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## AUREUS MINING INC.

# NEW LIBERTY GOLD MINE (NLGM) PROJECT ENVIRONMENTAL IMPACT STATEMENT (EIS)

# VOLUME I

**Submitted to:**
The Liberian Environmental Protection Agency (EPA)
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REPORT

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# Executive Summary

## Introduction

Bea Mountain Mining Corporation (BMMC), a company registered in Liberia, is a wholly owned subsidiary of Aureus Mining Incorporated (Aureus). BMMC holds a Class A mining license issued by the Liberian Ministry of Land, Mines and Energy on 29 July 2009 to mine the New Liberty Gold Mine (NLGM) deposit for a period of 25 years, with the right to extend this license for an additional term of 25 years. BMMC proposes to develop an open pit gold mine, referred to as the NLGM Project (the ‘Project’), which is one of a series of gold exploration deposits located within BMMC’s 457 $km^2$ mining license area. (Note that the Project refers to the NLGM project area only of the Class A mining license area).

According to Section 37 of the Environment Protection Agency Act of Liberia, BMMC is required to undertake an environmental impact assessment (EIA) for the proposed project. Informed by the findings of the EIA, the Liberian Environmental Protection Agency (EPA) will make a decision on whether the project may proceed or not. The EIA has been undertaken to meet Liberian legislative requirements. (Reference has also been made to applicable international standards/limits).

BMMC appointed an independent consulting company, Golder Associates (Ghana) Ltd, based in Accra, Ghana, to undertake the EIA and associated specialist studies, with assistance provided by the local Liberian consulting company, EarthCons Inc., as per requirements of the Liberian Environmental Protection and Management Law (2006).

This report presents the Environmental Impact Statement (EIS) for review by the EPA. The EIS is a consolidated report detailing the findings of the specialist studies conducted during the EIA, and also presents the Environmental Management Plan (EMP). It has been prepared by Golder Associates (Golder), with assistance from EarthCons, on behalf of BMMC. The format for this EIS is taken from and aligned with the Liberian EPA “Environmental Impact Assessment Procedural Guidelines” (2006).

The key factors considered in the EIA are as follows:

- The existing/baseline environment, and obtaining relevant baseline data;
- The potential direct and indirect environmental and socio-cultural impacts of the proposed Project;
- The environmental consequence of the environmental impacts referred to above;
- Measures that are technically and economically feasible and that would mitigate any significant adverse environmental or social impacts related to the proposed project;
- Project alternatives, including an alternative means of carrying out the Project that are technically and economically feasible; and
- The effects of the Project on the biophysical and social environment.

A number of specialist studies were undertaken as part of the EIA in order to investigate the areas of importance highlighted in the Scoping Report. (The Scoping Report was submitted to the EPA in April 2012 and BMMC received the EPA’s letter approving the Scoping Report dated the 22nd May 2012). The EIA specialist studies included:

- Soils and land use;
- Surface water, also including surface water quality;
- Groundwater;
- Geochemistry;

- Air quality;
- Noise;
- Terrestrial ecology;
- Aquatic ecology;
- Protected areas;
- Socio-economic aspects;
- Cultural heritage;
- Visual aesthetics; and
- Closure objectives and closure costing.

The Environmental Protection and Management Law of Liberia (EPML, 2002) identifies the key steps in the environmental impact assessment review process in Liberia, which are stipulated in Sections 6 through to 23. The scope of the EIA was based on this, and thus to date the following process steps have taken place:

- Application for an Environmental Impact Assessment License by BMMC;
- Notice of Intent completed;
- Development of a Project Brief submitted to the EPA (carried out in November 2010);
- Conducting the Scoping Phase of the EIA and submitted a Scoping Report to the EPA (carried out in April 2012); and
- Conducting the Impact Assessment Phase of the EIA, notably the applicable specialist study assessments. Based on the findings of the specialist assessments, this EIS has been developed for submission to the EPA.

The NLGM EIA was completed using accepted international standards (notably those of the World Bank and World Health Organisation), best practice principles and techniques, and the Liberian EPA EIA Procedural Guidelines (2006). The public participation that was followed as part of the EIA process was conducted with reference to Liberian legislation.

The study area for the EIA consists of the footprint of the proposed Project (as shown in the site layout map; upstream and downstream areas, local topography (studied as part of the infrastructure design process and fed into the EIA), directly affected villages (i.e. Kinjor and Larjor) and neighbouring villages within a radius of approximately 5 km of the site. In addition, consideration was given to the wider geographical context where applicable.

In terms of the assumptions and limitations associated with the EIA, a description of the proposed project provided by Aureus informed the project description described by Golder in the EIS. The project description contained in this EIS has been reviewed and signed off as correct by Aureus. Golder was requested to finalise the assessment of possible environmental and social impacts of the proposed Project by end of the second quarter 2012, on the basis of the established environmental baseline and project description provided. To meet this time schedule a number of specialist studies reflect a qualified opinion by the specialist team, based on the experience of the specialists concerned and their knowledge of the current local conditions gained through baseline. A decision was made by Aureus to conduct the relevant quantitative assessments during the operational phase of the Project. Recommendations that modelling be completed for air quality and hydrogeology are contained in the mitigation plan/EMP in order to reduce uncertainty in prediction of possible impacts.

## Project Description

The proposed Project is located within the Grand Cape Mount County of the Republic of Liberia, West Africa, within the south-western part of the greater Bea Mountain Mineral Development Agreement (Bea-MDA) property/concession area. The NLGM Project area is approximately 33 km² in extent, which was the focus of the EIA. (The MDA is an agreement between the Liberian Government and the Project owners, BMMC/Aureus)

The proposed Project will involve the open-pit mining of the NLGM deposits and processing of ore by conventional carbon-in-leach (CIL) technology. The proposed Project will involve an open pit gold mine that is expected to operate for approximately 8 years with an ore production and treatment rate of approximately 3,050 tonnes per day. (With the life of mine of 8 years. the mining license period is 25 years due to exploration activities in the rest of the BMMC Class A mining license area). Waste rock will be mined at an average daily production rate of 45,000 tonnes per day. The Project includes all activities and physical works associated with the pre-construction, construction, operational, and decommissioning and closure phases of the Project, including the following key infrastructure components:

- Resettlement of the Kinjor and Larjor communities (as part of the pre-construction phase);
- Open pit gold mine and associated waste rock dump (WRD);
- Topsoil stockpiles;
- Gold processing plant, including an associated power plant made up of eight diesel or heavy fuel oil generators;
- Water dams associated with the processing plant, mainly used for storage purposes;
- Tailings Storage Facility (TSF);
- Support facilities and infrastructure at the mine site, including water, waste infrastructure and storage facilities;
- Diversion Channel (DC) of the Marvoe Creek;
- Staff accommodation and associated facilities such as a sewerage treatment plant. (The sewerage will be disposed to septic tanks and the sewerage slurry will be disposed of at the TSF. A sewerage treatment plant and system will service the accommodation camp and processing plant areas. The sewerage treatment plant will comprise of an underground tank, and an aerobic treatment unit and sludge disposal to the TSF);
- General waste landfill site, and an associated incinerator; for incineration of hazardous wastes;
- Power and water supply;
- Ancillary facilities and buildings, such as administrative offices, service buildings, laboratory, hydrocarbon storage, explosives storage; and
- Non-paved roads and haul roads; existing and new.

In line with Liberian labour legislation, BMMC has made local hiring and training/capacity building a priority, and this make up a prominent proportion of BMMC's Human Resources (HR) Policy, which is currently being developed.

During the different phases of the Project, BMMC envisages the following employment numbers:

- Construction Phase: Approximately 400 personnel with approximately 65% Liberians; and
- Operational Phase: Approximately 300 personnel will be employed within the mining operations. Approximately 80% of these will be Liberians, which will comprise of skilled, semi-skilled and unskilled personnel.

## Description of the Environment

The following bullet points provide a brief summary of the key points associated with the existing/baseline environment within the NLGM Project area:

- Meteorological data for the region surrounding NLGM Project site is scarce; however the bulk climate and seasonal variations are distinct. BMMC has established a meteorological station at the NLGM exploration camp. The Project area has a tropical climate with two seasons: wet and dry. The annual average rainfall for the site was estimated at 3,500 mm based on distance from regional stations throughout Liberia. Monthly average temperatures tend to vary between 24.3°C and 26.7°C.
- The NLGM site is located within the “rolling hills” physiographic region, some 40 km from the coast, where the topography is gently undulating with occasional small hills. Elevation above sea level at the site ranges from 50 m in the south, gradually rising via rolling topography to 80 m in the north. A series of perennial streams segments the rolling topography. Mid-slopes have moderately sloping gradient (8 to 15% slope).
- In terms of geology, the lithologies underlying the Bea-MDA property consist of a sequence of highly deformed granitic gneisses into which sequences of ultramafic schists have been folded. Within the Project area are three main stratigraphic units, which are further subdivided into minor zones of varying mineralogical assemblages. The geology is dominated by tremolite-chlorite-actinolite-talc ± magnetite rich meta-ultramafics, sometimes with phlogopite, and flanked by migmatitic gneisses.
- In general, the soils in the Project area show limited variation and are characterised by a shallow layer of topsoil that is low in organic matter content, and deficient in magnesium and calcium Four relatively homogeneous soil groups are recognized. The historic and current artisanal mining activities has resulted in elevated concentrations of a number of trace elements such as Ag, As, Cd, Co, Mo, Sb and Se which are also above soil screening values. Other constituents that are significantly elevated above baseline concentrations but not above screening values are Cr, Cu, Mn, Ni, Ti and V
- The current land use of the surrounding area contiguous to the NLGM Project area is for the most part the same as within the Project area itself – current land use is mainly tall tropical forest or disturbed forest area from on-going logging operations and artisanal mining activities.
- The results of the water quality analysis show that the water on site (in the Marvoe Creek)is of good quality. However, there are some concentrations, particularly aluminium and iron, which are exceeding the Liberian, and WHO drinking water limits.
- The potential aquifer(s) zones underlying the Project area may be classified as:
  - Perched water table aquifer zone – which occurs in the saprolite. The presence of the water table aquifer was confirmed by test pit profiling during the DC investigation conducted by Golder’s engineering team in 2012. This reported, as seepage in boreholes TP-01 (1.2m), TP-02 (0.7m) TP-03 (0.8m) and TP-04 (0.8 m). Most of the hand dug village water supply wells reach this aquifer.
  - A shallow aquifer zone – this potentially occurs along narrow sections where pockets of weathering/fracturing in hard bedrock prevail. Although these aquifer zones seldom produce large quantities of water, they may be developed for local supplies and may play a significant role in maintaining river base flow. The extent may be limited and water quality variable; and

- A deep aquifer zone – this may occur along deeply weathered and fractured contact zones between the strata and ore zone. Such an aquifer system may be highly productive and able to support large abstractions for public supply and other purposes. The groundwater quality is good.

- From the groundwater quality analysis, it is apparent that the Project area is characterised by one dominant ground water type with bicarbonate ($HCO_3$) the dominant anion and calcium the dominant cation. This is typical of recently recharged groundwater from rainwater.

- Groundwater quality analyses (major cation and anion and metal) of the hydrocensus samples reveal that the groundwater at the site is of good quality, within SANS 241 class I and World Health 1998 drinking water standards. The only exception was the sample obtained from the mineral exploration borehole KGD 146, which has elevated arsenic and iron levels which exceeded both SANS and WHO standards.

- The baseline air quality in the area is good, based on the six month monitoring which was undertaken as part of the EIA. Annual and 24 hour $NO_2$ concentrations are less than 5% of the relevant WHO standards as is 24 hour $SO_2$. 10/ 15 minute $SO_2$ is slightly higher but still only 6.3% of the relevant WHO standard. The $O_3$ background concentration is higher, but this is still only 53.9% of the WHO standard. Baseline monitoring also indicates that deposited dust is much lower than the recommended levels in both the South African and International guidelines. The baseline monitoring identifies that background air quality is good and concentrations are well below the relevant standards.

- Due to the remote setting of the NLGM site, the thick forest vegetation around villages, the fact that the area is in a rural setting and there are no commercially based industries in the region, the baseline noise levels are relatively low, with no marked impacts on the local population.

- Based on physiognomy, moisture regime, rockiness, slope and soil properties, four main communities were recognised within the Project area, namely:
  - Natural Forest community;
  - Rubber plantation;
  - Disturbed forest community; and
  - Transformed vegetation community.

- A total of 329 plant species were recorded during the terrestrial ecology surveys. Floral species diversity in the area is high and even the 329 species recorded are not considered to be the total species count for the area. A large proportion of the species recorded are indigenous with few exotic species occurring in the area, although in areas of higher anthropogenic disturbances, notably along roads, some exotic species are more prevalent.

- During the surveys two Red Data floral species were recorded *Anopyxis klaineana* and *Raphia palma-pinus*.

- One Red Data avifaunal species was recorded in the study area during the 20010/11 surveys, namely the African Grey Parrot (*Psittacus erithacus timneh*).

- Mammal species diversity was very low in the study area due to hunting for the bushmeat trade. Of the 85 mammal species known to occur in the Project area, 10 species were recorded during the 20010/11 ecology surveys.

- A total of 17 fish species were recorded in the sample area during the November 2010 survey (0 to 8 species per site). A total of 18 fish species were recorded in the project area during the April 2011 survey (4 to 8 species per site).

- Two Red Listed fish species were recorded during the EIA aquatic ecology surveys, namely *Doumea chappuisi* which is listed as Vulnerable and *Malapterurus stiassnyae* which is listed as Near Threatened by the IUCN's Red List of Threatened Species.
- There are thus no protected areas that are close to the NLGM Project site; the closest is approximately 30 km to the southwest, downstream of the site. In terms of wetlands of international importance, the wetland area of Lake Piso (near Robertsport), located approximately 30 km south of the Project area, downstream, has been identified as a RAMSAR Wetland.
- The Project area is surrounded by a number of small, agricultural villages and an artisanal mining community spread across the villages of Kinjor and the smaller Larjor. Dependence on natural resources extends to a large extent to food supply, although more so in agricultural villages than mining ones. Whilst farming is the basis of livelihoods in many of the older villages, forming 'a whole year business' and supplying the majority of food supplies, very few households in Kinjor and Larjor have access to farming land. Households in mining villages more commonly purchase food either from surrounding farmers or from Monrovia.
- A total of 26 cultural heritage sites were identified during the baseline survey.

## Impact Prediction and Evaluation

During the EIA, environmental and social related impacts were identified and assessed during each of the specialist assessments, and an impact assessment matrix in line with the Liberian EPA EIA Procedural Guidelines (2006) was used to rate the significance of impacts before and after mitigation, for the construction, operational, and decommissioning and closure phases of the Project. The key potential Project related impacts identified during the EIA are listed below. These impacts were rated as being of high significance before mitigation measures are applied. The potential impacts include:

- Contamination of local water bodies;
- Contamination of underlying aquifers from TSF;
- Contamination of underlying aquifers from the WRD;
- The permanent diversion of the Marvoe Creek
- Dust generated from the working face during open pit mining;
- Potential emissions from ore processing;
- Physical displacement impacting built structures and sites of religious significance (i.e. related to the RAP, required for relocating the Kinjor and Larjor villages)
- Economic displacement impacting agricultural land and natural resources, and impacting upon artisanal mining opportunities; and
- Loss of burial sites within the villages of Larjor and Kinjor, as these two villages will be relocated.

The impact prediction and evaluation section of the EIS (Sections 5 and 6 discuss the potential Project impacts in detail).

## Cumulative and Residual Impacts

Cumulative impacts/effects generally refer to impacts that are additive or interactive (synergistic) in nature and result from multiple activities over time, including the project being assessed. This, the cumulative impact assessment considers the Project within the context of other similar land uses, in the local study area and greater regional context.

Key cumulative impacts associated with the proposed Project include:

- Related to surface water is the diversion of the Marvoe Creek by means of the proposed DC. As the Marvoe Creek will be permanently diverted, the cumulative impact of this is assessed to be of moderate significance before mitigation, and of minor significance after mitigation.

- From a terrestrial ecology perspective, forest clearing and disturbances in the greater area arise from subsistence agriculture, commercial logging and artisanal mining. The significance of the cumulative impacts from a terrestrial ecology perspective is assessed to be moderate, due to the scale/size of the potential disturbance area.

