knowledge and understanding (awareness) of HIV/AIDS. Recent statistics for the levels of HIV/AIDS in the district is however difficult to be ascertained. This may be due to the fact that people are shy to speak about having HIV/AIDS. A Voluntary Confidential Counselling Team has been established at the district hospital for this purpose.

According to the Kono District Development Plan (2010 – 2012), the district's healthcare system has gone through three stages subsequent to the civil war:

- Stage 1 – a transitional period of emergency development during early 2004;
- Stage 2 – a period of health system reform with the decentralization of healthcare delivery to the District Councils and the formation of the district health board; and
- Stage 3 - the termination of the operation of some international health service organizations due to the lack of funding.

The district has also improved access to healthcare facilities. The district has 67 health facilities including one hospital that is now fully operational with three doctors and a total of 294 medical staff, including an anaesthetist, pharmacists and laboratory technicians. The hospital has two ambulances, eight motorbikes and two vans to transport patients to and from healthcare facilities.

In addition to the hospital, the district has 11 Community Health Centres, 25 Community

Health Posts and 33 Maternal Health posts.

The district has trained 500 Traditional Birth Attendants (TBAs) who have been provided with "child birth kits" from UNICEF. Two collaborative centers for TBA/Leprosy Management have been established at Jaiama Sewafe and the hospital. These centres mainly provide maternal health care services to the population. These facilities collectively provide healthcare services to approximately 60 percent of the district population.

Health care in the district has been focussed on reducing maternal and infant mortality and improving the general health status of the community. The healthcare system in the district and the management thereof is however compromised by a lack of resources, specifically personnel in the form of doctors and administrative staff.

7.5.2.5 Nutrition

The morbidity trends among children specifically are indicative of general poor and mal- nutrition in the community. A typical meal for the majority of the population in the district comprises mainly rice, cassava and/or potatoes. Protein and vitamin intake is low even though households in the district grow and produce citrus and vegetables. The prevalence of certain diseases further suggests that the

majority of the population live on an unbalanced diet (Kono District Development Plan, 2010 – 2012 and Sierra Leone Demographic and Health Survey, 2008).

According to the Kono District Development Plan (2010 – 2012), the district Health Management Team is aiming to alleviate this problem by providing iodized salt supplements to the population and through nutrition surveillance programmes. These programmes aim to strengthen and reinforce the regular growth monitoring at maternal and child health clinics at the sub district level. The district also provides supplementary feeding programmes at Periphery Health Units (PHUs). Vitamin A supplements are also available to the population in all PHUs.

7.5.2.6 Immunisation

In addition to undertaking feeding programmes, the district Health Management Team has undertaken immunisation programmes among children in the Kono District. The programme aims to enhance resistance in children against the main life-threatening diseases in the district namely: measles, diphtheria, whooping cough and tetanus.

7.5.2.7 Education

The District Directorate of the Ministry of Education Science and Technology is responsible for managing and overseeing the education system in the district. This includes formal, non- formal, public and private schools.

The population density in the chiefdoms has been a major determinant in the placement of schools. The uneven distribution of schools and the low enrolment rates are major concerns for the development of education in the district. The other major concern is the number of children dropping out of schools at the primary level. The main reasons for this, according to the Kono District Development Plan (2010 – 2012), are poverty and accessibility to schools (travelling distances). Other factors contributing to poor education in the district are: inadequate and insufficient teaching and learning material for science and technology, ill- equipped laboratories, ill-equipped libraries, insufficient furniture and lack of decent accommodation facilities for teachers.

7.5.2.8 Economic activities

The main economic activities in the district comprise mining (diamond and gold), and agriculture (rice, oil palm and other crop plantations e.g. coffee and cocoa). Goods are traded with people moving through the district from neighbouring towns.

The district is predominately rural, with most of its residents engaged in crop and livestock agriculture. Most agricultural activities are undertaken at subsistence level and commercial agriculture is not evident. According to the Kono District Development Plan (2010 – 2012) the district has the potential to become an agricultural driven economy if the relevant resources and mechanisms are implemented.

Mining is the other main economic activity undertaken by the people in the Kono District and approximately 50 to 55 percent of the total population of the district total population depends directly or indirectly on mining. Mining leases and surface rent paid to government enables small scale mining undertakings by chiefdoms and the district at large (Kono District Development Plan, 2010 – 2012).

Other economic activities in the district include owning/running bars, as well as petty trading (selling of assorted items including cell phone products, clothing, food stuff) (Kono District Development Plan, 2010 – 2012).

7.5.2.9 Taxes

Community members are obliged to pay monthly taxes to the Kono District Council. According to the Kono District Development Plan (2010 – 2012), residents above the age of

18 have to pay a monthly fee of Le 5000. The taxes are divided between the District Council and Native Administration at 40 and 60 percent respectively.

The District Council utilises the money for various official expenditures including salaries for staff, payments to government (including the Ministry of Health and Sanitation, the Ministry of Agriculture and Food Security, Ministry of Social Welfare and the Ministry of Education) and community development projects.

7.5.2.10 Roads and transport

The main form of transport in the Kono District is by land (road) and water (rivers and canoes). The population of Kono rarely owns private vehicles and they predominantly walk or rely on public transport (taxi vans and motorbikes) for transport (Kono District Development Plan, 2010 – 2012).

The roads in the Kono District are not tarred and during the raining season, heavy rains lead to soil erosion (Photograph 1) resulting in poor and dangerous road conditions and damage to vehicles.

Figure 7.5-1: Motorbike taxi travelling on eroded gravel road

7.5.2.11 Communication

The majority of the population of Kono communicate by using cell phones through the Airtel, Africell and Sierratel cell phone services providers (Kono District Development Plan, 2010 – 2012). Communication by land-line telephones is limited. Koidu Town has a post office, which is not currently operational due to damage caused during the civil war.

7.5.2.12 Housing

The Kono District suffered 94% housing infrastructure loss as a result of the burning of houses during the war. Some houses have been re-constructed with sandcrete and mud bricks with corrugated iron roofs. The average number of persons per household in the district is five and the average number of rooms per house is two in the urban areas while the rural parts have houses that may have more than three rooms.

7.5.2.13 Water and sanitation

People in the Kono District predominantly source water from wells , boreholes, ponds and rivers. Infrastructure for piped-borne water has been installed in only 5 of the 24 wards in the district. There are currently 397 standpipes in the district. According to the Kono District Development Plan (2010 – 2012), the current water supply is not adequate to serve the growing population.

The majority of the rural communities does not have access to potable water, and therefore are compelled to use water from streams or rivers which are often contaminated.

Figure 7.5-2: Hand-dug well in the Kono District

People in the Kono District predominantly make use of pit latrines. Most households have access to a toilet on their property or a neighbour's facility. The toilets are generally constructed out of plastic/corrugated iron sheets with no roof (Photograph 6) or a more permanent structure constructed with bricks and a corrugated iron roof (Photograph …).

7.5.2.14 Energy

Although electricity is supplied on a local grid, the rural population mostly get their energy from shops or individuals selling wood and charcoal within the community. Other sources are filling stations (for kerosene) and generators generated electricity.

7.5.2.15 Refuse disposal

There is no formal waste disposal system or landfill site in the Kono District. Solid waste is mostly disposed of in the bush or at open public dumping sites or in the backyards of individual households (Kono District Development Plan 2010 – 2012).

7.5.3 Local context

The Expansion Project is located within Koidu Town which is the capital of the Kono District. Koidu Town is governed by the Koidu New Sembehun City Council with Koidu Town and New Sembehun Township forming the largest part of its geographical administrative area. These two towns are also the headquarters of the Gbense and Tankoro Chiefdoms respectively, covering approximately 80 percent of the total area of the two Chiefdoms. The Koidu New Sembehun City Council is divided into three electoral wards namely:

- Tankoro South – also known as Ward 62
- Tankoro North – also known as Ward 63
- Gbense – also known as Ward 64

The council borders Nimikoro to the south-west and Kamara to the north-west and is characterised by extensive wetland and swamp areas used for subsistence agriculture in the rainy seasons. The area is also characterised by vast areas of "waste land" as a result of extensive artisanal mining activities (Koidu New Sembehun City Council Development Plan, 2011 – 2013).

Various socio-economic aspects of the local area are described. Mots of the description comes froom the 2011 Digby Wells ESIA. Updates of the current situation are however provided where appropriate.