- Related to the socio-economic assessment is the resettlement action plan (RAP). The Kinjor and Larjor communities will be permanently relocated as a result of the Project, and from a social perspective the cumulative impact associated with this is assessed to be high to moderate, but can be managed if the appropriate mitigation measures are implemented effectively.

For the purposes of the NLGM impact assessment, residual impacts are those that remain significant following the application of mitigation measures. Key residual impacts associated with the proposed Project include:

- Permanent land/soil sterilisation in the mine infrastructure footprint area (due to the presence of the TSF, WRD and processing plant etc.) will occur.
- The surface water related impacts resulting from the proposed Project were rated as moderate using the methodology prescribed, which makes use of a numerical system. There are no envisaged impacts that remain significant following the application of mitigation measures.
- It is impossible to develop the proposed Project within a relatively natural area without having a “net loss” of biodiversity. As the project stands there are no substantial losses in biodiversity predicted, provided the mitigation measures mentioned in the EMP
- The majority of socio-economic impacts identified during the impact assessment can be reduced to low significance following the implementation of mitigation measures. However, impacts of physical and economic displacement remain of moderate significance, even with mitigation, due to their permanent nature.

## Environmental Management Plan and Mitigation Measures

Based on the potential impacts identified and assessed during the EIA, an EMP was developed. The list below briefly highlights some of the key mitigation measures to be implemented by BMMC during the life of the Project:

- Compensate affected families for loss of crop production and assist in securing other suitable land for their relocation.
- Undertake and implement a detailed RAP in line with Liberian and IFC PS5 standards – currently being undertaken by Digby Wells Environmental.
- Excessive soil contamination by fuel or oil spills, for example, from mining vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ using bioremediation, in accordance with BMMC’s procedures.
- Maintain the stormwater management system.
- Conduct a quantitative groundwater modelling study for the mining operations (by latest, the start of the construction phase).
- Commission a groundwater monitoring system.
- Continuous monitoring of the water table in de-watering and monitoring boreholes.
- Separated rainfall runoff into clean and dirty water.

- All dirty water will be captured, to be re-used where possible.
- Implement quarterly groundwater quality monitoring.
- The total footprint area to be disturbed / developed will be kept to a minimum by demarcating the construction areas and restricting construction to these areas only.
- Conduct a quantitative air quality modelling study (before or during the construction phase).
- Locate machinery, fuel and chemical storage and dust generating activities away from site boundaries and sensitive receptors where possible.
- Implement a vehicle speed limit monitoring system on site, to help prevent/control dust from vehicles and for health and safety purposes.
- Use of water suppressant systems or dampening down whenever possible.
- Annual official inspection and monitoring of site power plant emissions in relation to appropriate emission limits/standards.
- Training of personnel to adhere to operational procedures that reduce the occurrence and magnitude of individual noisy events.
- Earthworks/material stockpiles will be placed as barriers to protect boundaries from noise from operations and especially from haul roads.
- Sediment traps should be installed and maintained where appropriate;
- Riparian vegetation bordering on drainage lines and rivers should be considered environmentally sensitive and impacts on these habitats should be avoided;
- The development of alternative livelihood strategies should be the preferred mitigation measure, maximising all possibilities for involvement in employment opportunities available.
- A Livelihood Restoration Plan and Community Development Plan should be developed to ensure households are not left worse off following displacement.
- Implementation of skills development programmes to ensure support local population in obtaining employment opportunities.
- BMMC must undertake a Phase 2 Geochemical Assessment, which includes kinetic testing.
- A detailed health and safety plan must be developed to mitigate the construction and operation risks of the proposed project on the surrounding communities.
- Cyanide will be transported, stored and managed in line with the International Cyanide Code principles, management measures and guidelines.

The Project will require the physical resettlement of approximately 300 households, and approximately 1,800 people, residing in the two villages, Kinjor and Larjor, located within the Project area. BMMC/Aureus contracted Digby Wells Environmental and EarthCons to develop a comprehensive RAP for the proposed Project. BMMC has committed to following the applicable Liberian legislation/regulations and international best practice in the implementation of associated resettlement activities.

Based on the mitigation measures highlighted in the EMP, an associated environmental and social management plan was compiled for the Project.

## Identification of Alternatives

As part of the Project pre-feasibility and feasibility studies and the EIA, a detailed identification of alternatives process was conducted. The alternatives for the location, design and volumes associated with each key Project infrastructural component were assessed, including for the resettlement village location (undertaken as part of the RAP). The Go-No-Go option was also assessed.

## Closure Objectives and Closure Costs

As part of the NLGM EIA, closure objectives were determined and are presented in the EIS.

The closure costs were determined for scheduled closure (2022), as well as unscheduled closure as at May 2012. The estimated closure cost for unscheduled and scheduled closure for the respective areas as at May 2012, amounts to approximately USD1.07 million and USD1.20 million, respectively.

## Public Consultation

Public consultation forms an integral part of the EIA as it provides interested and affected parties (I&APs) with project information and an opportunity to comment. It is also a requirement of Liberian guidelines and is in line with international best practice.

## Conclusion and Recommendations

Key recommendations that come out of the EIA include:

- The RAP must be completed in line with Liberian legislative requirements and IFC Performance Standard 5;
- BMMC needs to undertake quantitative groundwater modelling to ascertain the potential impact on groundwater levels, quality and contamination in the surrounding streams, rivers and boreholes, and committing to establish a comprehensive ground and surface water monitoring program on site;
- In association with the quantitative groundwater study, BMMC needs to undertake a Phase 2 Geochemical Assessment, which includes kinetic testing;
- BMMC needs to undertake quantitative air quality modelling, aimed at further assessing and managing air quality and dust impacts associated with the Project; and
- BMMC needs to implement the EMP mitigation measures and the associated environmental and social monitoring measures as outlined in this EIS.

In conclusion, the technical challenges faced by BMMC to manage and mitigate the environmental and social impacts associated with the NLGM Project are amenable to standard technical solutions. No issue has been identified that presents a technical challenge beyond that which is regularly encountered and resolved by comparable mining operations elsewhere in Africa.

The proposed Project will result in both temporary and permanent changes to land use and vegetation within the Project footprint. However, provided that the management and mitigation measures outlined by the EMP are adopted and implemented properly, and the site decommissioning is planned diligently and undertaken, Project impacts on local ecology and downstream environments are likely to be manageable and within acceptable levels in terms of Liberian legislation and best practice principles.

The largest socio-economic impact associated with the proposed NLGM Project is the involuntary relocation of two communities that will need to take place, and associated economic displacement. The socio-economic effects of the NLGM Project are expected to be generally positive and result in an overall improvement in the material, physical and social well-being of the communities living within the vicinity of the Project site. However, wherever possible, it is important that health and community programs supported by BMMC are culturally appropriate and sustainable beyond the life of the project.

Environmental management of the NLGM Project will be an evolving process over the life of the mine. In particular, the environmental management and mitigation measures and the monitoring program outlined in this EIS must be updated annually for continual improvement to occur and for management practices to remain current and aligned with Liberian legislation and industry best practice.

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## Terms and Abbreviations

| Term / Acronym | Explanation |
|---|---|
| **AAM** | African Aura Mining |
| **ABA** | Acid base accounting |
| **AMC** | Australian Mining Consultants |
| **ANFO** | Ammonium nitrate and fuel oil |
| **Aquifer** | A permeable body of rock or soil that stores and transmits groundwater in sufficient quantity to supply wells. |
| **ARD** | Acid Rock Drainage |
| **Artisanal miner** | Subsistence miner, not officially employed by a mining company, but rather works independently. |
| **AQ** | Air quality |
| **Aquifer** | A permeable body of rock or soil that stores and transmits groundwater in sufficient quantity to supply wells. |
| **BID** | Background information document |
| **Biodiversity** | Quantity of plant and animal species found in a given environment. |
| **BM** | Benchmarks |
| **BMMC** | Bea Mountain Mining Corporation |
| **BOD** | Board of directors |
| **Bullion** | Gold or silver in bars or ingots |
| **C** | Celsius (temperature) |
| **CAPEX** | Capital expenditure |
| **CEMS** | Continuous emissions monitoring system |
| **Climate** | A measure of the long-term averages, i.e., normal, of key atmospheric variables such as temperature, precipitation/rainfall and wind. |
| **Closure** | Project closure is the period of time when the mining and ore processing production activities have ceased, and final decommissioning and site reclamation are being completed. |
| **CIL** | Carbon in leach |
| **CITES** | International Trade in Endangered Species of Wild Fauna and Flora |
| **Concession area** | The area within which the proponent (i.e. BMMC) has the right to carry out the project once authorisation by the relevant government department is provided. |
| **COO** | Chief Operating Officer |
| **CSR** | Corporate social responsibility |
| **DC** | Diversion channel (of the Marvoe Creek) |

| Term / Acronym | Explanation |
|---|---|
| **DEC** | District environment committee |
| **DEM** | Digital elevation model |
| **DMRRB** | Design Manual for Roads and Bridges |
| **DO** | Dissolved oxygen |
| **DTM** | Digital terrain model |
| **EHS** | Environment, Health and Safety |
| **EIA** | Environmental impact assessment is the process by which the environmental (and social) consequences of a proposed project are evaluated and alternatives are analysed |
| **EITI** | Extractive Industries Transparency Initiative |
| **EIS** | Environmental Impact Statement |
| **Elution** | Separation of material by washing |
| **EMP** | Environmental Management Plan |
| **Endangered species** | A species facing imminent extinction or extirpation (no longer occurring in the country) |
| **Environment** | The physical environment (land, water, soils, air, etc) and the biological environment (plants and animals) |
| **EP's** | Equator Principles |
| **Equator Principles** | A set of 9 Principals used by lenders as a means of ensuring that the projects they finance are socially and environmentally responsible and sound. |
| **EPA** | Liberian Environmental Protection Agency |
| **EPAA** | Environmental Protection Agency Act |
| **EPML** | Environmental Protection and Management Law |
| **Eurofins** | Accredited laboratory in the Netherlands |
| **Feasibility study** | An in-depth assessment of whether a proposed project should go ahead, or not, based on economic, technical and environmental/social criteria |
| **FAO** | Food and Agricultural Organisation of the United Nations |
| **FDA** | Forestry Development Authority |
| **Flocculation** | Flocculation is a process of contact and adhesion whereby the particles of a dispersion form larger-size clusters |
| **GDEM** | Global digital elevation model |
| **Geochemistry** | The study of the chemical composition of the Earth, chemical processes and reactions that determine the composition of rocks and soils, and the cycles of matter and energy that transport the Earth's chemical components |
| **GP** | Gauge plates |
| **GPS** | Global positioning system |
| **GIS** | Geographical information systems |

| Term / Acronym | Explanation |
|---|---|
| **Groundwater** | Water that occurs below the surface of the Earth, where it occupies spaces in soils or geological strata |
| **HCG** | Hydrogen cyanide gas |
| **HCN** | Hydrogen cyanide |
| **HR** | Human resources |
| **Hydrology** | The science dealing with the properties, distribution, and circulation of water |
| **IAIA** | International Association for Impact Assessment |
| **I & AP's** | Interested and affected parties |
| **IDF** | Intensity duration frequency |
| **ICMC** | International Cyanide Management Code |
| **IFC** | International Finance Corporation |
| **IFC PS5** | International Finance Corporation Performance Standard 5 |
| **IHAS** | Invertebrate Habitat Assessment System |
| **ILO** | International Labour Organisation |
| **Impact** | A change in the status (e.g. health, standard of living, etc.) of the environment and/or individuals, families, or communities as a result of a development |
| **ISO** | International Organisation for Standardisation |
| **IRR** | Internal rate of return |
| **ITTA** | International Tropical Timber Agreement |
| **IUCN** | International Union for Conservation of Nature |
| **IWRM** | Integrated water resources management |
| **IWRMP** | Integrated water resources management plan |
| **km** | Kilometres |
| **km$^2$** | Square kilometres |
| **KPI** | Key performance indicator |
| **LAeqI** | Equivalent continuous A-weighted noise levels |
| **LHS** | Liberia Hydrological Service |
| **LOM** | Life of mine |
| **LRP** | Livelihoods restoration plan |
| **LWSC** | Liberia Water and Sewer Corporation |
| **m** | Metres |
| **mbgl** | Metres below ground level |
| **MDA** | Mineral Development Agreement |

| Term / Acronym | Explanation |
|---|---|
| **METI** | Ministry of Economy, Trade, and Industry |
| **Mitigation** | An activity which makes an impact less harsh or hostile |
| **ML** | Metal leaching |
| **Mm** | Millimetres |
| **MOA** | Ministry of Agriculture |
| **MOH** | Ministry of Health and Social Welfare |
| **MPEA** | Ministry of Planning and Economic Affairs |
| **MPW** | Ministry of Public Works |
| **MRD** | Ministry of Rural Development |
| **mt** | Million tonnes |
| **MSDS** | Material safety data sheet |
| **NAF** | Non-acid forming |
| **NASA** | National Aeronautics and Space Administration |
| **NECOLIB** | National Environmental Commission of Liberia |
| **NEP** | National Environmental Policy |
| **NEPC** | National Environmental Policy Council |
| **NGO** | Non-governmental organisation |
| **NI 43-101** | National Instrument 43-101 |
| **NLGM** | New Liberty gold mine |
| **$NO_2$** | Nitrogen dioxide |
| **$NO_x$** | Mono-nitrogen oxides |
| **NPV** | Net present value |
| **NT** | Near threatened |
| **Open pit mining** | Extracting metal ores and minerals that lie near the surface by removing the overlying material and breaking and loading the ore |
| **OPEX** | Operating expense |
| **Ore** | Aggregate of economically important minerals that are sufficiently rich to separate/mine for a profit |
| **ORP** | Oxidation reduction potential |
| **PAP** | Project affected person |
| **PAF** | Potential acid forming |
| **PAG** | Potentially acid generating |
| **PCD** | Pollution Control Dam |

| Term / Acronym | Explanation |
|---|---|
| **PM** | Particulate matter |
| **POP** | Persistent organic pollutants |
| **PPE** | Personal protective equipment |
| **PSA** | Pressure-Swing-Adsorption |
| **PWD** | Process Water Dam |
| **RAMSAR** | Refers to the Ramsar Convention of Wetlands of International Importance |
| **RAP** | Resettlement Action Plan |
| **RC** | Resettlement Committee |
| **Red Data List** | IUCN Red List of Threatened Species |
| **Remediation** | Also known as "clean up"; remediation is taking action to reduce, isolate, or remove contamination from the environment |
| **Resettlement** | The moving of people (as a family) to a new location as a result of a new development |
| **RC** | Resettlement Committee |
| **RH** | Relative humidity |
| **Riparian** | Relating to or located on the bank of a natural watercourse (such as a river) |
| **ROM** | Run of mine |
| **RWD** | Return Water Dam |
| **SANS** | South African national standards |
| **SER** | Society for Ecological Restoration |
| **SIA** | Socio-economic impact assessment |
| **SMUS** | Silicified metamorphosed ultra-basic suite |
| **Social** | The social environment (people), the economic environment, the cultural resources. |
| **STI** | Sexually transmitted infection |
| **Study area (or Project area)** | The area of land that was included in the EIA specialist studies - i.e. the spatial area within which local impacts were assessed, within close proximity to the activities where direct effects are anticipated |
| **SWAT** | Soil and Water Assessment Tool |
| **TB** | Tuberculosis |
| **TDS** | Total dissolved solids |
| **ToR** | Terms of reference |
| **TSF** | Tailings storage facility |
| **UK** | United Kingdom |
| **UNCCD** | United Nations Convention to Combat Desertification |
| **UNDTCD** | United Nations Department of Technical Cooperation and Development |

| Term / Acronym | Explanation |
|---|---|
| **UNESCO** | United Nations Educational, Scientific and Cultural Organization |
| **VAC** | Visual absorption capacity |
| **VGF** | Vibrating grizzly feeder |
| **VIA** | Visual impact assessment |
| **Viewshed** | A viewshed is an area of land, water, or other environmental element that is visible to the human eye from a fixed vantage point |
| **WB** | World Bank |
| **WGB** | World Bank Group |
| **WHO** | World Health Organisation |
| **WQ** | Water quality |
| **WRD** | Waste rock dump |

# 1.0 INTRODUCTION

Bea Mountain Mining Corporation (BMMC), a company registered in Liberia, is a wholly owned subsidiary of Aureus Mining Incorporated (Aureus). BMMC holds a Class A mining license, issued by the Liberian Ministry of Land, Mines and Energy on 29 July 2009 to mine the New Liberty Gold Mine (NLGM) deposit for a period of 25 years, with the right to extend this license for an additional term of 25 years. BMMC proposes to develop an open pit gold mine, referred to as the NLGM Project (the Project), which is one of a series of gold exploration deposits located within BMMC's 457 $km^2$ mining license area. (Note that the Project refers to the NLGM project area only of the Class A mining license area).

According to Section 37 of the Environment Protection Agency Act of Liberia, BMMC is required to undertake an environmental impact assessment (EIA) for the proposed Project. Based on the findings of the EIA, the Liberian Environmental Protection Agency (EPA) will make a decision on whether the project may proceed or not. The EIA has been undertaken to meet Liberian legislative requirements – (reference has also been made to applicable international standards/limits).

BMMC appointed an independent consulting company, Golder Associates (Ghana) Ltd, based in Accra, Ghana, to undertake the EIA and associated specialist studies, with assistance provided by the local Liberian consulting company, EarthCons Inc., as per requirements of the Environmental Protection and Management Law (2002).

This report presents the Environmental Impact Statement (EIS) for review by the EPA. The EIS is a consolidated report detailing the findings of the specialist studies conducted during the EIA, and also presents the Environmental Management Plan (EMP). It has been prepared by Golder Associates (Golder), with assistance from EarthCons Inc., on behalf of BMMC. The format for this EIS is taken from and aligned with the Liberian EPA "Environmental Impact Assessment Procedural Guidelines" (2006).

As noted in the EPA's EIA Procedural Guidelines, the EIS is the document produced after studying the potential environmental and social impacts of a proposed project. This EIS provides all relevant details on the project and its effect on the environment. It also provides a summary level of detail adequate to allow the average reader to make an informed decision on the project. It includes a broad range of data including information on the developer/proponent, schedule, and the detailed description of the project, regulatory framework, and review of alternatives, environmental management plan, socioeconomic factors, environmental impacts, mitigation, monitoring and rehabilitation.

This EIS includes the following sections:

- Introduction;
- Policy, Legal and Administrative Framework Applicable to the Project;
- Detailed Project Description;
- Description of the Environment
- Impact Prediction and Evaluation;
- Socio-economic Analysis of Project Impacts;
- Economic Information regarding the Project;
- Environmental Management Plan (EMP) and Mitigation Measures (including the EMP for exploration activities);
- Identification of Alternatives;
- Environmental Management and Training;
- Monitoring Programme;

- Closure Objectives and Closure Costing;
- Public Participation;
- Emergency Response Plan; and
- Conclusions and Recommendations.

## 1.1 Project Developer/Proponent

Aureus Mining Inc, which owns BMMC, is an established minerals development company listed on the London and Toronto Stock Exchanges. For the purposes of the EIA, BMMC is referred to as the proponent as this company has been operating in Liberia for a number of years and the name "BMMC" is widely known in the country. Aureus consists of a number of gold assets in Liberia, Sierra Leone and Cameroon.

Aureus has a highly motivated and experienced team with a track record of discovering mines and taking projects through development and into production. For further information on Aureus, please see www.aureus-mining.com

Aureus is committed to conduct its business activities in a manner that promotes sustainable development and an improvement in the social welfare of the regions in which it operates. It is the Company's fundamental policy to conduct its business responsibly and in a manner designed to protect its representatives, the communities in the area of its operations and the environment.

Aureus is in the process of developing its corporate social responsibility (CSR) policy, and is committed to CSR initiatives in the countries and affected communities where it operates. In the BMMC concession area, the company has been engaged in community development/uplifting efforts, such as providing surrounding villages with boreholes for water supply, and the building of a school at Kinjor.

BMMC has been exploring the Project area since 1997. Between 1997 and 2009, exploration and resource drilling was carried out on the Project site by various BMMC employees and drilling companies, as follows:

- The exploration programme commenced in 1997 with preliminary geochemical sampling across the artisanal workings in areas where primary rock was exposed. A programme of trenching over the target area was undertaken to estimate continuity between the proposed Larjor and Kinjor pits; 24 trench excavations were initially completed in June and July 1998;
- In February 1999 a programme of diamond drilling was undertaken by contractors Drillsure Limited. The programme comprised 19 holes and intersected mineralisation at depths ranging from 20 to 30 metres below surface;
- In early 2000, a second campaign of drilling was undertaken with the aim of testing the mineralisation at greater depth under the Kinjor and Larjor zones and to investigate the mineralisation in the Marvoe zone;
- The third diamond drilling campaign started in January 2005 and was aimed at closing on-strike inter-hole distances and at the same time certain selected holes were drilled in order to intersect the ore body at greater depth; and
- In 2009, when Aureus bought BMMC, the exploration drilling programme was again extended. To date approximately 492 exploration holes have been drilled within a 10 km radius of the NLGM exploration camp in order to assess the resource potential. Currently, the average depth is 180 m and the deepest holes were approximately 520 m below surface.

### 1.1.1 Ownership

The Bea-MDA property covers an area of 457km² and the agreement has an initial and renewable term of 25 years. In July 2009 Bea Mountain Mining Corporation ("BEA"), a wholly owned subsidiary of Aureus, was granted a Class A Mining License for the whole area, subject to an annual license fee under the terms of the

Bea-MDA the Republic of Liberia is entitled to receive, free of charge, an equity interest on BEA's operations equal to 10% of its authorised and outstanding share capital without dilution (i.e. a 10% "carried interest"). There is also a 3% royalty, calculated on a production basis, payable to the Republic of Liberia in the Bea-MDA areas.

Under the arrangement, among other things, the Transferred Assets were acquired by Aureus and each participating shareholder received new common shares in Afferro and Aureus in exchange for the AAM common shares held by such shareholder on the basis of one new Afferro common share and one Aureus common share for each African Aura common share held by such shareholder.

Table 1 summarises the ownership history.

**Table 1: Ownership history**

| Date | Company | Comments |
|---|---|---|
| August 1995 | KAFCO | Assigned rights in area to Golden Limbo |
| 18 November 1996 | Golden Limbo | Assigned rights to BMMC |
| 22 November 1996 | BMMC | Approval received |
| 22 April 1998 | BMMC | Bea-MDA defined as 1000 km² |
| 28 November 2001 | BMMC | Bea-MDA reduction to 457 km² came into effect |
| 29 July 2009 | BMMC | Granted a Class A Mining License |

## 1.2 EIA Objectives

The EPA Environmental Impact Assessment Procedural Guidelines (2006) note that EIA is a systematic process to identify, predict and evaluate the environmental effects of proposed projects, plans or policies. This process is applied prior to major decisions and commitments being made.

The EIA relates to the environment assessments of the Project that aim to integrate environmental considerations into the earliest stages of policy, plan and programme development for the Project. In line with this, the objectives of the NLGM EIA (and associated EMP) are as follows:

- To ensure that environmental considerations are explicitly addressed and incorporated into decision-making processes related to the Project;
- To gain a thorough understanding and record of the baseline environmental conditions on site;
- To anticipate and avoid, minimise, mitigate or offset the significant adverse biophysical, social and other relevant potential impacts associated with the proposed Project;
- To protect the productivity and capacity of natural systems and the ecological processes that maintain their functions;
- To promote development that is sustainable and optimises resource use and management opportunities;
- To identify potential impacts and whether they are within predicted or permitted limits;
- To develop mitigation measures that will be required to be implemented, based on the impacts identified; aimed at reducing negative impacts and enhancing positive impacts; and
- To help ensure that environmental benefits are maximised through the implementation of best practice principles and the mitigation measures as stipulated in the EMP.

## 1.3 EIA Scope and Methodology

### 1.3.1 Scope of the Project

The scope of the Project is important in terms of defining the scope of the EIA.

The scope of the Project includes the physical works related to the construction, operation and closure and decommissioning of the proposed components of the Project and related undertakings.

The scope of the Project for the NLGM EIA during the pre-construction phase includes a resettlement action plan (RAP) and initial site clearing and levelling, and the construction phase includes the construction of all Project facilities and infrastructure.

The scope of the Project during the operational phase includes standard open pit gold mining operations, including blasting; excavation of the open pits, hauling the ore to the ROM pad, hauling the waste rock to the waste rock dump; management and maintenance of the processing plant and associated infrastructure; concurrent rehabilitation of mined out areas as the mining operations progress; management and maintenance of the water dams on site; management of the TSF; management and maintenance of the creek diversion; maintenance of all roads on site; and monitoring.

The scope of the Project during decommissioning and closure includes rehabilitation of the site upon closure; and on-going monitoring.

### 1.3.2 Scope of the EIA

The scope of the environmental and social issues to be considered in undertaking the EIA was determined through the consideration of both the EPA's EIA Procedural Guidelines (EPA, 2006) and relevant international guidelines, as well as through the EIA scoping process and comments and feedback received as a result of the associated public consultation.

The scope of the EIA included the identification and assessment of the Project's potential direct and indirect environmental and social impacts. Based on the potential impacts identified and the impact assessment, the EMP was developed. The EMP is aimed at providing appropriate mitigation measures that BMMC will be required to implement throughout the life of the Project to manage, maintain, and where possible, enhance environmental and social performance on site and in the surrounding area adjacent to the mine.

The key factors considered in the EIA are as follows:

- The existing/baseline environment, and obtaining relevant baseline data;
- The potential direct and indirect environmental and socio-cultural impacts of the proposed Project;
- The environmental consequence of the environmental impacts referred to above;
- Measures that are technically and economically feasible and that would mitigate any significant adverse environmental or social impacts related to the proposed project;
- Project alternatives, including an alternative means of carrying out the Project that are technically and economically feasible; and
- The effects of the Project on the biophysical and social environment.

The EPML (2002) identifies the key steps in the environmental impact assessment review process in Liberia, which are stipulated in Sections 6 through to 23. The scope of the EIA was based on this, and thus to date the following process steps have taken place:

- Application for an Environmental Impact Assessment License by BMMC;
- Notice of Intent completed;

- Development of a Project Brief submitted to the EPA (carried out in November 2010);
- Conducting the Scoping Phase of the EIA and submitted a Scoping Report to the EPA (carried out in April 2012); and
- Conducting the Impact Assessment Phase of the EIA, notably the applicable specialist study assessments. Based on the findings of the specialist assessments, this EIS has been developed for submission to the EPA.

During the EIA, public participation with interested and affected parties (I&APs), notably the potentially affected communities in the vicinity of the proposed Project, has taken place. The public participation that has taken place to date is described in Section 13.0 of this EIS.

#### *1.3.2.1 Specialist Studies*

A number of specialist studies were undertaken as part of the EIA in order to investigate the areas of importance highlighted in the Scoping Report. The specialist studies included:

- Soils and land use;
- Surface water, also including surface water quality;
- Groundwater;
- Geochemistry;
- Air quality;
- Noise;
- Terrestrial ecology;
- Aquatic ecology;
- Protected areas;
- Socio-economic aspects;
- Cultural heritage (and archaeology);
- Visual aesthetics; and
- Closure objectives, including a closure costing framework.

The final specialist assessment reports are presented in **Volume II** of this EIS.

### 1.3.3 EIA Methodology

This EIA was completed using accepted international standards (notably those of the World Bank and World Health Organisation), best practice principles and techniques, and the Liberian EPA EIA Procedural Guidelines (2006). The specialist assessment reports that were used to develop this EIS contain detailed methodologies as to how baseline data was collected and how it was interrogated in terms of the impact assessment and definition of mitigation measures. In some instances, customised approaches were developed from relevant international EIA best practice where Liberian standards or data were not evident. For example, with the surface water study, World Health Organisation (WHO) standards/limits were used, and where very little information on the volumes of runoff for Liberia were available, an estimation of runoff for a 4-million km$^2$ area covering 18 countries in West Africa, including Liberia, was made by application of the distributed hydrological model ‘‘Soil and Water Assessment Tool’’ (SWAT).

The public participation that was followed as part of the EIA process was conducted with reference to Liberian legislation.

A variety of information was used in completing the EIA. The information focused on the details specific to the purposes of the EIA and included Project design details and environmental and socio-economic information collected specific to the Project. This information included existing reports and data, baseline data collected during site visits, geographical information systems (GIS) and aerial photography interpretation and information collected during public consultation.

### 1.3.4 Delineation of study area for the assessment

The proposed study area consists of the footprint of the proposed Project (as shown in the site layout map; (Figure 2), upstream and downstream areas, local topography (studied as part of the infrastructure design process and fed into the EIA), directly affected villages (i.e. Kinjor and Larjor) and neighbouring villages within a radius of approximately 5 km of the site. In addition, consideration was given to the wider geographical context where applicable. (Applicability was determined by means of the nature of the specialist discipline being studied and the potential project impacts envisaged. For example, the surface water study involved monitoring points on the Marvoe Creek upstream and downstream of the NLGM site.

## 1.4 Project Rationale

The project rationale from BMMC's perspective has been to advance the exploration and development of the NLGM Project. The exploration drilling has delineated four contiguous zones of mineralization known as Larjor, Latiff, Kinjor and Marvoe zones, forming a combined strike of over 2 km in length.

Exploration at the Project site has confirmed the persistence of gold mineralisation within defined zones extending from known surface occurrences to drill intersections more than 500m below surface. The extensive 2011 infill drill campaign largely confirmed and raised the level of confidence in the interpretation of the mineralisation as well as the tonnage and grade estimates for the upper, potentially open pit portion of the resource. On the basis of this evaluation the project is viable at the average gold price of $1,350 used for the technical evaluation.

Substantiating the project rationale, some of the key initial benefits that will be realised by the Project include that it will be the first gold mine in Liberia and will initiate Liberia's entry into the gold mining industry, raising the country's profile as a player in the West African gold mining industry; royalties will be paid to the Liberian Government by BMMC; local personnel will be provided with training in skills associated with a mining operation; and direct and indirect job creation and employment (with the associated multiplier effect) – during operations.

## 1.5 EIA Assumptions and Limitations

The EIA was undertaken and this EIS has been prepared by Golder and EarthCons who have no vested interest in the proposed Project. Golder and EarthCons, and their appointed specialist team provide an independent assessment of potential risk and environmental and social impact. A description of the proposed project provided by Aureus informed the project description described by Golder in Section 3. The project description contained in this EIS has been reviewed and signed off as correct by Aureus. This project description was finalised by Aureus during the second quarter of 2012.

Golder have been requested to finalise the assessment of possible environmental and social impacts of the proposed Project by end of the second quarter 2012, on the basis of the established environmental baseline and project description provided. To meet this time schedule a number of specialist studies reflect a qualified opinion by the specialist team, based on the experience of the specialists concerned and their knowledge of the current local conditions gained through baseline. No modelling has been completed to inform a quantitative assessment. Recommendations that modelling be completed for air quality and hydrogeology are contained in the mitigation plan/EMP (Section 8) in order to reduce uncertainty in prediction of possible impact. Limitations and assumptions that relate to individual specialist studies are included in a consolidated format in **Appendix A**, and also reflected in each specialist study reports (EIS Volume 2).

Due to BMMC exploration activities still ongoing within the greater Bea-MDA Class A mining licence area, Golder have included the exploration activities in the EMP section of the EIS. Thus, an EMP for exploration has been included, which provides a broad framework for the management of environmental and social components during exploration. The exploration EMP has not been informed by impact assessment.

## 1.6 Independent Environmental Consultants

BMMC retained Golder Associates Ghana Ltd (Golder) and EarthCons Inc (EarthCons), to undertake the EIA for the proposed Project. The Liberian Environmental Protection Agency (EPA) requires environmental consultants from outside of Liberia, such as Golder, to collaborate closely with local Liberian consultants so that local expertise, capacity building and exchange take place.

**Golder Associates** is an international ground engineering and environmental consulting company and is experienced in environmental assessment and management. Golder is familiar with the EPA's EIA requirements for mining development projects in Liberia. The company is well known for its integrity, independence and skill in assisting interested and affected parties to participate in the EIA process.

**EarthCons** is a registered Liberian environmental, geological, geotechnical and petroleum, mining consultancy firm that provides services within the mining and construction industries. EarthCons was established in 2005 and is the largest premier locally owned and operated environmental company in Liberia and our clientele base is both domestic and international.

The combination of companies undertaking the NLGM EIA provides for international and local experience in environmental assessment and management, as well as complying with the EPA requirements. Neither Golder nor EarthCons have any vested interest in BMMC or the proposed Project.