7.5.3.1 Population

According to the Koidu New Sembehun City Council Development Plan (2001 – 2013), Koidu Town has an estimated population of 80,025 and approximately 95 persons per km2. The population is predominantly involved in trading, mining and subsistence farming as their main economic activities.During key informant interviews undertaken by Digby Wells (April 2011) with the Tankoro Youth Development Association, it was established that approximately 65 percent of the population in Koidu consists of youth between the ages 15 to 35 years. The population numbers in Tankoro has reportedly increased subsequent to the war, as children who were born and people who were living in refugee camps in Guinea have moved back into the area.

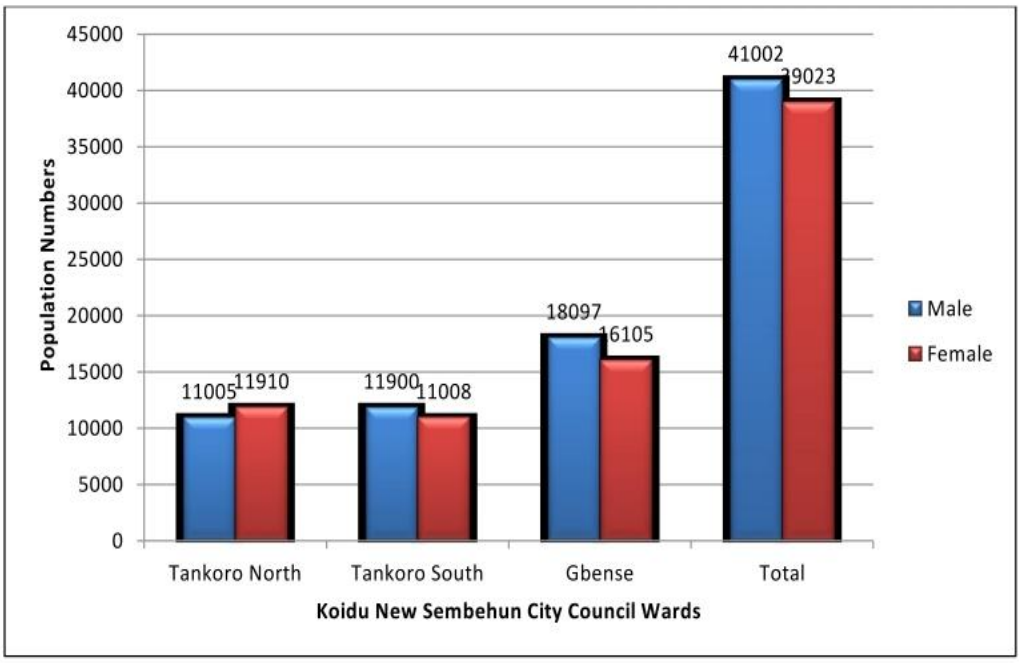


Figure 7.5-3: Population statistics for Koidu town

7.5.3.2 Household structure

Most households in the Tankoro Chiefdom are made up of extended family units spanning a few

generations. Household sizes can range from four to thirty people in one household.

The main role of women is to take care of the household and to undertake agricultural and petty trading activities to earn an income. Men who are employed will bring money into the household whilst women mostly contribute to the maintenance of the household. The women from the Tankoro Women's Organisation expressed a desire to be treated equally to men when considered for formal employment. The main role of children, when not attending school, is to fetch water and wood and run general errands for the household (Digby Wells interviews, April 2011).

7.5.3.3 Ethnicity and religion

Similar to the ethnic composition of the Kono District, the dominant ethnic group in local area is the Kono. Other ethnic groups in the area include the Mende, Temne, Kissi and Limba. The ethnic groups generally live together in harmony (Digby Wells interviews, April 2011).

As in the larger Sierra Leone and the Kono District, the dominant religions within the Tankoro Chiefdom area are Muslim and Christianity. Traditional religion is still practiced by some community members in the area but is mostly conducted in a private manner.

7.5.3.4 Education

A survey undertaken by the Koidu New Sembehun City Council (2009/2010) has established the number of education facilities and resources in Tankoro. According to enrolment figures obtained from the Kono District Education Office during the visit of CEMMATS Consultants, there has been an alarming increase in the number of educational institutions and enrolment figures at all levels of education in 2016 compared to the 2009/2010 figures. In particular the number of pre-schools had increased from 1 with a total enrolment of 11 in 2009/2010 to 25 with a total enrolment of 2,126 in May 2016. These figures are presented in the following table.

Table 7.5-2: Education facilities and enrolment for the Tankoro Chiefdom

Pre-Schools	**2012**	**May 2016**
Number of Schools	**01**	25
Number of male pupils	04	983
Number of female pupils	07	1,143
Total Number of Pupils	11	2,126
Government Assisted and Community Primary Schools		

Pre-Schools	2012	May 2016
Number of Schools	40	56
Number of male Pupils	6 438	10,670
Number of female Pupils	7 845	11,474
Total Number of Pupils	14 283	22,144
Junior Secondary Schools		
Number of Schools	10	16
Number of male pupils	3 435	3,084
Number of female pupils	1 626	3,974
Total Number of Pupils	5 061	7,055
Senior Secondary Schools		
Number of Schools	03	9
Number of male pupils	977	2,121
Number of female pupils	298	2,921
Total Number of Pupils	1 275	5,042

In addition to the educational facilities listed above, Kono also has one Technical Training Institute which currently has an enrolment of 109 males and 269 females. During CEMMATS update exercise in May 2016, the number of Tecnical/Vocational Institutes in Tankoro chiefdom had increased to two with a total enrolment of 366 students comprising 158 males and 208 females.

The inspector explained that the Government approved teacher to pupil ratio is 1 to 40/45 students and in Koidu it currently stands at an average of 1 to 70-80 students. The education system is compromised by a lack of infrastructure, qualified teachers and teaching materials. High school drop-out levels as a result of teenage pregnancies is a major concern. Levels of education are low in Koidu and there is a need for education, specifically adult-based education.

All primary education in Koidu is provided at no cost to pupils. Payment is required for boys from the "Junior Secondary Level" but not for girls. This is to encourage girls to enroll for

higher levels of education. The costs for the first three years for Junior Secondary School and Senior Secondary School is Le 20 000 and Le 75 000 per term respectively.

Tertiary education is generally provided by private intuitions and too expensive for general community members to afford. As a result, the approximate 50 percent of pupils who write the West African Senior School Examination at the end of Senior Secondary School do not proceed to get a tertiary education (Digby Wells Key Informant Interview, April 2011).

7.5.3.5 Health

During an interview with the Koidu Hospital on 18 April 2011, Digby Wells established that there are six healthcare facilities within the Tankoro Chiefdom. However during the field visit of CEMMATS Group consultants to the project affected communities in May 2016, it was found that the Swarray Town MCHP was transferred to the resettlement town of Kimbadu and upgraded by KL to Community Health Centre with a wide range of facilities including the provision of regular supply of water and electricity. Also during the field visit, the Kono District Health Medical Team (DHMT) advised that a new Community Health Post (CHP) had been advised at Kissy Bona, bringing the total number of health facilities within Tankoro chiefdom to 7. The facilities and associated resources are listed in Table 7.5-3.

Table 7.5-3: Health Care Facilities within Tankoro Chiefdom

	2012		2016	
Clinic	**Number of Beds**	**Staff**	**Number of Beds**	**Staff**
Koaquina (CHC)[1]	8	1 Lab Assistant 1 Vaccinator 2 MCHA's 1 CHO	8	1 Lab Tech 1 SECHN 1 MCHA's 1 CHO 1 Midwife 6 TBAs
Baiama (MCHP)[2]	4	1 Vaccinator 1 MCHA	4	1 MCHA 1 SECHN
Woama (CHP)		1 Vaccinator 1 MCHA		1 Vaccinator 1 MCHA 1 SECHN 4-6 TBAs
Swarray Town (MCHP)		1 Vaccinator 2 MCHA		Clinic transferred to Kimbadu and upgraded to CHC.
Tongoro (MCHP)		1 Vaccinator 1 MCHA		2 MCHAs 6 TBAs

	2012		2016	
Clinic	**Number of Beds**	**Staff**	**Number of Beds**	**Staff**
Kainsay (CHP)		1 Vaccinator 1 MCHA		1 Vaccinator 2 MCHA 1 SECHN 6 TBAs
Kissy Bona (CHP)	-	-	-	1 Vaccinator 3 MCHA 1 SECHN 6 TBAs
Kinbadu (CHC)				1 CHO 1 Mid wife 1 Vaccinator 2 MCHA 1 SECHN 6 TBAs

As can be seen from the table below, the total staff strength of Government paid workers in the Koidu Government Hospital has dropped from 137 in 2012 to 129 in May 2016. The total staff strength in May 2016 has however increased to 241due to services of additional 112 volunteer staff as indicated below. The volunteer staff are paid jointly by an NGO PIH (Partners In Health) and the Koidu New Sembehun District Council.