Golder's Accreditation Certificate to conduct Environmental Impact Assessments in Liberia can be found in **Appendix B**. Contact details of Golder and EarthCons are provided in Table 2 below.

**Table 2: Golder Associates (Ghana) Ltd and EarthCons Inc. Contact Details**

| **Name** | **Golder Associates (Ghana) Ltd** |
|---|---|
| **Address** | **Golder Associates (Ghana) Ltd.**<br>KEK Insurance Building, 40-41 Senchi Street, Airport Residential, Accra, Ghana<br>**Telephone:** [+233] (302) 779 124<br>**Email:** cfell@golder.com |
| **Contact Person** | Chris Fell (Environmental Consultant and Regional Manager: West Africa) |
| **Name** | **EarthCons Inc.** |
| **Address** | **EARTHCONS Inc.**<br>Camp Johnson Road and Warren Street, PO Box 10-2198, Monrovia, Liberia<br>**Telephone:** [+231] 6 518 443 or [+231] 4 713 338<br>**Email:** michael.suah@yahoo.com |
| **Contact Person** | Michael Suah (General Manager/Environmental and Social Consultant) |

The qualifications and experience of key EIA team members is provided in **Appendix C**.

# 2.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK APPLICABLE TO THE PROJECT

In order to ensure legal compliance regarding the EIA, a comprehensive review was undertaken to identify Liberian environmental legislation, standards and environmental systems.

This section sets out the policy, legal and administrative framework applicable to the Project including brief summaries of selected legislation concerning environmental, social and mining issues that are appropriate to the Project, in line with the EPA EIA Procedural Guidelines (2006). It does not seek to provide comprehensive details on all legislation in Liberia.

In cases where Liberian legislation and standards were not evident, such criteria have been taken from international standards, notably those of the World Health Organisation (WHO).

In terms of the NLGM EIA, this policy, legal and administrative framework review is important as it enables the determination of assessment criteria appropriate to each specialist discipline, as well as to the EIA.

## 2.1 National Environmental Policies and Plans

### 2.1.1 National Environmental Policy (NEP)

The Constitution of Liberia (1986) provides for the protection and management of the environment and natural resources.

The National Environmental Policy (NEP) provides a broad framework for the implementation of national objectives and plans. The policy aims at ensuring a sound management of resources and the environment.

The policy provides for:

- Integration of environmental considerations in sectoral, structural, regional, and socioeconomic planning at all levels.
- Sound management of the environment and natural resources.
- Protection and maintenance of human habitats, the ecosystems, and ecological processes essential for the functions of the biosphere.
- Guidance for national action plan and for healthy environmental practices on the national development effort.
- Sustainable development.
- Common approach to environmental issues.

The primary aims of this policy are pursued through harmonization and enforcement of relevant laws on environment protection.

The NEP identifies that the EPA that will operate under the guidance of the National Environment Council.

### 2.1.2 The National Environmental Action Plan

Under Section 30 of the Environmental Protection Agency Act (EPAA), the EPA will prepare a National Environmental Action Plan every five years in consultation with the Line Ministries and County Environmental Committees.

The National Environmental Action Plan will:

a) Contain all matters affecting the environment and provide general guidelines for the management and protection of the environment and natural resources of Liberia well as the strategies for preventing, controlling, or mitigating any deleterious effects.

b) Be the basis for national environment planning and implementation of development programmes.

c) Recommend appropriate economic and fiscal incentives as instruments for environmental protection to be incorporated into the planning and operational processes of the economy and recommend areas for environmental research and outline methods of utilizing research information.

d) Recommend methods for building national awareness on the importance of sustainable use of the environment and natural resources for national development.

e) Take into account County Environment Action Plans.

f) Identify and recommend policy and legislative approaches for preventing, controlling or mitigating specific as well as general adverse impacts on the environment.

### 2.1.3 Integrated Water Resources Management Plan (IWRMP)

The Integrated Water Resources Management Plan (IWRMP) (2009) provides an overarching approach to manage water resources in Liberia that are sustainable and most beneficial to people. This policy was designed to provide a broad-based charter that must be recognized by all concerned sector institutions, and be considered by all public and private projects and programs.

Two broad areas are covered in this policy:

- Water Resources Management – this covers the management framework, including policy objectives, principles and strategies for monitoring, assessment, allocation and protection of resources.
- Water Resources Use – covers the policy objectives, principles and strategies for the development and use of water for people, water for food security, water for industry and other water uses such as hydropower, recreation, non-revenue water and water for maintenance of productive ecosystems.

### 2.1.4 National Forestry Policy

The National Forest Policy was published in 2006. The aim of the forestry policy of Liberia is to conserve and sustainably manage all forest areas, so that they will continue to produce a complete range of goods and services for the benefit of all Liberians and contribute to poverty alleviation in the nation, while maintaining environmental stability and fulfilling Liberia's commitments under international agreements and conventions.

### 2.1.5 Mineral Policy

The Mineral Policy was introduced in 2010. The policy is intended to provide adequate indications to the investment community (both national and foreign) of a competitive mineral regime in Liberia that is informed by international trends, adheres to international norms, -is grounded in local conditions and is accountable to national common interests.

### 2.1.6 National Biodiversity Strategy and Action Plan

The overall goal of the National Biodiversity Strategy and Action Plan (2004) is to sustainably use biodiversity on a long-term basis to meet the needs of both the present and future generations.

## 2.2 Administrative Framework

Historically, the most important institution dealing with environmental matters has been the Forest Development Authority (FDA), which was established in 1976 to replace the former Bureau of Forest Conservation and Wildlife. The FDA has the mandate to protect, manage and conserve government-owned forests and wildlife on a sustainable basis.

In 1999, as a commitment to environmental management, the Government of Liberia established the National Environmental Commission of Liberia (NECOLIB). NECOLIB was given the executive authority over all programmes and activities relating to environmental management in the country as well as serving as the focal point for international environmental agreements.

In November 2002, the Liberian Government adopted the National Environmental Policy, the Environment Protection Agency Act and the Environment Protection and Management Law. The three documents became law in April 2003 when they were published into leaflets as required by the Constitution of Liberia.

### 2.2.1 Environmental Protection Agency and related Environmental Committees

#### *2.2.1.1 Environmental Protection Agency (EPA)*

The EPA is the agency responsible for coordinating, integrating and harmonizing the implementation of the Environmental Policy under the guidance of the National Environmental Policy Council (NEPC). Additional key functions of the EPA are:

The key functions of the EPA are to:

- Propose environmental policies and strategies to the NEPC and ensure the integration of environmental concerns in overall national planning.
- Collect, analyze and prepare basic scientific data and other information pertaining to pollution, degradation and on environmental quality, resource use and other environmental protection and conservation matters and undertake research and prepare and disseminate every two years a report on the state of the environment in Liberia.
- Ensure the preservation and promotion of important historic, cultural and spiritual values of natural resources heritage and, in consultation with indigenous authority, enhance indigenous methods for effective natural resource management.
- Encourage the use of appropriate environmentally sound technologies and renewable sources of energy and natural resources.
- Establish environmental criteria, guidelines, specifications and standards for production processes and the sustainable use of natural resources for the health and welfare of future generations.
- Review and approve environmental impact statements and environmental impact assessment.
- Initiate and co-ordinate actions required in a state of environmental emergency or any other situation which may pose serious threat to the environment and public health.
- Function as the national clearinghouse for all activities relating to regional and international environment-related conventions, treaties and agreements, and as national liaison with the secretariat for all such regional and international instruments.
- Advise the state and participate in the process of negotiating, ratifying or acceding to relevant regional and international environmental agreements.

The EPA also has Board of Directors to oversee the implementation and successful operation of the national environment management policy and functions of the EPA. The government constituted the NEPC, Board of Directors and the Executive Director.

#### National Environmental Policy Council

The National Environmental Policy Council (NEPC) was established under Section 7 of the EPAA.

#### County Environment Committees

Section 24 of the EPAA states that the NEPC will establish Environment Committees in every county.

#### District Environment Committees

Under Section 26 of the EPAA, the CEC will create District Environment Committees (DEC).

### 2.2.2 National Environmental Commission of Liberia

The National Environmental Commission of Liberia (NECOLIB) was created in 1999 with the mandate to co-ordinate environmental management activities, including conservation of biological diversity. NECOLIB is the focal institution for the Convention on Biological Diversity, the Cartagena Protocol on Biosafety, United

Nations Framework Convention on Climate Change and its Kyoto Protocol, and the Stockholm Convention on Persistent Organic Pollutants (POPs).

### 2.2.3 Forest Development Authority

The Forest Development Authority (FDA) was established in 1976. The FDA is in charge of the sustainable management of the forest and associated resources, including forest lands and wildlife. It provides medium and long term planning within the forest sector, the preparation and promulgation of forest policy, law and administration, the release of forest concession agreements, monitoring activities of timber companies and managing protected area programs and wildlife and national parks.

Other FDA activities include forest conservation, educational awareness, agro-forestry programs, environmental awareness-raising in communities surrounding protected areas, and discussion of trans-border issues (such as hunting in restricted areas, which tend to extend into neighbouring countries).

### 2.2.4 Ministry of Lands, Mines and Energy

The Ministry of Lands, Mines and Energy ensure the sustainable management and judicious utilisation of the country's Lands Mines & Energy resources. There are three main departments: Lands, Mineral Resources and Energy. These are further described below.

#### *2.2.4.1 Lands Department*

The Lands Department provides various types of services including:

- Management and Administration of State Land and properties leased to Government.
- Identify and initiate development proposals for vacant land and assist the National Housing in the upgrading and resettlement of squatter areas.
- Procurement of land for all Government departments.
- Carrying out aerial photography, preparation and compilation of maps, plans and continuous updating and maintenance of land records.
- Examination and approval of all land surveys and overseeing the accuracy of land surveys undertaken by registered surveyors in the country.
- Upgrade and maintain the geodetic network of Liberia for a sound survey system.
- Provision of a National Land Information system for Liberia.

#### *2.2.4.2 Mineral Resources Department*

The Mineral Resources Department acts as both the National Geological Survey and Mines Department of the Republic of Liberia, with the mandate to look after the Mining. Its two major operating areas are Mines Administration and Geological and Mineral Investigations, which address the following:

- Administration of exploration and mining tenements; processing of applications for grant and renewal, granting licenses, special site licenses or permits as well as certification of mining personnel and specific mining equipment.
- Monitoring mining and exploration activities, through regular inspections, for adherence to safe environmental practices, health and safety of workers and other specified conditions laid down in the licenses.
- Issue of licenses for importation, possession and transportation of explosives and fireworks and grant of export permits for geological and mineral samples.

- Facilitating mining and exploration projects through assistance in negotiations with relevant Government and non-government agencies and providing support with landowner liaison.
- Hydrogeological assessment and advice on groundwater potential, the siting of potential abstraction sites and drilling of abstraction wells for groundwater.

## 2.3 Environmental Assessment Legislation

### 2.3.1 New Constitution of Liberia

The constitutional basis for environmental law is provided in Article 7 of the Constitution (1986). The Article provides for:

- Environmental protection as a fundamental rule.
- Provides for public participation of all citizens in the protection and management of the environment and natural resources.
- Binds state organizations to adopt and activate environmental policy and formulate national development plans that are environmentally sustainable.

### 2.3.2 Environmental Protection Agency Act

The Environmental Protection Agency Act (EPAA) (2002) provides for the establishment of the EPA, the NEPC, the Environmental Court of Appeals, the Environmental Administrative Court and the Environment Protection Fund, for the designation of Environmental Inspectors and other matters relative to administration in the field of environment, for environment impact assessment and monitoring and for environmental enforcement orders.

Under Section 37 of the EPAA, the following stipulations regarding environmental impact assessment are identified:

- The EPA shall require that an environment impact assessment be undertaken on all projects, policies, programmes and activities specified by the EPA in consultation with relevant ministries and agencies and published by notice.
- A developer, or project proponent, shall not commence, carry out, execute, implement or conduct a project or activity for which an environmental impact assessment is required unless an environmental impact assessment has been concluded and environmental regulations made there under.
- A licensing or permitting agency or authority under any law in force in Liberia shall not issue a license for any project for which an environmental impact assessment is required under the Act, unless the applicant produces to the licensing agency or authority an environmental impact assessment license or permit issued under the EPAA and the regulations.

### 2.3.3 Environment Protection and Management Law

The Environment Protection and Management Law (EPML) (2002) arranges the rules, regulations and procedures for environmental impact assessment, auditing and monitoring. It establishes regulations for environmental quality standards; pollution control and licensing; guidelines and standards for the management of the environment and natural resources. It also addresses the protection of biodiversity, national heritage and the ozone layer. Other areas covered include environmental restoration orders; inspections; international obligations; and information access; education and public awareness.

### 2.3.4 Public Consultation

Section 37 of the Environmental Protection Agency Act of Liberia applies the following to public consultation:

- Identify, inform and receive input from effected stakeholders and interested parties;

- Determine and narrow the scope of the issues to be addressed in the environmental impact assessment;
- Identify and define, at an early stage of the EIA process, the significant environmental issues, problems and alternatives related to the different phases of the proposed Project or activity;
- Ensure public participation early in the EIA process;
- Ensure that all relevant issues and alternatives are adequately addressed in the environmental impact study;
- Provide the applicant with the information necessary for formulating the terms of reference for the environmental impact study and impact statement; and
- Guide the applicant's consultants in preparing the environmental impact statement.

## 2.4 Regulations Pertaining to Mining

### 2.4.1 Minerals and Mining Act

The Minerals and Mining Act (2000) states that minerals on the surface of the ground or in the soil or subsoil, rivers, streams, watercourses, territorial waters and continental shelf are the property of Liberia. Section 3.4 allows for the establishment of a Minerals Technical Committee consisting of: Minister of Lands, Mines and Energy, Ministry of Justice, Ministry of Finance, Ministry of Planning and Economic Affairs, National Investment Commission, Ministry of Labour, Council of Economic Advisors, and Central Bank of Liberia. This committee has power to negotiate agreements for Class A Mining Licences.

The Law, which is administered by the Ministry of Lands, Mines and Energy, has a clearly defined exploration and licensing system, as follows:

- **Exploration Licenses**
  - These licenses are issued to exploration and mining companies at an initial term of 3 years and are renewable for a single two year term upon written application of the holder who has fulfilled its work and expenditures obligations;
  - At or before the expiration of the initial period of the exploration license the holder may select the entire area or any part of a production area. If the holder does apply for an extension of the exploration license, 50% of the exploration area is surrendered at the end of the initial term; and
  - At the end of the extension period, the holder can declare all or part of the entire remaining area as production area. The remaining area is surrendered to the government.
- **Class A Mining Licenses**
  - Upon notice to the Minister that exploitable deposits were found under the exploration program, the Minister can grant a Class A Mining License;
  - A Feasibility Report is to be submitted to the Minister; and
  - The initial terms of a Class A license is not more than 25 years and can be extended, if proven reserves are shown to exist and upon submission of an updated feasibility report, for consecutive additional terms of up to 25 years.

In order to receive an Exploration License or a Class A License, an applicant must conclude a Mineral Development Agreement (MDA) with the Government. The terms contained in the MDA are valid for no more than 25 years and are subject to periodic review every five years.

The surface rights granted under a license include the following:

- Erection of habitations, office buildings, mill buildings, engine houses, store houses;
- Buildings of dumps, ditches for drainage and roads within the surface boundaries of the production area;
- Making trenches and open cuts for mining operation;
- Cutting of timber only for to clear for the construction of buildings and other structure identified above and in construction of the mining site; and
- Use of water and other resources necessary for the work.

Chapter 8 of this Law deals with environmental protection and states that an Environmental Impact Assessment Study for a Class A and Class B Mining License and Environmental Management Programs are to be prepared under Sections 8.5 and 8.6, respectively. (Even though the legislation here refers to 'Environmental Management Programs', for the purposes of the EIA and this EIS, the term 'Environmental Management Plan' has been used, as this is the term noted in the Liberian EPA EIA Guidelines (2006). Section 8.2 identifies the requirement for environmental restoration. These are further discussed below:

- Section 8.2 states that every holder of a mining license must restore the site disturbed by exploration of mining to its original state. If this is not possible, then it is to be restored to a state that is environmentally and socially desirable.
- Section 8.3 stipulates that all water polluted by exploration or mining is restored to its original state and that any water courses that have been closed are re-opened or a suitable water course opened to maintain natural runoff with minimal erosion. Reforestation is also required if exploration or mining resulted in large scale felling.
- Section 8.4 states that each applicant for a Class A and Class B license must submit, as a precedent to the granting of the license, an Environmental Impact Assessment Study. The study is to give special attention to potential impacts to nearby communities. The Minister of Mines will only grant a license after review of this study and confirms that the mitigation and reclamation procedures are adequate to protect the environment.
- Under Section 8.5, an Environmental Management Plan is to be submitted by the holder of a mining right for any affected land by exploration, mining or other operations and this plan will be submitted prior to the start of operations.

Chapter 11 addresses rights of owners and occupants of land affected by the Minerals and Mining Law, which is discussed further as follows:

- Section 11.3 provides for compensation to landowners or occupants diminution in the land value caused by the government to exercise its rights as owner of mineral rights, which supercedes any landowner or occupant rights with respect to exploration and mining.
- Any landowner or lawful occupant has the right of first refusal in any application for Class A or Class B mining license as against third parties (Section 11.4).

Chapter 16 address health and safety requirements. Section 16.2 states that the permission to import, export, buy, sell, manufacture, store, handle purchase, use, dispose or otherwise deal with explosives needs to apply to the Ministry of State of Presidential Affairs.

## 2.5 Treaties and Conventions

The Government of Liberia is a signatory of the following international conventions and agreements:

- United Nations Convention to Combat Desertification (UNCCD);
- Convention of Biological Diversity;

- UNESCO Convention Concerning the Protection of the World's Cultural and Natural Heritage;
- UNESCO Ramsar Convention on Wetlands of International Importance;
- United Nations Convention on Climate Change;
- United Nations Environmental Program (UNEP) Convention on the Conservation of Migratory Species of Wild Animals;
- UNEP Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES);
- International Tropical Timber Agreement (ITTA); and
- Extractive Industries Transparency Initiative (EITI).

## 2.6 Terms of the Mineral Development Agreement

Section 16 of the Mineral Development Agreement between the proponent, BMMC, and the Liberia Government is of relevancy to this EIS which reads "16.1 Environmental Impact Statement: The Parties recognize that Operations may result in some pollution, contamination or other environmental damage to land, water and the atmosphere within the Contract Area and elsewhere. Accordingly, the Operator shall submit to the Minister before the commencement of Exploration and Production and Environmental Impact Statement ("EIS") The EIS shall show the adverse effect operations will have on the environment and review plans to mitigate such effects".

The MDA and its commitments were taken into account during the development of the EMP (Section 9).

Under Part III of the Act creating the Environmental Protection and Management Law (EPML) of the Republic of Liberia (2002), an EIA License or Permit is required from the EPA prior to commencement of activities specified under Annex 1 of that Law. Consideration of the NLGM Project's Project Brief (submitted to the EPA in November 2010) by the EPA identified the need for a full EIA as the mining and other associated components of the Project fall into the following Categories:

- Category 13 (Building and Civil Engineering Industries);
- Category 14 (Chemical Industries – Manufacture, transportation, use and storage of pesticide or other hazardous and or toxic chemicals);
- Category 15 (Extractive Industries – Mining);
- Category18 (Waste Treatment and Disposal);
- Category 13 (Building and Civil Engineering Industries); and
- Category 19 (Water Supply – Diversion of normal flow of water and abstraction or utilization of ground and surface water for bulk supply).

## 2.7 International Standards

While conducting the EIA, the Golder and EarthCons team referred to relevant international standards, guidelines, best practice documents and limits, notably those of The World Bank Group (WGB), including the International Finance Corporation (IFC) Performance Standards, the Equator Principles (EP's) and the World Health Organisation (WHO) Guidelines and Limits; notably:

- The IFC's General Environmental, Health and Safety Guidelines (IFC, 2007b);
- The IFC's Environmental Health and Safety Guidelines for Mining (IFC, 2007c);
- Guidance and standards for drinking water quality have been taken from the WHO standards (WHO, 2004); and

- The World Health Organisation Air Quality Guidelines Global Update (WHO, 2005).

Due to the fact that cyanide will be used in the processing plant process, the International Cyanide Management Code was referred to. The "International Cyanide Management Code" for the manufacture, transport and use of cyanide in the production of gold is a voluntary industry program for the gold mining industry to promote:

- Responsible management, including health and safety management of cyanide used in gold mining;
- Enhance the protection of human health; and
- Reduce the potential for environmental impacts.

The International Cyanide Code was particularly referred to when the EMP was developed, as it will be important for BMMC to transport and manage cyanide based on the best practice management measures outlined by the Code.

## 2.8 Aureus Safety, Health, Social and Environmental Policy

Aureus has a Safety, Health, Social and Environmental Policy in place, and is committed to implementing this policy and operating according to its requirements. This policy can be found in **Appendix D** of this EIS.

# 3.0 DETAILED PROJECT DESCRIPTION

## 3.1 Statement of Need

In line with BMMC's MDA, the company has moved forward with conducting a comprehensive exploration drilling program at the NLGM site. At the same time, BMMC have retained the independent environmental consultants', Golder and EarthCons, to undertake the EIA for the proposed Project.

It is important to note that BMMC is committed to ensuring that Liberia, particularly Grand Cape Mount County and its people, benefit from its planned mining operations. Some of the key initial benefits that will be realised by the Project include:

- The Project will be the first gold mine in Liberia and will initiate Liberia's entry into the gold mining industry, raising the country's profile as a player in the West African gold mining industry;
- Royalties will be paid to the Liberian Government by BMMC;
- The training of local personnel in skills associated with a mining operation;
- Direct and indirect job creation and employment (with the associated multiplier effect) – during the mining operational phase approximately 300 personnel will be employed;
- Contribution to the social, economic and institutional development of the communities within the greater BMMC mining concession area; and
- BMMC has an agreement with the Liberian government through the MDA, related to the closure commitments as included in the MDA.

## 3.2 Project Concept and Phases

In terms of the Project concept, based on the exploration program that has been undertaken on the NLGM site to date, BMMC is proposing the development of an open pit gold mine and associated infrastructure, which will be described further on in this section of the EIS.

The NLGM Project forms part of a Minerals Development Agreement (MDA) between BMMC and the Liberian Government, (which was signed on the 14th March 2002). The Liberian Government retains a 10% ownership in the Project and a 3% Net Smelter Return. The terms of the MDA are for 25 years, which can be further extended for another 25-year period and falls under the auspices of the Mining Code of 2000.

From a project development perspective, the Project is in the Feasibility Phase, whereby feasibility studies for the main Project components including the open pits, the WRD, TSF, Marvoe Creek Diversion, and gold processing plant are underway. The EIA has been undertaken in parallel with the feasibility study, and project description information from the feasibility study was used to inform the impact assessment.

The key phases of the Project are as follows:

- Pre-construction Phase;
- Construction Phase;
- Operational Phase; and
- Decommissioning and Closure Phase.

The impact assessment and EMP completed during the EIA have thus been based on the phases as noted above, and the activities associated with each of these phases are elaborated on further on in this EIS.

## 3.3 Project Location, Scale and Scheduling

### 3.3.1 Project Location and Accessibility

The Project is located within the Grand Cape Mount County of the Republic of Liberia, which is situated on the coast of the southwest corner of West Africa and is bordered by Sierra Leone, the Republic of Guinea and Cote d'Ivoire. It lies between longitude 7º30' and 11º30' west, latitude 4º18' and 8º30' north.

The Project is situated within the south-western part of the greater Bea Mountain Mineral Development Agreement (Bea-MDA) property/concession area. (Note that the Project refers to the NLGM license only of the Class A area as shown in Figure 1).

The Project is accessible from Monrovia by vehicle, with approximately 100 km of paved road to the town of Sinje and then 45 km of laterite road to the Project site. The recently renovated Dangaytee road has reduced the total journey distance by 21 km and travel times to 2.5 hours. A new road which exits the tarmac at Daniel's Town, has further reduced the laterite section to 18 km allowing easier access to the Project site. Secondary roads, built by BMMC, provide access across the property. The sandy nature of the roads allows all year round access, including during the height of the rainy season.

In describing the location of the Project, it is important to highlight the following important features:

- The Marvoe Creek – runs through the centre of the Project site and joins the Mafa River to the west. The Mafa River flows into the Lake Piso wetland area, near Robertsport; and
- The closest protected area, a Forest Area, is approximately 30 km south of Project area.

### 3.3.2 Project Scale

In terms of scale, the Bea-MDA property covers an area of 457 km² with boundaries described by cadastral and cartographic survey in maps at the Ministry of Lands, Mines and Energy Republic of Liberia. (The Bea-MDA property, which is covered by a Class A Mining License, has been reduced from a prior exploration lease which covered a total of 1,000 km²). The NLGM Project area is approximately 33 km² in extent, which was the focus of the EIA.

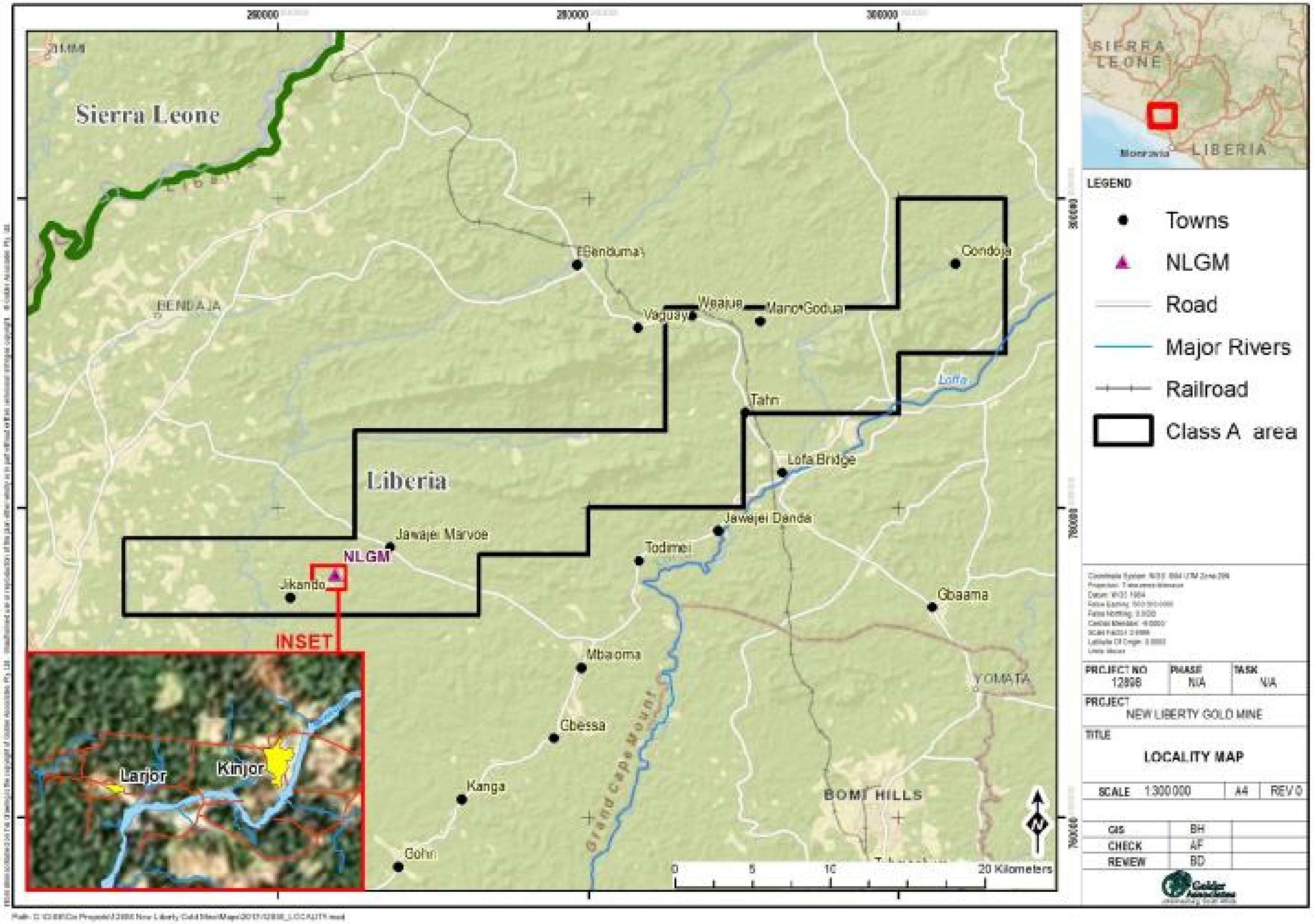


*Figure 1: BMMC Concession area, NLGM Project Location and Surrounding Communities*

### 3.3.3 Project Schedule

The NLGM Project schedule is subdivided into four phases, as follows:

- Pre-construction – 1st Quarter 2013;
- Construction Phase – 4th Quarter 2013;
- Operational Phase – 1st Quarter 2014; and
- Decommissioning and Closure Phase. – 1st Quarter 2022.

BMMC proposes to initiate the pre-construction activities to begin on site in the 1st Quarter of 2013. The construction phase of the project is envisaged to begin in the third or 4th Quarter of 2013. The duration of the construction phase will be approximately 12 months. The operational phase will be initiated in the 1st Quarter of 2014, and will last approximately 8 years. At this stage in the mine planning process, BMMC envisages the rehabilitation and closure phase beginning around the 1st Quarter of 2022.

The current Project schedule as described above, together with the EIA schedule and deliverables, is shown in Table 3.

**Table 3: NLGM Project Schedule (including the EIA Schedule and Deliverables)**

| Milestone | Date | Key Activities |
|---|---|---|
| Project Brief | 4th Quarter 2010 | Submission of a project brief that outlines the key components of the proposed works. |
| EIA TOR | 1st Quarter 2012 | TOR submitted and approved by authorities.<br>(See **Appendix E** for the TOR as submitted to and approved by the EPA) |
| Scoping Report | 2nd Quarter 2012 | Conduct public consultation. |
| | | Scoping Report submitted to authorities for review, and approved by means of a letter to Aureus dated the 22nd May 2012. |
| Letter of Intent | 2nd Quarter 2012 | Submitted to relevant authorities. |
| Baseline Studies | 4th Quarter 2010 to 2nd Quarter 2012 | Completed baseline studies for each specialist discipline. |
| EIS | 2nd to 3rd Quarter 2012 | Developed the EIS based on specialist impact assessments. |
| | | EIS reviewed by authorities. |
| | | EPA and other relevant Authorities decision on the EIS |
| Pre-Construction | 1st Quarter 2013 | Pre-construction related activities, notably related to the Resettlement Action Plan (RAP) and the building of the resettlement village, where the Kinjor and Larjor communities will be relocated to. |
| Construction | 3rd to 4th Quarter 2013 | Construction related activities. |
| Operations | 1st Quarter 2014 | Operational related activities. |
| Mine Closure | 1st Quarter 2022 | Rehabilitation and closure related activities. |

### 3.3.4 Mining and Treatment Schedule

A mining schedule was developed by AMC based on the mineral reserves determined by AMC and Aureus.

The schedule parameters are:

- Processing plant throughput of approximately 3000 tonnes per day; and
- Total material movement averaging 48,000 tonnes per day.

The mining schedule sees waste stripping starting at the Larjor zone of the open pit and the starter areathe in Latiff/Kinjor zone of the pit. The waste from these pit zones will be deposited to a single waste rock dump to the south of the pit area. The Larjor zone of the pit will be exhausted in approximately Year 4 and after that this zone will be backfilled with mine waste (AMC, 2012).

The feasibility mining schedule sees the operation produce, ex-pit, a total of 8.7 million tonnes of plant feed at an average mined grade of 3.1 g/t Au, with an associated waste production of 130 Mt over a 8.5 year mining period. Table 4 summarises the annualised mining production from the open pit. A steady state mining rate is planned, after an initial period of waste pre-stripping, at an annualised plant feed mining rate of 1.1 Mt tonnes and an associated annualised waste mining rate of +/- 21.5 million tonnes (AMC, 2012).

Table 4 details the mill treatment and gold production schedule which assumes a maximum treatment rate for ore of 1.1 Mt tonnes per annum.