Table 7.5-4: Comparison of staff strength at Koidu Government Hospitala in 2012 and 2016

2012		May 2016			
Category	**No. of Payroll staff**	**Category**	**No. of Payroll staff**	**Volunteer staff**	**Sub -Total**
Doctors	2	Doctors	2	0	2
Matron	1	Hosp. Sec.	1	0	1
Secretary	1	F/Officer	1	0	1
Finance Officer	1	Midwife	8	0	8
CHOs	2	SRN	5	1	6
Midwives	5	CHO	5	1	6
Staff Nurse	2	Anaesthetist	2	0	2
SECHN	17	Ophthalmic nurses	3	1	4
MCH Aide	5	Lab Tech	11	10	21

2012		May 2016			
Category	**No. of Payroll staff**	**Category**	**No. of Payroll staff**	**Volunteer staff**	**Sub -Total**
Nursing Aide	40	Pharmacy Technician	3	0	3
Lab Technicians	4	CHA	0	2	2
Lab Assistants	4	SECHN	24	28	52
Orthopaedic	5	MH Nurse	1	3	4
Drivers	3	Rehab/Physiotherapy	7	1	8
Clerk	1				
Cook	1	Nutritionist	1	0	1
Security	3	Nursing Aide	29	29	58
Volunteer Nursing Aide	40	Security	6	8	14
		Drivers and mate	2	4	6
		Porters/cleaners	12	8	20
		Stores	1	2	3
		Caterer	1	0	1
		Cooks/Steward	3	10	13
		Carpenter	1	0	1
		Clerk	1	4	5
TOTAL	**137**		**129**	**112**	**241**

Minor medical cases are admitted to community health centres, while serious and emergency medical cases are admitted to government hospital. The Community Health Centre

(CHC) and Maternal and Child Health Posts (MCHPs) currently provide the following health care to the Tankoro population:

- Immunisation
- Family planning
- Antenatal care
- Baby deliveries
- Postnatal services
- Outreach programs

Health care services are provided for free to children under the age of five, pregnant and lactating women, while the rest of the community has a pay for health care and medication.

The Koidu Government Hospital (KGH) representative noted that the services offered at the medical facilities within Tankoro are often not adequate to provide comprehensive services to everyone in the rural areas. The KGH representative listed the following inadequacies in the health care facilities:

- Inadequate accommodation for medical staff (only two clinics has staff quarters);
- Lack of medical facilities and equipment;
- Transport constraints;
- Lack of medical supplies;
- Lack of water and electricity; and
- Poor access to information (e.g. internet)

The most common diseases in Tankoro, as obtained from the Koidu Government Hospital medical records, are presented in Table 44. Whereas Diarrhoea, AFP, Measles and yellow fever were reported as the most common diseases cases recorded for Tankoro in 2010, Malaria, ARI/RTI (Acute Respiratory Infection/Respiratory Tract Infection), Warm Infestation and skin infection were reported as the most common diseases cases recorded for Tankoro in 2015.

Table 7.5-5: Common diseases cases recorded for Tankoro in 2010 and 2015

	Disease	No. of Patients 2012	Disease	No. of Patients 2015
1	Diarrhoea	965	Malaria	6556
2	AFP	3	ARI/RTI	3384
3	Measles	55	Worm Infestation	1372
4	Yellow fever	2	Skin infection	767

Other diseases/medical conditions prevalent in the community area are: eye infection, malnutrition, and bilharzia (KGH, April 2011).

The maternal death rates recorded for 2010 were 857/100,000 live births. The most common cause of death in Koidu is malaria (KGH, April 2011). The average life expectancy for people living in Koidu is 47 years.

The KGH noted that HIV and STD infection rates have stabilised in 2010 but that accurate statistics could not be provided as people do not generally disclose their HIV status. The KGH undertakes HIV/AIDS awareness campaigns in the community through the National AIDS Secretariat, Community Based Organisations (CBO's) and health management teams. The campaigns promote the use of condoms and encourage voluntary testing.

The KGH noted that there is high occurrence of teenage pregnancies in Koidu. This can be attributed to poverty, unemployment and peer pressure. The occurrence of mental and physical disabilities in Koidu is low, and the few cases that have been reported resulted from the rebel war (KHG, April 2011).

7.5.3.6 Employment and unemployment

There are high levels of unemployment in Koidu with approximately 80 percent of the population being unemployed (Digby Wells Focus Group Meeting with Town Chief, 16 April 2011). Current staff strength on the Koidu Kimberlite Project is 648 permanent employees and 115 casual labourers.

Despite its high agricultural, commercial and mining potential in Koidu, approximately 98 percent of the population live on less than US$1 per day. The poverty level has forced many young girls into commercial sex. With the high level of unskilled youth members, unemployment is common. The frustration has also coerced some youth members to indulge in drug-abuse and addiction resulting in a high incidence of crime in Koidu Town (Koidu New Sembehun City Council Development Plan, 2011 – 2013).

7.5.3.7 Land use and ownership

The dominant land use in the Koidu area is agriculture. The community use extensive areas in Koidu for the planting of economic trees such as cocoa, coffee and oil palm. The main crops that are cultivated are rice, cassava and maize. The land is also used for keeping livestock such as sheep, goats and chickens. Cattle are not generally kept in urbanised areas. This is enforced through an informal law that was developed by the town chiefs (Digby Wells Focus Group Interview with Town Chiefs, 16 April 2011).

Officially, all land is owned by the Paramount Chief. Land within each settlement is allocated by the relevant Town Chief through the endorsement of the paramount Chief. New landowners pay for the land by giving a token to the Town Chief. The amount is paid once off and the

value is determined by the Town Chief. Land ownership is also allocated through inheritance within families (Digby Wells Focus Group Interview with Town Chiefs, 16 April 2011).

7.5.3.8 Services and infrastructure

Similarly to the larger Kono District, Koidu Town has experienced severe damage to community infrastructure as a result of the rebel war. Between 2004 and 2000, efforts were made, through the Sierra Leonean Government, to rehabilitate and restore some of the services and infrastructure but there is still a 55 percent backlog in terms of services provision. Some individual households have reconstructed their own houses. The Sierra Leone Road Agency (SLRA) also undertook basic road maintenance by reconstructing drainage systems and culverts on main roads.

As in the larger Kono District, there is no formal electricity supply in Koidu and community members use private generators for power generation. The Koidu New Sembehun Council is however committed to supplying electricity to the larger town provided that they have access to the relevant resources (Koidu New Sembehun City Council Development Plan, 2011 -2013).

The Town Chiefs of Tankoro noted in an interview with Digby Wells on 16 April 2011 that the most critical community needs in terms of services provision within Koidu are:

- Roads (to improve access to markets in larger cities such as Freetown);
- Water supply;
- Electricity supply;
- Health Services;
- Meeting places; and
- Credit facilities

7.6 Koidu Limited's Non-Mining Related Activities

7.6.1 Introduction

Since its inception in 2003, the Koidu Kimberlite Project has contributed time and resources to the implementation of community development initiatives in both the Tankoro Chiefdom and the Koidu New Sembehun City. Developmental activities were carried out in line with internally developed annual community development action plans, with additional activities implemented on an ad hoc basis. In keeping with the provisions of the Mines and Minerals Act of 2009, the Project has recently initiated discussions with lead stakeholders for the development of a formal Community Development Agreement (CDA).

The following sections provide an overview of the Project's current and past contributions to local and community development and how this has contributed to the current socio-economic baseline conditions in the broader project area:

Some of these affected the resettlement areas which are considerably better than other communities in the project area. A more comprehensive description of the resettlement areas is provided in the RAP report.

7.6.2 Road Refurbishment Programme

The Project has been directly involved in the continuous improvement of roads and infrastructure in and around Koidu Town. It has graded laterite roads that become severely potholed during the rainy season, and has provided materials for road surfacing. In 2009, the Project has rehabilitated 15 of the town's major roads and cleared all the garbage sites across the town.

In 2007, the Project refurbished the abandoned Old Yengema Road following the collapse of the Koaquima Bridge. In 2006 it refurbished the road linking the Kono and Kenema districts (the Koidu-Tongo road), which has increased commercial activities between the two districts and their environs. Most recently, the Project has partnered with the Kono District Council to rehabilitate the Koidu-Gandorhun Road.

7.6.3 Infrastructure Programme

KL has contributed to various district infrastructure projects since 2003. These include:

- The rehabilitation of both the Tankoro and Motema Police Stations
- Materials for work concluded at the RSLAF headquarters
- Backfill material to the new Koidu market location and earth moving machinery to conclude the earthworks
- Provision of aggregate tailings and mined granite to various local community projects.