**Table 4: Mining and Treatment Schedule (AMC, 2012)**

| Period | Total | Year 0 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ore Mt | 8.7 | 0.3 | 1.2 | 1.1 | 1.1 | 1.1 | 1.3 | 1.2 | 1.5 | - |
| Grade g/t | 3.1 | 2.5 | 3.2 | 3.4 | 3.8 | 4.2 | 2.3 | 3.1 | 2.4 | - |
| Contained Gold 000 oz | 873 | 21 | 123 | 121 | 132 | 149 | 94 | 116 | 116 | - |
| Waste Mt | 130 | 11.0 | 21.4 | 21.5 | 21.6 | 21.5 | 21.3 | 6.9 | 4.3 | - |
| Total Material Mt | 138 | 11.2 | 22.6 | 22.6 | 22.7 | 22.6 | 22.6 | 8.0 | 5.8 | - |
| Strip Ratio t w:o | 14.9 | 41.6 | 18.1 | 19.4 | 20.2 | 19.5 | 16.4 | 5.9 | 2.8 | - |
| | | | | | | | | | | |
| Ore Milled Mt | 8.7 | - | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 |
| Grade g/t | 3.1 | - | 3.3 | 3.5 | 3.8 | 4.3 | 2.5 | 3.3 | 2.8 | 1.2 |
| Contained Gold 000 oz | 873 | - | 115 | 126 | 135 | 152 | 89 | 117 | 100 | 39 |
| | | | | | | | | | | |
| Recovery | 93% | - | 93% | 93% | 93% | 93% | 93% | 93% | 93% | 93% |
| Gold Produced 000 oz | 812 | - | 107 | 117 | 126 | 141 | 83 | 108 | 93 | 37 |

## 3.4 Key Project Components and Building Plans

The proposed Project will comprise of an open-pit gold mine that is expected to operate for approximately 8 years with an ore production and treatment rate of approximately 3,050 tonnes per day. Waste rock will be mined at an average daily production rate of 45,000 tonnes per day. (Whilst mining operations are taking place within the NLGM mine site, BMMC will continue with gold exploration activities within its greater Bea-MDA license area).

The Project includes all activities and physical works associated with the construction, operation, modification and decommissioning of the Project, including, but not limited to, the following key activities and components:

- Resettlement of the Kinjor and Larjor communities (as part of the pre-construction phase);
- Open pit gold mine and associated waste rock dump (WRD);
- Topsoil stockpiles;
- Gold processing plant, including an associated power plant made up of eight diesel or heavy fuel oil generators;
- Water dams associated with the processing plant, mainly used for storage purposes;
- Tailings Storage Facility (TSF);
- Support facilities and infrastructure at the mine site, including water, waste infrastructure and storage facilities;
- Diversion Channel (DC) of the Marvoe Creek;
- Staff accommodation and associated facilities such as a sewerage treatment plant. (The sewerage will be disposed to septic tanks and the sewerage slurry will be disposed of at the TSF. A sewerage treatment plant and system will service the accommodation camp and processing plant areas. The sewerage treatment plant will comprise of an underground tank, and an aerobic treatment unit and sludge disposal to the TSF);
- General waste landfill site, and an associated incinerator; for incineration of hazardous wastes;
- Power and water supply;
- Ancillary facilities and buildings, such as administrative offices, service buildings, laboratory, hydrocarbon storage, explosives storage; and
- Non-paved roads and haul roads; existing and new.

The key Project infrastructures are outlined in the following sections with a map of the proposed NLGM site infrastructure layout shown in Figure 2.

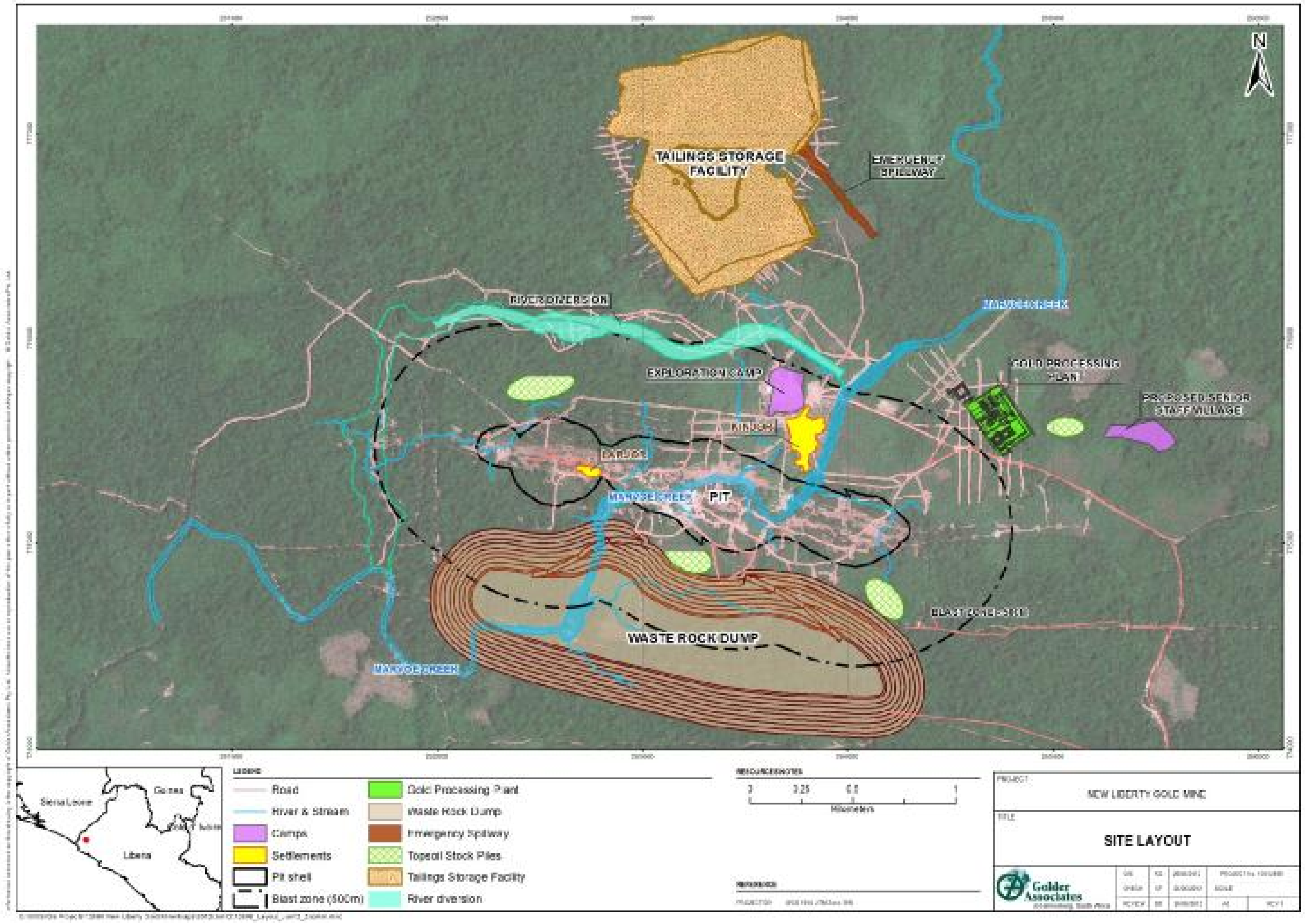


*Figure 2: NLGM Mining Infrastructure Site Layout Map*

### 3.4.1 Exploration

The key activities associated with BMMC's exploration program, which is currently on-going within the Bea-MDA include:

- Desk study – historical data compilation and review;
- Mapping and rock chip sampling;
- Stream sediment sampling;
- Opening up tracks and roads to gain access;
- Siting of the drill rigs;
- Soil sampling;
- Digging of borrow pits;
- Trenching – to obtain rock and soil samples;
- Core drilling (on a grid pattern);
- Managing water used in the drilling process;
- Transporting and using diesel and oil for vehicles, drill rigs and mobile generators; and
- Managing the core – transport to core shed, recording and analysing core.

Note that BMMC's current on-going exploration activities were not included within the scope of the NLGM EIA, however, mitigation measures for exploration activities are provided in the EMP (section 9) of this EIS. Table 5 below shows the proposed exploration works programme for the envisaged BMMC exploration works for Quarter 2, Quarter 3 and Quarter 4 2012 (Aureus, 2012).

**Table 5: Exploration areas in the Bea-MDA and associated activities**

| Area within the BEA-MDA Concession | Exploration Related Activities |
|---|---|
| Gondoja | ▪ Continue trenching.<br>▪ Start drilling and do surface mapping. |
| Ndablama & Leopard Rock | ▪ Complete surface mapping.<br>▪ Complete trenches and mapping of trenches.<br>▪ Complete planned IP gradient array survey in the gap area between Ndablama and Leopard Rock |
| New Liberty | ▪ Continue drilling geophysics targets and the As soil anomaly.<br>▪ Start regional soil sampling,<br>▪ Complete planned IP gradient array surveys.<br>▪ Make a long section of New Liberty resource area showing geology.<br>▪ Surface mapping and produce a Geology map of New Liberty area. |
| All areas | ▪ No exploration field work due to the rainy season setting in. Most staff will take time off or work in the office and review data and plan for Quarter 4 and 2013. |
| Silver Hills | ▪ Regional soil sampling and mapping,<br>▪ Produce geology map. |
| Gondoja | ▪ Trenching and mapping at target 2 and 3.<br>▪ Produce geology map. |
| New Liberty | ▪ Drilling anomalous soil targets and new geophysical targets.<br>▪ Data review, finalize mapping,<br>▪ Geological model finalize. |
| Regional | ▪ Geochemistry work – based on recommendations from consultant.<br>▪ Structural study, confirm on the ground and generate targets from that for follow up work.<br>▪ Plan for 2013 exploration program. |

### 3.4.2 Mining Method

The choice of mining method is largely determined by the geology and depth of the gold ore body. Open pit mining refers to a method of extracting rock or minerals by means of an excavation from surface. (The term is used to differentiate this form of mining from underground extractive methods that require tunnelling into the earth). Open pit mining involves the removal of the non-mineralised top layers of material, usually termed "overburden/topsoil", to get access to the ore body. The topsoil will be stored as close as possible to the point of removal for ease of rehabilitation and to minimise rehabilitation costs.

Mining will be undertaken by conventional open pit methods: drilling, blasting, excavating, and road haulage of ore and waste. The mining area will be cleared of vegetation and topsoil will be removed prior to rock excavation and stored for rehabilitation purposes. After selective blasting within the planned open pit, the blasted ore and waste rock will be loaded onto trucks using excavators. The ore will be transported to the processing plant. The waste rock will be identified as NAF (non-acid forming) and PAF (Potential acid forming) waste rock and disposed of as per engineering design at the waste rock dump. Non-sulphide bearing materials may be used internally to construct haul roads, the run of mine (ROM) pad, and the TSF starter embankment Figure 3 below shows the open pit mining process that will be followed.

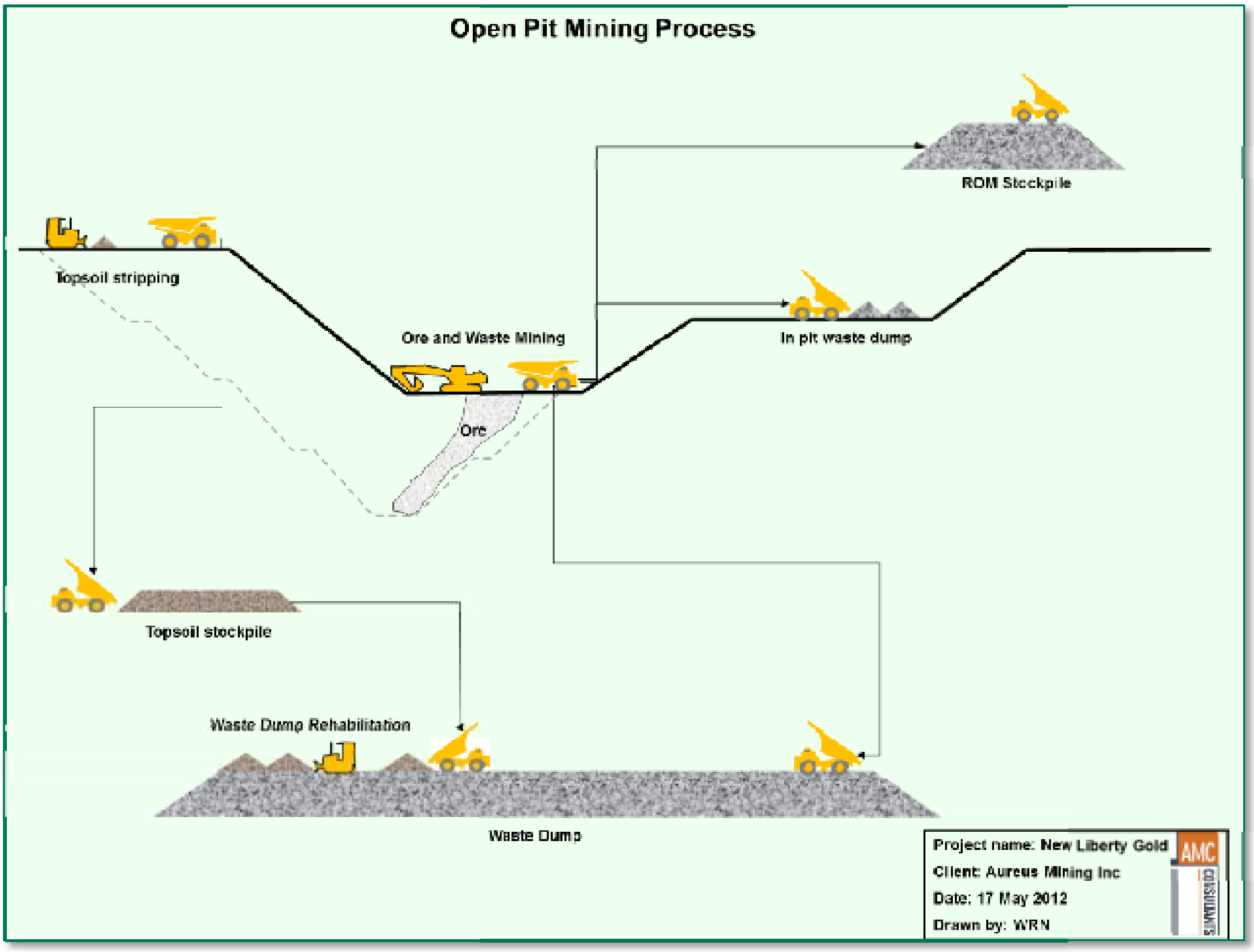


*Figure 3: Open pit mining process (AMC, 2012)*

### 3.4.3 Open Pit

The NLGM open pit will form a contiguous mining area along a strike length of 2 km. The depth of the open pit will be approximately 220 m below surface. Water from the dewatering of the open pit will be pumped into the Marvoe Creek, if the water quality complies with the Liberian water quality discharge standards.

For the purpose of the mining schedule the open pit was divided into three areas or zones, as follows:

- The Larjor zone;
- The combined Latiff and Kinjor zone; and
- The Marvoe zone.

The Latiff, Kinjor and Marvoe zones coalesce into a single pit. Due to its width and strip ratio the Latiff/Kinjor zone was further split to a starter pit/area and then a final pit/area.

The Larjor pit area will be backfilled with waste rock once mined out to minimise closure costs and to ensure sound environmental practices.

Figure 4 shows the final pit layout, as well as the waste rock dump (WRD) layout (AMC, 2012).

### 3.4.4 Waste Rock Dump (WRD)

A waste rock dump (WRD) design has been developed by AMC Consultants and is expected to cover a footprint area of 1.49 million m² and will have a maximum height of 68 m and a minimum height of 42 m. The current design capacity of the WRD is approximately 52.3 million $m^3$.

As noted earlier, the waste rock will be placed on the WRD for the first four (4) years of production. After this time, the Larjor pit will be exhausted and waste rock mined after this time, will either be taken to the ex-pit WRD or be used to backfill the Larjor pit if needed.

The location of the WRD will be to the immediate south of the open pit in the valley area currently occupied by the Marvoe Creek, as shown in Figure 2.

The key design specifications of the WRD (AMC, 2012) are as follows:

- The WRD will be constructed with an 18º degree overall slope angle to conform to post closure stability angles;
- Berm width 25-30 m – (the berm in this design is 25 m to preserve overall angle close to 18º);
- Stormwater from the WRD will be diverted to a sediment pond;
- The WRD will be located at a 100 m stand off from side of the open pit; and
- The ramps will be 25 m wide.

Figure 4 shows the final pit layout, including the different pit zones, and the proposed WRD design.

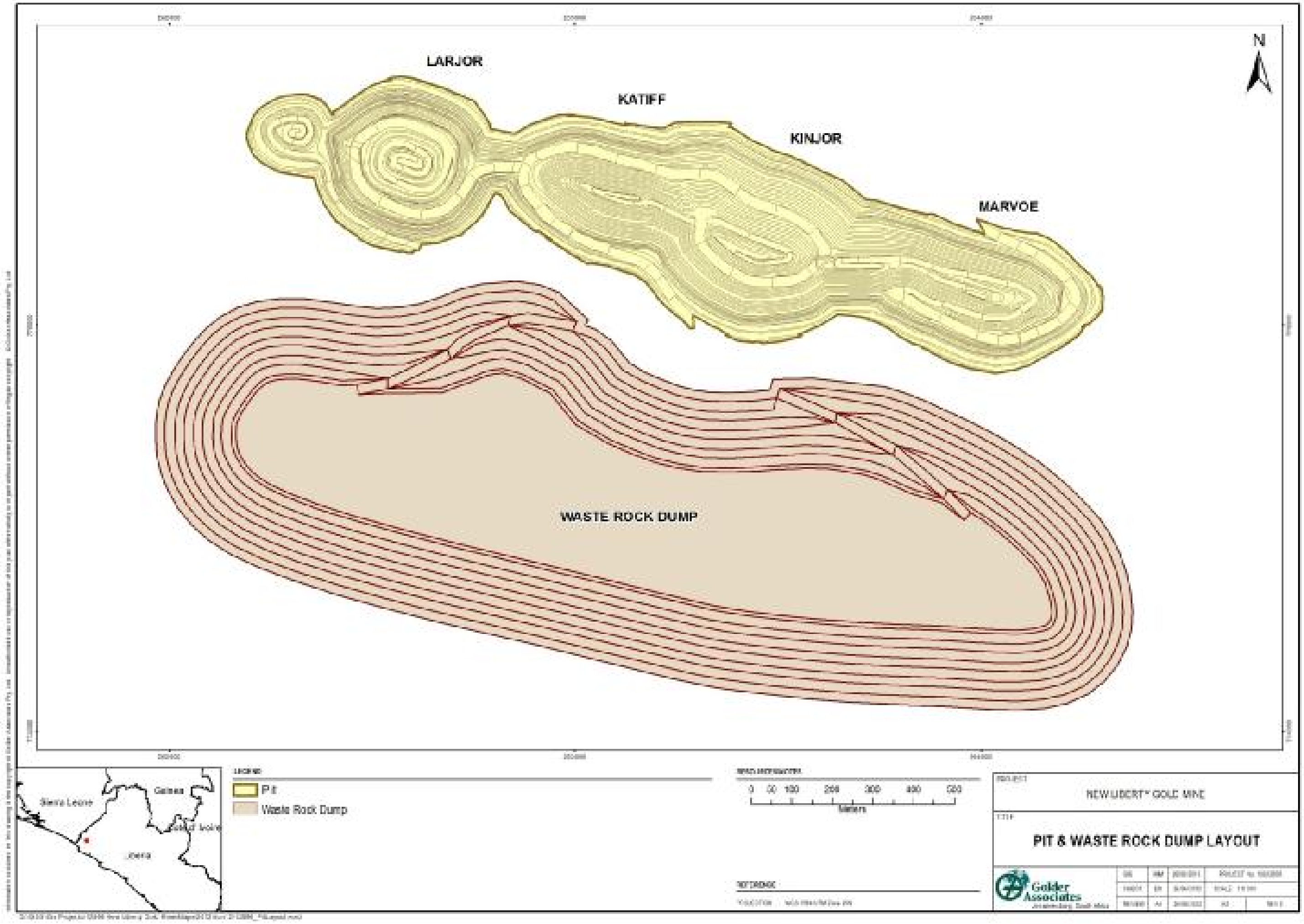


*Figure 4: Final Pit Layout and Waste Rock Dump (WRD) Design (AMC, 2012)*

### 3.4.5 Topsoil Stockpiles

Based on an estimate of stockpiling the first 0.5 m of cleared-ground for use as topsoil, AMC calculate the volumes of topsoil for the Project to be:

- Volume stripped from the pit: 354,000 $m^3$ – (based on the total area of the pit footprint being 707,000 $m^2$); and
- Volume stripped from the WRD: 750,000 $m^3$ – (based on the total area of the WRD footprint being 1.5 million $m^2$).

This gives a grand-total of topsoil material to be stockpiled for the Project of 1.1 million $m^3$.

AMC has not undertaken specific design work for the topsoil stockpile areas as yet, but the proposed stockpile storage areas that could be suitable are shown in the site layout map (Figure 2).

### 3.4.6 Gold Processing Plant

A gold processing plant will be constructed to extract the gold from the ore. DRA Mineral Projects are currently conducting the feasibility study and detailed design of the processing plant. Ore will be processed using a conventional Gravity/Carbon in Leach (CIL) gold recovery circuit designed to treat +-1,100,000 Mt/year and (+-91,670 tonnes per month) and will comprise of the following:

- A crushing and milling circuit;
- Gravity circuit to recover free gold;
- A CIL leaching and adsorption circuit, in which cyanide leaches the gold from the crushed ore and carbon recovers the gold from the leachate slurry by adsorption;
- Cyanide detoxification of residual slurry prior to discharge to the TSF;
- An acid wash followed by an elution circuit to strip gold from carbon; and
- Electro-winning of the gold from the elutriate solution and smelting of the loaded electrodes to produce gold bullion.

The processing plant design criteria are summarised in Table 6 below.

**Table 6: Processing Plant Design and Throughput Criteria**

| Item | Unit | Value |
|---|---|---|
| Annual throughput fresh ore | Tonnes | 1,100,000 |
| Comminution circuit | | crushing, closed circuit Ball Mill |
| Crusher Operating Hours | hr/day | 18 |
| Crusher Availability | % | 75 |
| Crusher Feed Rate (fresh) | Tph | 228 |
| Milling Availability | % | 90 |
| Mill Feed Rate | Tph | 146 |
| Grind Size P90 | µm | 95 |
| Gravity Circuit | | Concentrators |
| Leach circuit design | | CIL |
| Leach Residence Time | Hrs | max 48 |
| Recovery | % | 93 |
| Cyanide Consumption | kg/t | +- 0.8 |
| Lime Consumption | kg/t | +- 0.8 |
| Elution Circuit | | AARL |

The processing plant layout and operation will be optimised with detailed on-going studies forming part of the feasibility study programme that DRA is currently undertaking. The proposed plant layout is shown in Figure 5 below.

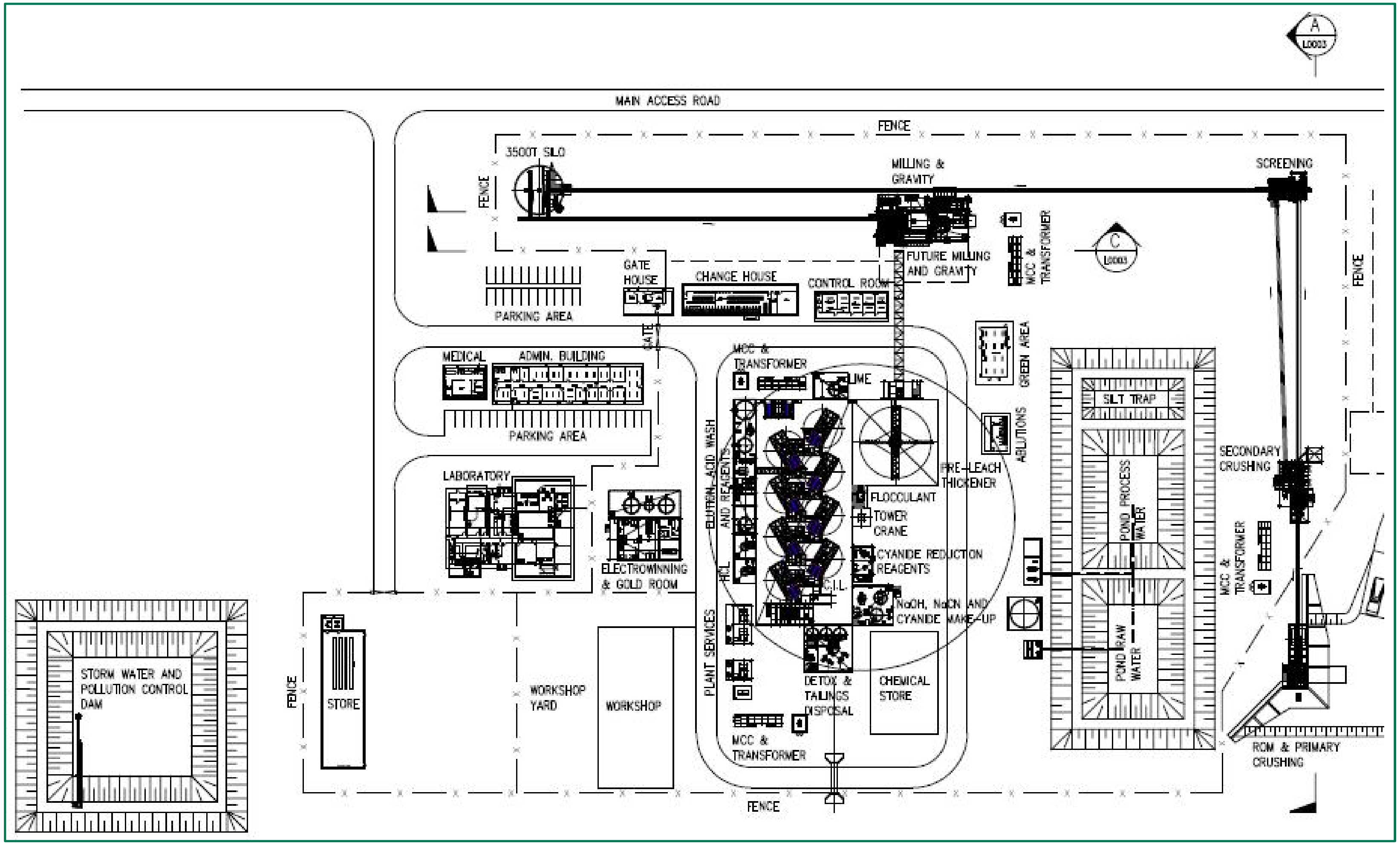


*Figure 5: Gold Processing Plant Layout/Design (DRA, 2012)*

Further detail on the proposed processing plant process is provided below.

### *Ore Receipt and Crushing*

Ore will be hauled by trucks for up to 12 hours per day and stockpiled on a ROM pad, or delivered directly into a ROM bin by a truck or front-end loader

The ROM bin will discharge onto an apron feeder which will feed a vibrating grizzly feeder (VGF) to screen the feed to a jaw crusher. Crusher product, VGF undersize and apron feeder dribblings, 80% <160mm will collect on the screen feed conveyor. This conveyor will be equipped with a belt scale and an overhead self-cleaning magnet, and feed a double-deck vibrating sizing screen which removes <22mm material to the fine ore silo. This sizing screen oversize will be crushed in one of two secondary cone crushers, the product of which will be returned to the screen by the closed circuit conveyor. Surge bins will control the rate of feed to the secondary crushers, discharging onto vibrating feeders.

### *Milling*

The fine ore silo will receive the <22 mm ore from the sizing screen, and discharge the ore into the ball mill via two variable-speed belts feeding the mill feed conveyor at a controlled rate. In addition to ore, the ball mill will receive water from the Process Water Dam for density control, cyclone underflow for regrinding, lime for slurry conditioning, 80 mm steel balls as grinding media, and recycled gravity tailings for further grinding.

The ball mill will discharge pulp through a trommel screen into the mill discharge sump, serviced by two cyclone feed pumps. This hopper will receive its water from the Process Water Dam, including gravity fines, to effect efficient classification in a cluster of hydro-cyclones (two on standby) to remove <75 micron material to the pre-leach thickener.

### *Gravity Concentration*

The cyclone underflow will equate to approximately 250% of mill feed mass, and will be split between gravity concentration (40%), and recycle to the ball mill (60%). The gravity concentrator feed will pass through a scalping screen before being diluted and fed to two gravity concentrators, which will recover the gold into <1% of the feed mass. Gold is recovered in gravity concentrators by centrifugal forces, and the concentrated gold will be collected in a batch tank. Gravity tailings will join the scalping screen oversize and be returned to the ball mill for further grinding.

Once a suitable quantity of gravity concentrate has been collected, it will be subjected to an upward flow of water to remove low-density and ultra-fine particles to the mill discharge hopper. These fines will interfere with electro-winning, and are amenable to conventional cyanidation. The elutriated concentrate will be discharged into an Acacia intensive-cyanidation leach reactor, where it will be contacted with high-strength cyanide solution and a slow-releasing oxidant (Leach Aid) to maximise gold dissolution into clear pregnant liquor, suitable for electro-winning.

On completion of the leach cycle after approximately 16 hours, the residual concentrate will be washed with water from the Process Water Dam to ensure total recovery of dissolved gold to electro-winning, as well as remove any cyanide compounds before emptying the reactor to the Carbon-in-Leach (CIL) section.

### *Thickening & CIL*

The cyclone overflow from the milling section will be screened on a linear screen to remove all mining and engineering debris. Screen undersize will report to a thickener, for solid/liquid separation. Solid settling will be accelerated by the addition of polyacrylamide flocculants to assist supernatant water clarity. The clear water which overflows the thickener will be pumped and recycled to the Process Water Dam for re-use in the milling section and general utility water.

Solids will settle in the thickener to a slurry of 45 – 50% solids w/w, which will be pumped to the CIL Section. The CIL section will consist of eight mechanically-agitated tanks all equipped with carbon-transfer pumps and MPS (P) inter-stage screens. Oxygen-enriched air will be injected into the tanks to accelerate gold dissolution, and activated carbon will be present in all tanks to adsorb any gold dissolved by the cyanide added to the feed slurry.

Barren (regenerated or new) carbon will be added to the last (No 8) tank, from where it will periodically be pumped upstream, counter-current to the slurry flow. This ensures that the carbon with the highest potential for gold adsorption is in contact with solution with the lowest gold concentration.

Test work leach kinetics have shown that the gold dissolution profile requires a residence time of up to 48 hours, and the CIL and Elution plants have been sized accordingly.

Recessed-impeller vertical spindle pumps move carbon upstream, and MPS (P) screens retain the carbon in the tanks, and transfer the slurry downstream, to maintain a constant slurry level in all vessels. As the carbon is progressively and periodically moved upstream, the gold concentration (loading) on the carbon will increase. The carbon in the first (No 1) tank will therefore have the highest loading of 1360 ppm and be in contact with the highest dissolved gold concentration.

Once the carbon in Tank No 1 is saturated, or has attained a desired loaded carbon grade, it will be pumped to the loaded carbon screen located above the acid wash hopper. The carbon will be washed clean before released into the acid wash hopper, and the washings and slurry will gravitate back to No 1 CIL Tank.

### *Acid Wash and Elution*

Over the period of 24 hours, a carbon batch of approximately 4.0 tonnes of gold loaded carbon will be collected in the acid wash hopper. Here the carbon will be contacted with an upward flow of 3% hydrochloric acid (HCℓ) pumped from the dilute acid storage tank located in the elution section. The carbon will soak in the acid for an hour or until all reaction signs have ceased. HCℓ washing is necessary to remove all calcium oxides or carbonates adsorbed on the carbon from the lime products or ore constituents.

Acid-washed carbon will be rinsed before being dropped into the elution column. This column will be heated by circulating a caustic-cyanide through heated heat-exchangers until the carbon is at 125oC, when the hot solution will be transferred to the pregnant solution tank at the electro-winning section where gold is stripped off the carbon. The eluted carbon will then be rinsed with Weak Electrolyte from the Weak Electrolyte Tank and cooled before being regenerated.

The elution column contents will be emptied over a dewatering screen located above the kiln hopper. Carbon will be withdrawn from the kiln hopper by a screw feeder feeding a horizontal, diesel-fired regeneration kiln. The kiln will heat the carbon to 710 – 750 $^{o}$C in the absence of oxygen (due to prevalent steam) thereby volatilising organics and reactivating the carbon for re-use in the CIL. The kiln discharges into a quench tank, from where the carbon is screened to remove all undersized carbon particles which could result in gold losses by escaping inter-stage screens. Undersized carbon is discarded to the TSF.