- The development of a metal recycling project in 2010. According to current planning the proceeds will be contributed to the Tankoro Chiefdom Authority (TCA) for development programmes. The first proceeds (in excess of US$ 20,000) have been committed, in accordance with a proposal received from the TCA, to the refurbishment of the Tankoro Native Administration (TNA) building. Work on the refurbishment started in April 2011 and is currently in progress.

The Project has provided earth moving machinery to conduct the bulk earth works for the New Koidu Power Station site and committed a total of 18,000 blocks from its brick factory to the building of infrastructure at the site.

7.6.4 Education

In the early stages of its operations, the Koidu Kimberlite Project has collaborated with the Diamond Dealers Association to award scholarships to deserving Junior Secondary (JSS) Students. The scholarships covered tuition fees and learning materials. Between 2004 and 2007, over 50 children have benefited from this initiative.

In March 2011, the Project has awarded scholarships to 25 university students. With effect from 2010, it will allocate USD $100,000 annually for skills training and scholarships to Kono indigenes. These funds will be managed by a Board of Trustees by including various stakeholders from Kono District and central government. The Board will be responsible for establishing the criteria for eligibility and ensuring that the awarding of scholarships is conducted in a fair and transparent manner.

From 2004 until 2007, Koidu Holdings had provided regular support to the Kono Students' Union (KONSU) with facilitating holiday lessons for secondary school pupils and undertaking other academic related activities in Koidu Town. The Project has also assisted with the refurbishment of a number of learning institutions, such as the United Methodist Church Girls Secondary School and the Ansarul Islamic Boys Secondary School, both located in Koidu Town.

7.6.5 Adult Education Project.

As part of its contribution to the enhancement of education in the project affected communities, KL intends to introduce an Adult Educational project for the project affected communities. According to the KL CDAP quarterly monitoring report for July to September 2015, the Adult Education project will be supported under the RAP 2 implementation plan now that KL have relocated all the three affected schools in the new resettlement location. These projects will be initiated in conjunction with the District Educational Authority as KL support to the GOSL Education agenda.

The selected schools and class rooms will be improved with electrical wiring to provide lights during the evening classes. This is to encourage the community and KL mine workers to access the free programme, opportunity to improve their educational knowledge in reading

and writing after working hours and take ownership of the project.

The Adult Education Project will improve KL workers understanding of the equipment they are operating, read/write simple letters and fill in forms and help them to improve their skills and climb the workers ladder of advancement. This project is presently on hold for approval from the MEST.

7.6.6 School Bus

KL recognises that that there had been real hardship in the movement of pupils to and from schools in the resettlement site. To mitigate against this, KL had provided free school bus transportation service twice daily for the affected three Primary and two secondary schools now relocated within the resettled town of Kimbadu. This free service is for the daily transportation of student/pupils living in the resettlement town of Kimbadu going to schools outside and for those outside but attending schools within Kimbadu. The bus service is now outsourced to a private contractor from the community.

7.6.7 Feeding Scheme

Since 2003 the Project has supported polio victims through the Polio Victims Association in Koidu. It assists them with their daily meals. The Project is currently reviewing a request for an increase in their weekly subvention.

7.6.8 Clean Water Supply

The Project has developed the necessary infrastructure to provide pipe borne water to the resettlement site. The water, which is sourced from a borehole, was tested by the Sierra Leone Water Company (SALWACO) and meets WHO standards. The water is pumped from the borehole to a 120,000 litre reservoir facility and then further reticulated to standing tap point in the resettlement village. A total of thirty eight tap points are functional, providing running water to 152 resettled households. The reticulation programme is part the on-going resettlement process, with one tap point allocated for every four houses. Currently the resettlement village is the only settlement in Koidu with pipe borne water supply.

7.6.9 Health Care

Koidu Holdings has established a clinic, with a full-time medical doctor, an advanced life support (ALS) paramedic and three nurses in the project site area. The clinic has the capacity to accommodate 30- 40 patients per day and is equipped with an electrocardiogram machine, defibrillator, laboratory and a fully equipped ambulance.

In October 2010, the Project has provided fuel to the District Health Management Team, (Ministry of Health and Sanitation), in order to ensure the provision of free drugs and health

care to peripheral District Health Centres throughout the 14 District Chiefdoms.

7.6.10 Support to Kimbadu Community Health Centre

According to CDAP quarterly monitoring report for July to September 2015, KL is also actively engaged in providing maintenance support to the Kimbadu Community Health Centre at the resettlement site. This project entailed the upgrading of the old CHU (Community health Unit) building from the resettled village of Swarray Town now enclosed in the concession. The health centre has both male and female observation room, a maternity ward with two separate observation /rest room. There are two internal W.C. and shower facilities for male and female, laboratory/test room, two separate medical consultation room for the health officers. Each of the 12 rooms has a hand wash basin and the medical store has air-conditioning unit to keep the cold chain drugs safe. There are two to three units outside public toilets for use; there is an incinerator for the disposal of used items.

A 24KVA diesel generator supplies electricity solely for the CHC with fuel from KL every second day. The pipe water supply from the main bore hole operated by KL for the resettlement use has become erratic due to the high demand for water from outside the resettlement area.

The CHC provides health supports to over 2800 individual from Kimbadu and twice that number from the immediate villages/settlements communities. This population is now increasing as the resettlement grows due to the clean environment and the service attracts new tenants.

The staff at this facility are employed and paid by MOH. KL is still providing the fuel and water supply and maintenance support to the facility.

7.6.11 Agricultural Pilot Project

In 2007, the Project launched its Agricultural Development Pilot Project. The aim of this initiative is to assist resettled households to embark on small to medium scale agricultural activities. Prior to the suspension of its operations in 2007, the Project was ready to allocate100 plots of 50 square meters each per household in the resettlement village for cultivation of high quality vegetables. According to current planning the pilot project will be re-launched in 2011 and will provide the initial capital outlay. Koidu Holdings will also provide the farmers with seeds, fertilizers and pesticides. Once production commences, the Company will help the farmers to market their produces.

To provide guidance to farmers, the Company has sent two of its employees, both of whom are Kono indigenes, to the University of Bloemfontein in South Africa for a week's training in vegetable cultivation and agricultural management. The Project has also set aside 0.1% of its annual export revenue for agricultural development in Tankoro Chiefdom.

According to KL CDAP quarterly monitoring report for July to September 2015, KL will embark on full promotion of agricultural activities in the resettled communities when majority of RAP2 have been resettled in their new places. In the meantime, KL is supporting some agricultural development projects including:

(a) Vegetable Basket Project.

The aim of this component is to assist the resettled households to embark on small to medium scale agricultural activities. It involves KL giving out certified seeds to resettled families to plant in their available backyard garden. The list of seeds given out and commonly grown and selected will be:

1. Okra:
2. Local pepper:
3. Imported high yield corn:
4. Eggplant (garden eggs): 5. Hot pepper (long fingers):
5. Carrot/onion:
6. Sweet pepper:
7. Lettuce /cabbage/cucumber.

The construction of the first chicken house has been completed, and effective programme will commence when most of the APOA are at their new homes and settled.

Koidu Limited is presently supporting 5 small piggeries within the Tankoro and Gbense chiefdom with the waste food from the two mine kitchens. This support has assisted the small scale farmers to increase their productivity and income.

7.6.12 Local Business Development

The Koidu Kimberlite Project has been constrained over the years by the unavailability of qualified service providers relative to its operations. It has endeavoured to enhance the growth of local businesses across the country by extending business opportunities to petty traders, small scale, medium and large scale enterprises in especially Koidu and Freetown. This work extends from Koidu, where the Project works with vegetable sellers, charcoal sellers, the local market women, timber sellers, local supermarkets and banks, to Freetown where it works with companies such as CEMMATS, Total, Monoprix Supermarket, Yazbeck Motors, etc.

The bulk of the resettlement project building materials are purchased in Sierra Leone, with a large portion of this material being sourced in Koidu Town from local suppliers.

KL has also enhanced employment opportunities for indigenes of Kono. According to KL CDAP monitoring report for the period July 2015 to September 2015, KL has created local job opportunity for the people of Kono as part of its objective in contracting out the

construction of the RAP 2 resettlement houses of over 873 structures to local contractors within Tankoro in particular and Kono generally. This construction work has presently created work for over 400 local/nationals inclusive of skilled and unskilled labour of both sexes.

7.6.13 Sport Development Programme

Since 2007, the Project has supported the Kono District football team, the Diamond Stars. This support started with a USD 10,000 annual sponsorship plus soccer kits, boots, and footballs commitment. The sponsorship programme experienced some difficulties, but the Project will increase its sponsorship in 2011 to USD 50,000 annually, in addition to the provision of kits, boots, footballs, etc. Currently Koidu Holdings is the official sponsor of the Diamond Stars Football Club. Support has also been extended to the Gem Stars Football Club of Tongo, bringing the Project's annual investment in the development of sport in the Eastern region to USD 100,000.

7.6.14 Employee Development Scheme

From 2004, KH has made employee development an integral part of its operations in Sierra Leone. The Company has committed to supporting its Sierra Leonean employees through training programmes and skills transfer. The Company has established an employee-training programme to provide hands-on training on safety precautions, mining practices, production management and data capturing. It has also enrolled staff in specialist training courses in Freetown and outside the country. Employees who qualified for training have been sent for drilling and blasting training in Ghana, health and safety and mining related training in South Africa, and computer training in Freetown. In February 2011, the Company has sent three of its operators (Sierra Leoneans) to Sweden for a two-week training programme at Volvo.

Koidu Holdings has recently hired the services of Prisma Mining Services, a South Africa based company, to carry out specialised in-house operator training for its employees and new recruits for a period of six months. The training modules are specifically tailored to meet the training needs of the employees.

7.6.15 Employee Welfare

Koidu Holdings provides its employees with one cooked meal per day and provides medical facilities to all its employees and two of their chosen dependants.

7.7 Community perceptions

The perceptions of the key stakeholders in the mining community were captured at a meeting on Wednesday June1, 2016 in Tankoro. Present at the meeting were 48 participants representing key stakeholders from the project affected communities.

Participants were asked a prepared set of questions on their socio-economic status and living conditions and their perceptions and concerns about the proposed change in KL mining method from surface to underground mining. The answers given by the participants are documented below.

Q1 When participants were asked to state the main economic activities in their communities, the following were outlined:

- Agriculture,
- Mining,
- Petty Trading,
- Building construction,
- Stone breaking,
- Fishing.

Q2 Responding to a question on the main constraints they face in their mining activities, the participants replied as follows:

- Lack of knowledge in mining,
- Lack of equipment,
- Lack of credit facilities,
- One has to dig very deep now before getting to gravel these days,

Q3 In response to the question on the main constraints they face in their agricultural activities, this is what the participants had to say:

- Poor road network,
- Loss of farm land to mining,
- Lack of planting materials and equipment,
- Lack of knowledge in agriculture, and
- Lack of storage facilities

Q4 When the attendees were asked about the constraints they face in Petty Trading, they replied as follows:

- Lack of business education,
- Lack of credit facilities,
- KL blasting operations.

Q5 Responding to a question on whether there had ever been any large scale mining in their communities, the participants replied in the affirmative, naming the Sierra Leone Selection Trust Limited that later metamorphosed to the National Diamond Mining Company.

Q6. What positive impacts occurred in their communities in general as a result of past mining activities, they outlined that Koidu limited:

- Provided housing facilities for their workers,
- Provided employment for our children,
- Awarded scholarships to deserving children from the communities,
- Presented Christmas gifts to chiefs,
- Provided medical facilities for community members,
- Provided canteen facilities for workers, and
- They had a Personnel Training Centre that provided technical education for workers.

Q7. Asked what negative impacts occurred in their communities in general as a result of past mining activities, this was what the participants had to say:

- Carried out blasting which was a big danger to the community,
- Never gave benefits to workers on mine closure,
- Never carried out reclamation of mined out areas,
- Created stagnant pools of water which were a great risk to health of community members, and
- Never held a Public Consultation and Disclosure Plan meetings

Q8 Responding to a question on what positive impacts/expectations they foresee as a result of KL mining operations in their communities, the respondents replied as follows:

- Potable water facility will be provided for all residents of the Extended Affected Area,
- Free electricity will be provided for residents of EAA,
- Seedlings and other planting materials will be provided for residents of project affected communities,
- KL will develop and implement a CDAP aimed at restoring livelihood and income of resettled communities,
- KL will continue to create employment facilities for children of affected communities,
- KL will provide a youth recreational centre,
- KL will provide housing and transportation facilities for its workers and
- KL will extend medical facilities to project affected communities.
- KL will award scholarships to deserving children of the project affected communities at secondary levels.

Q9 Responding to a question on what negative impacts they foresee as a result of KL mining operations in their communities, this is what the participants had to say:

- Waste dump will be left unattended,
- Mined out pits will be left unattended,
- Lack of refuse disposal facility at the resettlement site will pose a serious problem,
- Lack of good drainage system at the resettlement site will create serious problems for residents particularly during the rainy season,
- Loss of sacred shrines and cemeteries, and
- Relocated chiefs might lose their traditional rights if their villages are amalgamated at the new sight.

Q10 When asked what are the positive impacts on their communities as a result of Koidu Limited mining activities, the respondents replied as follows:

- Support to education by giving scholarships to community members,
- Employment,
- Creation of VRC which provides a channel for project affected communities to air their grievances,
- Enhancement of business activities by giving contracts to locals to build resettlement houses,
- Help in construction of community infrastructure and road works,
- Support to piggery farmers,
- Provision of transport for school children,
- Creation of a separate department to handle community affairs,
- KL is a foreign exchange earner for Sierra Leone,
- Provides scrap metals and empty drums for the communities, and
- Provides good drinking water for the project affected communities

Q11. When asked what are the negative impacts on their communities as a result of Koidu Limited mining activities, the respondents replied as follows:

- Medical facilities not extended to project affected communities,
- School enrollment has dropped in schools at the resettlement site because of distance,
- Huge pile of waste dump within the community makes a poor environment,
- Staff not integrating with community members,
- No recreational facilities within the resettlement site,
- Promised to develop a Community Development Action Plan aimed at providing income restoration programmes for the relocated people but up to now no such plan has been effected,
- Blasting operations damaging buildings of community members, and
- Not caring for the transportation of its workers.

Q12. Asked about the perception of the participants on the proposed change in KL mining activities from surface mining to underground mining, the participants replied as follows:

- Drinking water sources which are mainly those of water wells will be dried up,
- There will be subsidence due to removal of kimberlite ore and waste from underground,
- Waste dump will be reduced,
- There will be redundancy in the workforce, and
- There will be volcanic eruptions and earthquakes.

Q13. When asked if the participants foresee any impacts on their economic activities as a result of KL mining activities, the participants had this to say:

- Swamps will be destroyed by mine waste, hence hardship due to reduced economic activity,
- Dried up rivers and streams, hence loss of fish with its attendant loss of income,
- Loss of sacred bush,
- Employment will bring in regular monthly income,

- There will be Rural to Urban migration resulting to no or little agricultural productivity.

Q14. When asked if the participants foresee any impacts on their social activities as a result of KL mining activities, the participants had this to say:

Residents of the resettlement site have no recreational facilities and their movements to nearby recreational facilities are severely restricted due to lack of transportation.

Q15. Asked about the development needs of their communities, the participants replied as follows:

- Portable drinking water
- Enhancement of agricultural activities,
- Good road network,
- Regular electricity,
- Skills training Centre,
- Enhancement of educational facilities, and
- Enhancement of health facilities.

Q16. When asked about the barriers to development in their communities, the attendees replied as follows:

- The indigenes(Kono people) prefer to invest in other parts of the country than in Kono,
- Greed and selfishness- those in governance protect their own interest rather than the interest of the Kono people in general,
- Poor road network,
- Poor medical facilities,
- Poor educational infrastructure with ill-equipped schools, and
- Low agricultural output from all agricultural activities,
- Unreliable supply of electricity,
- Hunger, and
- Poverty.
- Unreliable electricity and water supply.

8 ESIA LIMITATIONS

The following limitations of the 2012 ESIA by Digby Wells were identified at the time of the study:

8.1 Air Quality

The range of uncertainty of the model predictions used by Digby Well's could be -50% to 200%. A model represents the most likely outcome of an ensemble of experimental results. The total uncertainty can be thought of as the sum of three components: the uncertainty due to errors in the model physics; the uncertainty due to data errors; and the uncertainty due to stochastic processes (turbulence) in the atmosphere.

8.2 Fauna and Flora

This assessment was based on information collected during a single site visit. The survey was conducted in February 2011 during the dry season. In order to obtain a comprehensive understanding of the dynamics of communities and the status of endemic, rare or threatened species in any area, faunal assessments should consider investigations at different time scales (across seasons/years) and through repetition.

The timing of the vegetation survey conducted for Koidu mine during February 2011, coincided with the dry season of the region, as described by the annual rainfall cycles experienced in the region. A definite distinction is made between a dry and wet season in the region. However, during the survey it was obvious that the remaining sensitive areas (primarily Monkey Hill) did not degrade during the dry season to the extent that was expected. Water accumulated at the foot of monkey hill and was responsible for a steady supply of water to these areas. Areas identified as not as sensitive were found to be burnt for agricultural purposes.

During the dry season study the study area consisted of large impacted areas, which was described in the flora report, a subsequent wet season study would not have revealed additional information, furthermore the floral diversity of the natural areas, such as monkey hill was not affected by the dry season conditions as a permanent source of water provided for the lack of rainfall, therefore the same conclusion was reached as with the impacted areas. To conclude, a wet season study was not deemed necessary due to prevailing natural and anthropogenic conditions present in the study area.

Satellite images were supplied to assist in the identification of the more important features such as homogenous vegetation units, hills, wetlands and human settlements.

Lastly sampling and trapping efforts were limited to due to fact that the site was easily accessed by the public. Traps used during the survey such as pitfall trapping and Sherman traps although well hidden could be tracked by the locals and taken. Locals utilized the site for

the poaching of animals, gathering of edible vegetation or that of cultural importance and the collection of firewood. For this reason trapping was limited to areas where the traps.

8.3 Aquatic Environment

Information pertaining to water resources for Sierra Leone in general is limited, with little or no information available for the study area. In light of this, internationally recognised methods were considered for the study.

The study area has been mined in excess of 70 years (documented) and this has had a considerable impact on the wetlands for the area, due to these activities. This has resulted in the topography of the area being altered, profiling implemented and the integrity of the wetlands being considerably impacted upon. In light of this, selected wetland areas have been "formed" due to these mining activities and recommendations have taking this into consideration

8.4 Heritage and Archaeology

Although this report has been written as comprehensively and inclusive as possible, it should be noted that most archaeological sites are located below ground, or some areas may have been disturbed to such an extent that any potential in situ deposit was unnoticed. This report may therefore not give a full perspective of archaeological and heritage sites found in the project area and consequently chance find procedures must be implemented. This implies that an archaeologist or heritage specialist must immediately be contacted should any archaeological or heritage features be uncovered during the construction or operational phase. Chance find procedures may form part of the environmental monitoring programme. Such archaeological and heritage features and/or objects may not be disturbed or removed in any way until such time that the specialist has been able to do an assessment of the site (or object).

The significance of these sites is uncertain and has preliminarily been rated. It was recommended that archaeological mitigation should take place at all three sites. These studies are currently being undertaken, after which the significance will be determined.

8.5 Blasting Assessment

The possible need for a blasting assessment has been identified. However, a blasting assessment was not conducted as part of this ESIA, as blasting-related issues raised during the Public Consultation and Disclosure Process (PCDP) indicated that concerns stemmed from within the Extended Affected Area, and blasting is only to occur during the first four years prior to open pit mining ceasing. As people residing within the Extended Affected Area will be resettled, the immediate need for this study was not identified.

However, as a result of the blasting-related issues raised, a blasting monitoring plan is recommended and contained in the EMP. Grievances relating to blasting can be lodged using the grievance mechanism which is contained in Volume 2 of this ESIA.

8.6 Social Environment

Biophysical assessments for this ESIA included the area provisionally earmarked for resettlement due to the expansion of the Koidu Kimberlite Project. A detailed socio-economic assessment of this and other potential replacement land will be conducted during the development of the RAP.

8.7 Health Baseline

As diamond mining is not associated with the use and release of hazardous substances, a health baseline assessment was not conducted. However, it is recommended that a Community Health and Safety Plan be compiled and implemented, using community health data and statistics, to be provided by the on-site clinic at Koidu Mine.

9 IDENTIFICATION OF POTENTIAL IMPACTS

9.1 Introduction

This chapter identifies and describes the potential environmental and social impacts of the project components on the biophysical and socio-economic conditions of the environment and communities. Where applicable, it also identifies mitigation measures that will reduce adverse impacts and that will enhance positive ones. The assessments carried out in this chapter are on potential impacts, on overall environmental and social receptors caused by the project activities in construction, operation and decommissioning phases with mitigation measures recommended accordingly.

9.1.1 Environmental and Social Impact Assessment Background

An ESI assessment (a combination of desk studies and on-site observations by the project team) was carried out on the potential environmental and social impacts identified at the time of the study. This was done in order to first, determine the potential for such impacts, and secondly, to identify and propose mitigation measures that would enable avoidance or reduction of severity should the potential impacts occur or to increase the benefit of potential positive impacts.

9.1.2 Methodology

As the method of assessment of project impacts is inherently subjective and sometimes difficult to quantify, the experience of the project team was relied upon to assess such impacts. This is important in the light of paucity of data on most aspects of the environment, but also for the cultural and traditional, the more indigenous, domain. The knowledge of the project area by team members was invaluable in analyzing impacts. A number of steps were followed:

- A matrix of important project-specific impact categories was prepared;
- The level of significance, achievability of mitigation steps measured against practicality and cost-effectiveness were discussed in workshop/meeting setting;
- An impact assessment scale was then developed.

Degree of Certainty of Impact

Certainty of Impact	Description
Certain	The incidence of this impact is unavoidable and to be expected.

Certainty of Impact	Description
Very Likely	There is a high percentage of possibility for this impact to occur, and measures need to be put in place to mitigate it.
Likely	There is an even chance that the impact will may occur
Unlikely	The possibility of this impact occurring is remote, however it must be considered

Environmental and Social Significance Scale

Significance scale	Description
Very High	Major or permanent alteration of environmental or social dynamics, with severe or very severe consequences, or (in the case of benefits), beneficial or very beneficial effects.
High	Long term effect on the social or natural environment. This category should be treated with a significant degree of importance at the project decision making stage.
Moderate	Medium to long term effects on the social or natural environment. This category should also be taken into cognizance in decision making as constituting a fairly important degree of threat. The threat is real but not substantial.
Low	These would have medium to short term ramifications on the social or natural environment; these are relatively unimportant and pose very little real threat.

Degree of Difficulty to Mitigate

Degree of Difficulty	Description
Very Difficult	The impact can be mitigated in theory, but the extent of financial or technical involvement militates against its application or effectiveness

Degree of Difficulty	Description
Difficult	The impact can be mitigated, but there is a significant degree of difficulty in implementing the proposed measured.
Achievable	The impact can be mitigated without much technicality or cost.
Easily Achievable	The impact can be easily and effectively mitigated

Impact	Description
Extreme	Very significant action would be required to avoid or reduce these impacts. In certain instances, such impacts would prevent the action or option concerned from being taken or approved; and alternatives would have to be considered.
Major	These impacts are significant, meaning that if effective mitigation measures are not taken, a project may be hindered from commencing or continuing. Such option would require effective management and monitoring, or abandoned altogether for other options.
Medium	These impacts though important, are of less serious nature; in such a case, the Best Available Technology (or Practice) Not Entailing Excessive Cost (BATNEEC) should be employed. Such impacts alone are usually not significant enough to prevent a project from commencing or proceeding.
Minor	These impacts fall within the acceptable limits of the impact of a project on the environment, and mitigation in desirable but not necessary. This does not preclude 'Best Practice' as a means of avoiding cumulative impacts.

9.1.3 Planning and Development Phase

During this stage, many of the impacts likely to occur during the life of the project can be avoided through the implementation of measures and strategies to avoid them. It is therefore crucial to

identify all the possible impacts, taking into consideration the full project cycle as early on in the project as possible. Table 9.1.1 outlines the impacts that are likely to occur, and which can start being addressed during planning and development.

Table 9.1-1: Environmental and Social Impacts in the Planning and Development Phase

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
Mine Planning and Design	Underground	Improper planning will lead to disasters which will result in loss of life, property and disruption of entire operation.	Certain	Very high	Effective and experienced mine planning and design personnel. Use of applicable structural, operational and safety codes and standards.	Achievable	Medium
Lighting and Ventilation	Underground	Inadequate lighting and ventilation will result in poor vision, thermal stress, heat & cold stress (heat rash cramps, syncope/fainting, exhaustion, stroke etc.). Exposure to such conditions over time will negatively affect worker health.	Certain	High	Proper design and installation of ventilation and lighting systems according to international codes and standards.	Achievable	Medium
Slope stability and subsidence	Underground	Slope failure and subsidence may result in injury, loss of life and equipment.	Likely	Very High	Proper mine planning and design; implementation of slope stability measures	Achievable	Medium

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
Flooding	Mined out pits and underground	Injury, loss of life, damage to equipment and disruption of operations	Likely	Very high	Implementation of adequate flood control design parameters and features ensuring that required design codes and standards are utilised. Continue with dewatering activities of mined out pits.	Achievable	Medium
Noise and Vibration	Underground and Processing Plant	Exposure to elevated noise levels will negatively affect workers' health including complications such as hearing loss, hypertension, elevated stress levels, etc. Prolonged use of vibrating machinery can lead to muscle and joint pains, which if ignored can affect the nervous system,	Likely	High	Provision of Personal Protective Equipment (PPE); implementation of administrative controls (SOP)	Achievable	Minor

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
		including tingling and loss of sensation in the hands					
Air Quality	Mine Site	Impact on workers, visitors and neighbouring communities	Likely	High	• Provision and training in the use of PPE; • Selection of equipment and machinery suited for underground or closed working environments. • Routine maintenance of all machinery to maintain emissions levels.	Achievable	Minor
Hydrology and Hydrogeology	Mine Site	• Pollution of community water sources as a result of untreated process water leaving the site, causing health problems in communities.	Unlikely Operations to date have not resulted in any water quality or quantity issues in the community	High	• Water recycling and treatment efforts to continue into the UG mining phase. • Monitoring of water quality and quantity within concession and neighbouring communities	Achievable	Minor

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
		• Reduction in water levels or quantities in communities, resulting in difficulty accessing water. • Pollution of water sources affecting aquatic life.			to continue on a monthly basis. • Assistance in the provision of water facilities in communities to continue.		
Flora/Revegetation	Mine concession	There will be no change in existing flora conditions; it is not planned for any new areas to be cleared of vegetation. However restoration of inactive mined out and mine waste storage areas will continue through revegetation.	Certain	High	Development of a defined reclamation plan including progressive reclamation. Continue with nursery program and revegetation of inert mine waste heaps.	Achievable	Positive
Fauna	Underground	Animals may wander into the underground work area and get trapped.	Likely	Moderate	Shaft gates will be installed at entranced to keep animals out; these will be kept closed at all times.	Achievable	Minor

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
Waste Management (Mine and Process Wastes)	Mine concession	Inimical effect on community safety; visual and other environmental impacts	Certain	High	• Development of a defined Mine Reclamation Plan. • Generation of waste rock will be considerably less during underground mining; however a new dumpsite should be identified to prevent existing waste heaps from becoming higher. • Continue use of mine and process wastes in brick manufacture, as well as donation of materials to construction companies and projects.	Achievable	Medium
Waste Management (Domestic and Hazardous Wastes)	Mine Concession	Improper management of domestic and hazardous wastes will result in environmental pollution and health hazards for workers.	Certain	High	Continued implementation of waste management plan involving segregation of wastes at source, recycling/reuse of materials, incineration, etc. Waste management system has been successfully	Achievable	Minor

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
					implemented in current operations		
Blasting	Underground	During the underground mining phase, blasting will be done underground and on a much smaller scale. While this will reduce the scale of potential impacts particularly on communities, improper management of these blasting exercises will expose workers to hazards involving injury and loss of life.	Certain	Very high	• Development of new procedures for underground blasting. • Training of staff in new procedures and what to expect during underground blasting. • Provision of adequate PPE	Achievable	Medium
Emergency Response	Mine Concession	Inadequate preparation for and response to emergency situations will result in disaster	Certain	Very High	Update of existing emergency response plan to cater for potential emergency situations related	Achievable	Medium

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
		involving life and property.			to underground mining.		
Occupational Health and Safety	Mine concession	Workers will be exposed to unfamiliar working environments underground, which puts them at a higher occupational health and safety risks.	Certain	High	Plan training and sensitization workshops/sessions for workers to be engaged in underground mining operations. Normal occupational health and safety trainings to continue for other aspects of the operation.	Achievable	Medium
Stakeholder Engagement	Community and institutional stakeholders	Ineffective or no communication with community and project stakeholders will result in misunderstandings and unrest, with inimical effects on operations.	Certain	High	Stakeholders to be regularly consulted with to ensure that they are familiar with the project, and understand the risks and benefits associated with it.	Achievable	Minor

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
Grievance Mechanism	Communities neighbouring mine site	Unavailability of a grievance mechanism for communities will result in the development of animosity and possibility for unrest and disruption of operations	Likely	High	Continued implementation of grievance mechanism currently in place. Communities to be made aware of the system for reporting grievances.	Achievable	Minor
Community Development		Social unrest and animosity may occur due to unfulfilled expectations if community development initiatives are not implemented	Likely	High	Development of Community Development Action Plan to include UGM phase of the project.	Achievable	Minor
Decommissioning and Closure		Unreclaimed land areas pose environmental as well as community health and safety risks	Certain	High	Implementation of progressive rehabilitation and end of mine rehabilitation as detailed in the Mine Reclamation and Closure Plan.	Achievable	Medium

9.1.4 Operations Phase

During the operations phase, impacts considered during the planning and development phase would be realised. Mitigation measures to minimise these impacts would be implemented and as the project progresses, modifications and inclusions will be made to better address issues based on experience.

Table 9.1-2: Environmental and Social Impacts in the Operations Phase

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
Lighting and Ventilation	Underground	Inadequate lighting and ventilation will result in poor vision, thermal stress, heat & cold stress (heat rash cramps, syncope/fainting, exhaustion, stroke etc.). Exposure to such conditions over time will negatively affect worker health.	Certain	High	Lighting and ventilation features should be monitored to ensure effectiveness. Faulty features should be repaired or replaced immediately. Multiple shift systems to be effected to prevent prolonged worker exposure to artificial lighting and ventilation.	Achievable	Medium
Slope stability and subsidence	Underground	Slope failure and subsidence may result in injury, loss of life and equipment.	Likely	Very High	Monitoring of condition of slope stability measures implemented during development.	Achievable	Medium
Flooding	Mined out pits and underground	Injury, loss of life, damage to equipment and disruption of operations	Likely	Very high	Continue with dewatering activities of mined out pits. Training of staff in flood response and evacuation procedures.	Achievable	Medium

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
Noise and Vibration	Underground and Processing Plant	Exposure to elevated noise levels will negatively affect workers' health including complications such as hearing loss, hypertension, elevated stress levels, etc. Prolonged use of vibrating machinery can lead to muscle and joint pains, which if ignored can affect the nervous system, including tingling and loss of sensation in the hands	Likely	High	Workers to be trained in importance and proper use of PPE. Machinery to undergo regular maintenance to ensure normal operating noise and vibration levels. Multiple shift system to be enforced to prevent over exposure of workers to confined working conditions.	Achievable	Minor
Air Quality	Mine Site	Impact on workers, visitors and neighbouring communities	Likely	High	• Provision and training in the use of PPE; • Routine maintenance of all machinery to maintain normal operating emissions levels.	Achievable	Minor

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
Flora/Revegetation	Mine concession	There will be no change in existing flora conditions; it is not planned for any new areas to be cleared of vegetation. However restoration of inactive mined out and mine waste storage areas will continue through revegetation.	Certain	High	Implementation of reclamation plan including nursery development and progressive reclamation..	Achievable	Positive
Fauna	Underground	Animals may wander into the underground work area and get trapped.	Likely	Moderate	Shaft gates will be kept closed at all times.	Achievable	Minor
Waste Management (Mine and Process Wastes)	Mine concession	Inimical effect on community safety; visual and other environmental impacts	Certain	High	• Storage of mine and process wastes at identified new site; • Continue use of mine and process wastes in brick manufacture, as well as donation of materials to construction companies	Achievable	Medium

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
					and projects.		
Waste Management (Domestic and Hazardous Wastes)	Mine Concession	Improper management of domestic and hazardous wastes will result in environmental pollution and health hazards for workers.	Certain	High	Continued implementation of waste management plan involving segregation of wastes at source, recycling/reuse of materials, incineration, etc.	Achievable	Minor
Blasting	Underground	Blasting will be done underground and on a much smaller scale. While this will reduce the scale of potential impacts particularly on communities, improper management of these blasting exercises will expose workers to hazards involving injury and loss of life.	Certain	Very high	• Training of staff in new procedures and what to expect during underground blasting. • Provision of adequate PPE	Achievable	Medium
Emergency Response	Mine Concession	Inadequate preparation for and response to emergency situations will result in disaster involving life and property.	Certain	Very High	Training sessions to be organised for staff including underground mining-specific emergency response procedures, and refresher courses on general	Achievable	Medium

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
					emergency response procedures.		
Occupational Health and Safety	Mine concession	Workers will be exposed to unfamiliar working environments underground, which puts them at a higher occupational health and safety risks.	Certain	High	Conduct occupational health and safety trainings for general and underground mining -specific occupation health and safety issues. PPE to be provided for all staff and safety signs erected in all operational areas, specifically underground.	Achievable	Medium
Visual Impact		Waste rock heaps can be seen for several kilometres outside the concession and have been criticised for not only the safety aspect, but also for the visual impacts on the township.	Certain	Moderate	Waste heaps will not be made to grow any higher, and are currently being dressed with laterite and seedlings planted to promote vegetation growth. This will reduce the contrast with surrounding environments, with heaps eventually resembling small	Achievable	Minor

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
					hills over time.		
Public Health and Safety	Communities neighbouring concession	Exposure of community residents to company operations, directly or indirectly may jeopardise their health and/or safety	Unlikely Mining concession is fenced and entry of outsiders into working areas is highly unlikely.	High	Sensitization and consultations with communities to continue. Community residents to be continually informed and reminded about the dangers of scaling and removing material from waste rock heaps.	Achievable	Medium
Resettlement	Affected communities	Underground Mining will not result in the need for evacuation. However, unrest may arise among families affected by surface mining operations and identified for resettlement, which are yet to be resettled.	Certain	High	Families to be reassured through consultations, that the RAP will not be discontinued. Implementation of Resettlement Action Plan to continue with monitoring and reporting to EPA-SL.		

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
Stakeholder Engagement	Community and institutional stakeholders	Ineffective or no communication with community and project stakeholders will result in misunderstandings and unrest, with inimical effects on operations.	Certain	High	Stakeholders to be regularly consulted with throughout the life of the project.	Achievable	Minor
Grievance Mechanism	Communities neighbouring mine site	Unavailability of a grievance mechanism for communities will result in the development of animosity and possibility for unrest and disruption of operations	Likely	High	Continued implementation of grievance mechanism currently in place. Communities to be made aware of the system for reporting grievances.	Achievable	Minor
Community Development		Social unrest and animosity may occur due to unfulfilled expectations if community development initiatives are not implemented	Likely	High	Implementation of Community Development Action Plan activities through the Community Development Management Committee. Progress and success of activities to be monitored and reported to	Achievable	Minor

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
					EPA		
Decommissioning and Closure		Unreclaimed land areas pose environmental as well as community health and safety risks	Certain	High	Implementation of progressive rehabilitation and end of mine rehabilitation as detailed in the Mine Reclamation and Closure Plan.	Achievable	Medium

9.1.5 Decommissioning and Closure

At the end of mine life, it is anticipated that if the project is not being acquired by another company decommissioning and closure of the site would have to occur. This would involve rehabilitation of mined out areas, waste dumps, removal of equipment and infrastructure. The following table highlights the expected impacts from these activities.

Table 9.1-3: Environmental and Social Impacts in the Decommissioning Phase

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
Slope stability and subsidence	Mine Concession	Slope failure and subsidence may result in safety hazards to members of the community.	Likely	High	Part of the decommissioning activities include levelling and grading of mounds and heaps (not including the waste rock heaps which will have been reclaimed during progressive reclamation). Monitoring following closure will be carried out and modifications made where necessary.	Achievable	Medium
Artificial Lakes	Mined out pits	Health and safety risks to community members including accidental drowning and breeding of disease carrying organisms.	Likely	Very high	Safety signs will be erected around artificial lakes. Community will be sensitized on safety in relation to the water bodies in consultations before and during decommissioning.	Achievable	Medium
	Mined out pits	Fish species introduced into the artificial lakes will serve as a source of food and income for communities.	Certain	High	Post closure monitoring will be carried out to ensure success of fish stocking programme.	Achievable	Positive

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
Noise and Vibration	Mine Concession	Noise and Vibration is expected to peak during closure of the site particularly in relation to removal of surface and underground structures and equipment. May affect workers and neighbouring communities. This impact will be short-lived as on completion of closure activities ambient noise levels will be achieved.	Likely	High	Workers to be provided with PPE. Closure activities to be conducted during the day in order to minimise noise impact on communities. Multiple shift system to be enforced to prevent over exposure of workers to elevated noise levels and vibration.	Achievable	Minor
Air Quality	Mine Site	Air pollution will likely occur due to exhaust emissions and dust generating activities during closure. Health Impact on workers, and neighbouring communities.	Likely	High	• Provision and training in the use of PPE; • Routine maintenance of all machinery to maintain normal operating emissions levels. • Post closure air quality monitoring will be carried	Achievable	Minor

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
		Impact will be reversed over time following closure.			out for at least 5 years.		
Flora/Revegetation	Mine concession	Mine reclamation activities include a revegetation programme in an attempt to return the site to a pre-project condition.	Certain	High	Post closure monitoring will promote success of revegetation project.	Achievable	Positive
Fauna	Underground	Cessation of operations and restoration of vegetation within the concession will encourage the establishment of animal habitats.	Certain	High	Post closure monitoring will take record progress with repopulation of animal species within concession	Achievable	Positive
Waste Management	Mine concession	Inimical effect on community safety; visual and other environmental impacts	Certain	High	• Waste dumps sites will be reclaimed. • Waste facilities (incinerator, etc) will be dismantled. • Areas contaminated with	Achievable	Medium

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
					petroleum products, chemicals, etc will be reclaimed and tests carried out to ensure complete restoration. • Waste materials from site will be recycled or donated for reuse where possible or disposed of in an environmentally acceptable manner suitable for the disposal of hazardous and non-hazardous wastes.		
Occupational Health and Safety	Mine concession	Workers will face occupational hazards during closure activities.	Certain	High	• Provision of PPE for all workers. • Risk assessments to be carried out prior to commencement of activities.	Achievable	Minor
Visual Impact	Mine concession	Site will be reclaimed to as best as possible blend in with the surrounding area.	Certain				Positive

Issue	Location	Impact	Certainty of impact	Significance	Mitigation measure	Degree of difficulty	Residual Impact Category
		Removal of operational features, surface levelling and grading, revegetation etc will contribute towards achieving this.					
Public Health and Safety	Communities neighbouring concession	Safety of residents should be ensured with access to the unfamiliar terrain possible, particularly in the early period following closure.		High	Sensitization and consultations with communities to continue throughout the project and into the decommissioning phase. Safety signs to be put up in sensitive areas e.g. ponds and newly revegetated area.	Achievable	Medium
Stakeholder Engagement	Community and institutional stakeholders	Communication with community and project stakeholders is crucial for the success and sustainability of the closure process.		High	Stakeholders to be regularly consulted with before and during decommissioning. Their views and suggestions should be taken into consideration in implementing the process.	Achievable	Minor

10 SUMMARY AND CONCLUSION

10.1 Summary

10.1.1 Components of the ESIA

10.1.2 Key Assessment Findings

The investigations of impacts on the social environment are a crucial part of the study, since the operation may impact the communities which reside at close proximity to the project site.

The investigation of social impacts has involved the following:

- A baseline socio-economic study of the community envisaged to be impacted by the project activities in both the development and operational phases;
- A Public Consultation and Disclosure Process (PCDP) undertaken to sensitize stakeholders.

The baseline environmental and socio-economic situations have been presented. There are minor socio-economic impacts of the projects.

A number of significant environmental impacts of the project's activities have been identified for the development and operations stages. The most significant of these impacts are the risk of air quality pollution during the operations phase of the project, though others such as slope stability and subsidence, noise and vibration, lighting and ventilation during the operational phase are also of importance. These impacts will affect both the staff and neighbouring communities.

Noise and vibration is also a significant impact, particularly during the operations phase. This will be mitigated against, after which the effects will be greatly reduced.

Generally, the investigations reveal that environmental and social problems wrought by the project can be adequately managed and that there are no insurmountable problems that should stop the project from proceeding.

A monitoring system must however be put in place to ensure that management practices for mitigating negative impacts and enhancing those that are positive be effected. It must however be ensured that recommendations made in the Environmental Management Plans are followed through.

10.2 Conclusion

The Koidu Kimberlite UG Project is being undertaken with appropriate consideration of biophysical, social and economic factors, as well as the relevant legislative requirements. The economic benefits of such a development are numerous, however, as in any mining project of this nature there are also negative impacts which will require planning, monitoring and mitigation during construction, operation, decommissioning and post-

closure. While the proposed UG mining method will not warrant any resettlement, previously identified household for resettlement constitutes a major impact which will require an integrated resettlement and development approach.

National and regional leaders in the country, security services, as well as NGOs and the international community, must interact with management to protect the Project from unnecessary and unwanted negative interventions which may have as their sole purpose the creation of economic advantage for individuals to whom none is due or owing.

REFERENCES

Digby Wells Environmental (2011). *Environmental and Social Impact Assessment Report for the Koidu Kimberlite Project.*