### *Electro-winning and Gold Room*

Two storage tanks will be provided for the separate storage of gravity pregnant solution and elution eluate solution. Four electro-winning cells will be located in the gold room and used to electroplate the dissolved gold, two for elution eluate and one for gravity liquor and one standby.

Pregnant liquor will be circulated between the storages and the cells until the solution has been depleted of gold (and called barren). Barren solution will be pumped to the CIL where it will add value in terms of reagent and residual gold.

Once an electro-winning cycle is complete, the plated cathodes will be hoisted from the cell and the gold washed off into a sludge tank. Collected cathode foil and sludge will be decanted into trays to be loaded into the diesel-fired drying oven, after which they will be charged into an Induction Furnace for pouring into moulds to produce bullion bars.

### *Detox and Residue Disposal*

Slurry discharged from the CIL Section contains residual cyanide making it unsuitable for disposal, and a cyanide detoxification section will be provided to neutralise the cyanide into complexes suitable for environmental disposal. Three vessels will be provided, into which staged additions of copper (as copper sulphate, CuSO4) and sulphur dioxide (as sodium metabisulphite, Na2S2O5). Oxygen-enriched air will be injected into the vessels to ensure the highest oxidation state of base metals and cyanide, and hence the precipitation of insoluble base metal cyanate complexes, which will be pumped to the Tailings Storage Facility (TSF). Two sets of two residue pumps in series (one duty, one standby) will be used to transfer plant residue to the TSF, which will be operated on a decant basis for water reclamation back to the process plant.

### *Reagents*

All reagents except cyanide will be stored in a ventilated chemical shed and made up in a dedicated area for distribution to the various points in the processing plant.

Mixing and storage tanks will be provided for lime (received in 1m3 bulk bags), hydrochloric acid (received as 33% HCℓ in 1000 litre IBC's), sodium metabisulhite (received as dry $Na_2S_2O_5$ in $1m^3$ bulk bags), copper sulphate and caustic soda received dry in 25 kg bags). Flocculant will have a specialised hydration plant and will be supplied as a vendor package.

Cyanide will be handled and distributed, as per the International Cyanide Code. The cyanide boxes and containers will be incinerated as per site hazardous waste management procedure as per the hazardous waste handling standards.

The main reagents to be used in the gold processing plant will include:

- **Cyanide –** All activities concerning cyanide handling and distribution will adhere to the International Cyanide Code.
- **Caustic Soda –** A spillage pump installed in the bund pumps spillage from this area to the Detoxification Feed Box.

  **Lime –**A. Lime slurry will be supplied to the Mill, CIL and detoxification areas. A safety shower will be installed in the lime make-up bund, as well as a spillage pump, which will deliver to the detoxification reactor.

  A safety unit will be located at the plant for regular emergency practises including personal protective equipment (PPE) etc.
- **Flocculant.**
- **Copper Sulphate.**
- **Sodium Metabisulphite –**An emergency safety shower will be installed in the Detoxification Reagent bund, and the area will be serviced by an overhead travelling hoist. The safety shower will be fed with potable water from the water treatment plant and emergency equipment will be made available.
- **Hydrochloric Acid.**
- **Oxygen.**
- **Air services.**

All the reagents will conform to safety, health and environmental standards as per site procedures which will be compliant with international standards.

### 3.4.7 Power Plant

The electrical power demand of the mine and processing infrastructure will be supplied by a diesel powered power plant located adjacent to the processing plant infrastructure. The power plant will be made up of multiple 400V diesel powered generators operating in parallel with step up transformers to supply an 11kV reticulation switchboard. The operating philosophy of the power plant will be on an N+1 basis as a minimum, but could be on an N+2 basis if deemed necessary by the generator manufacturer for maintenance purposes. Power to the processing plant 11kV substation will be supplied over the plant fence line from the power plant via dual 11kV feeders at 50Hz. The estimated installed capacity of the power plant is 10MW to be supplied by 8 generators.

### 3.4.8 Tailings Storage Facility (TSF)

The tailings storage facility (TSF) will be used for storing and managing the tailings received from the processing plant. Tailings leave the processing plant in the form of slurry via pipelines, consisting of a mixture between solid material (sand-like in texture) and process water.

In the TSF, solid and liquid separation will take place. The solid material forms the bulk of the capacity in the TSF. The slurry will settle down and the water will collect in the TSF pool. This water is then recycled back into the processing plant for re-use.

Golder's engineering team has designed the TSF for the NLGM Project. The mining process is expected to generate a total of approximately 8.7 Mt of tailings over the life of mine. The dry density of the deposited tailings is assumed to be 1.45 t/m$^3$. Based on this assumed density, the TSF will be designed to store a total of 6.0 M-m$^3$ of tailings over the life of the mine.

The TSF will be developed in stages. The start-up TSF will be required to provide storage for two years of tailings production.

The ultimate TSF will occupy a total footprint area of 84 ha. The key components of this facility are:

- Containment dams (main dam and saddle dams);
- Clay liner covering the TSF basin;
- Underdrain;
- Non-contact water diversion system;
- Contact water collection system; and
- Emergency spillway.

The NLGM TSF design specifications are summarised in the table below.

**Table 7: NLGM TSF Design Specifications (Golder, 2012)**

| Parameter | Design specification |
|---|---|
| Total capacity | 8.7 million tons (at 1.1 Mt/annum over 7.9 years) |
| In situ dry density of tailings | 1.45 t/m$^3$ |
| Specific Gravity | 2.9 t/m$^3$ |
| Annual tailings volume | 0.76 Mm$^3$ |
| TSF Area of footprint | 84 ha |
| Maximum height of TSF dam | 24 m |
| Overall side wall slope of TSF dam | 1:2.5 outside slope |
| TSF basin liner | 0.3 m compacted clay layer of permeability 10$^{-9}$ m/s under laboratory conditions |
| Drainage management system | Ditches and sumps sized for a 1:100 year, 24-hour storm event |

The NLGM TSF design is provided in Figure 6 below.

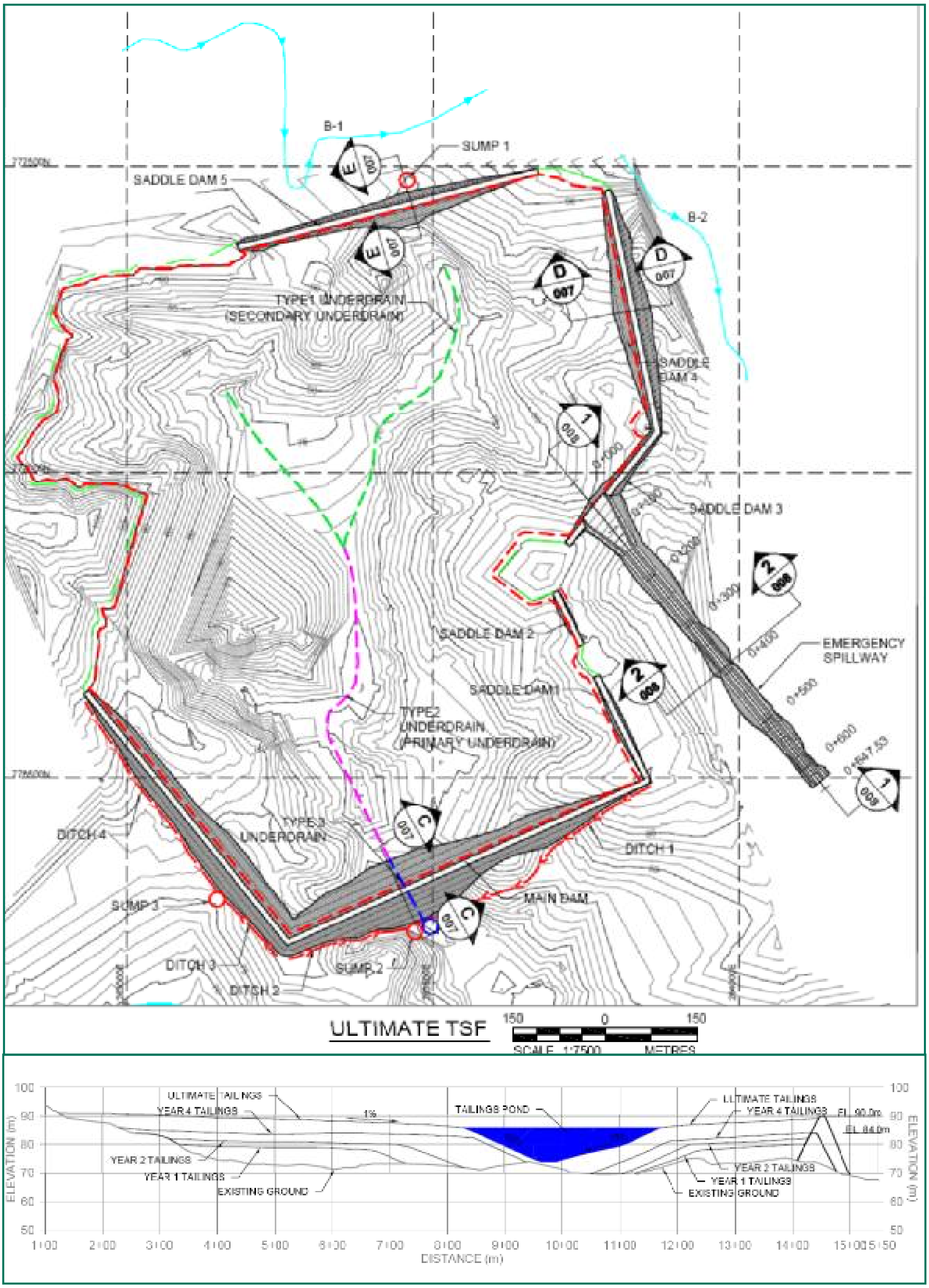


*Figure 6: TSF design (Golder, 2012a)*

The design of the TSF is aimed at minimising the risk to the environment. The ultimate TSF requires a total of six (6) dams; one main dam and five saddle dams. The main dam is located in the south at the deepest section of the valley. The dam will be 1.16km long, to a maximum height of 24m. The crest elevation of the dam is 90.0 m. The maximum elevation of the tailings against the main dam is 89.0m. Compared to the main dam, the saddle dams are smaller in size and their crest elevation varies from 90 to 92m.

In terms of the TSF basin liner, a 0.3m thick compacted clayey soil liner is provided at the basin of the TSF to control seepage. Where applicable, the native clayey soil will be used as the liner. Prior to construction of the clayey liner, the topsoil and all weak, loose, compressible and otherwise unsuitable soils within the basin will be excavated and removed. The clay liner will have a permeability of less than $1x10^{-9}$m/s.

A system of gravel drains are provided below the compacted clay liner at the valley bottom of the TSF basin to intercept groundwater from springs and to provide dry working surface for the construction of the compacted clay liner. Water collected by the underdrain system will be conveyed to a manhole equipped with a pump, which will be located downstream of the TSF main dam. The quality of the water collected in the manhole will be continuously monitored. If the quality is acceptable for discharge it will be pumped to the MCDC; if not, it will be pumped back to the TSF.

The TSF will have an Emergency Spillway consisting of three main structures: an overflow weir located to the east of the TSF, a rock chute, and a stilling basin as a terminal structure. All three structures have trapezoidal cross-sections and are rip-rap lined for erosion protection. The spillway location will be the same for all operational stages and closure. The ending of the rock chute and the stilling basin for the start up will also be a part of the spillway for the ultimate stage and closure.

### 3.4.9 Diversion Channel (DC) of the Marvoe Creek

The Marvoe Creek is the dominant drainage feature in the Project area. It is fed by numerous small tributaries and is itself a tributary of the Mafa River, which lies 5 km southwest of the Project site. The creek diagonally bisects the Project site and the alignment is such that it passes through the proposed open pit and WRD site. As a result, a permanent diversion channel (DC) is planned to route Marvoe Creek around the open pit and the WRD. The drainage area of the creek upstream of the proposed diversion is approximately 109 $km^2$.

Where it passes through the Project site, the Marvoe Creek is approximately 30m wide with a mild slope (approximately 0.01-0.04%). The peak discharge measured between December 2010 and February 2012 is 7.6 $m^3$/s (December 2010). The minimum measured discharge was 0.05 $m^3$/s, which was recorded in April 2011 (Golder, 2012a).

A conceptual design of the DC was developed based on a number of design criteria and assumptions. One of the most important of these is that the channel should contain flood flows within the alignment for all events up to and including the 100 year recurrence flood. Also, that the channel should have a 0.3m freeboard above the 100-year recurrence flood, for safety.

Construction of the DC will start from the outlet area (in the eastern part of the NLGM site, where the water will flow from the Marvoe Creek into the DC) and it will progress towards the inlet where it will merge with the existing Marvoe Creek. The construction requirements along the length of the DC are variable. The first half of the DC is through an existing stream and hence construction will be minimal. The second half of the DC goes through small hills and the construction of the DC in this area will involve deep excavations. Drilling and blasting may be required where bedrock is encountered. The sequence of construction activities in the DC will be determined by a number of factors. A preliminary sequence is provided below which aims at minimizing the impact of the construction activities on the environment.

To initiate the construction of the DC, lines will be cut through the dense forest for use as construction access roads. These access roads will be used as a route to start clearing the forest cover from the footprint areas of the DC. Run-off control berms or ditches and sediment control structures will be constructed along the DC to minimize the impact of erosion on the downstream environment. The topsoil from the cleared channel areas will be removed and stockpiled for use as a cover material for closure of the TSF and the WRD. The first half of the DC will primarily involve levelling, proof rolling, installation of non-woven Geotextile, and placement of rip-rap. These construction activities will also take place on the second half of the DC once the hills are excavated. The riprap in this segment of the DC will only extend util the 100-year flood line.

In some segments of the DC, berms will constructed to ensure that the 100-year flood is fully contained within the channel. The foundation areas of the berms will be cleared of vegetation cover, topsoil and other unsuitable materials before the placement and compaction of the fill materials take place. The construction activities in the flood control dykes will be the same as in the diversion berms; however, the only difference will be that coffer dams may be required upstream of the dykes before any construction activity can start. The coffer dams will be constructed by dumping soil material and compacting it.

The DC will be approximately 3.7 km in length and will join up with the Marvoe Creek at the east end of the pit and WRD.

The following elements are included in the design of the diversion channel:

- Shallow Excavation: These are areas at the inlet and outlet of the constructed channel. In these areas the channel depth is shallow and the width of the channel was kept as 30m to mimic the natural creek condition. The excavated channel will be rip-rap lined where required to minimise erosion. Such mitigation measures may consist of vegetation covers, energy dissipation structures, alignment modification and or local armouring.
- Deep Cut: There are areas along the alignment where a very deep excavation is required for the water to flow. The channel shall be rip-rap to a flow depth of 7m. Above this elevation, the excavated slopes will be re-vegetated.
- Containment Berm: These are areas where the natural topography does not provide full containment of the 100-year flood. Berms will be provided along the channel. These containment berms are assumed to have 5 m wide crests and side slopes of 2H:1V.
- Flood Control Dykes: Five dykes are proposed to be constructed at different locations to guide the flow to the diversion channel. The dykes will be homogenous embankments constructed using clayey soil with a minimum crest width of 5 m and side slopes of 2H:1V. The upstream surface of the dykes will be rip rap lined.

### 3.4.10 Mining Fleet

The envisaged mining fleet is provided in Table 8 below.

**Table 8: Proposed Mining Fleet (AMC, 2012)**

| Equipment | No of Pieces |
|---|---|
| Excavator 12 $m^3$ bucket | 2 |
| Excavator 6 $m^3$ bucket | 2 |
| Excavator 2 $m^3$ bucket | 1 |
| Haul Trucks 100 t | 21 |
| Haul Trucks 35 t | 2 |
| Dozers | 3 |
| Wheel Dozer | 1 |
| Graders | 2 |
| ROM pad loader | 2 |
| Water Carts | 2 |
| Fuel and Lube Trucks | 3 |
| Drills | 8 |
| Light Vehicles | 15 |
| Buses | 4 |
| Pumps, Lighting Towers, tyre handler etc | - |

### 3.4.11 General Waste Landfill Site

A general waste landfill is an important part of waste management at the NLGM site. The volume of waste being produced will increase during the life of the mine. Waste production shall first be, minimised, then recycled where possible, then prevented and re-used, before disposal is considered and earmarked for the NLGM general/domestic waste landfill site.

A general landfill site will be built into the ground, close to the NLGM accommodation camp, in which waste will be isolated from the surrounding environment (i.e. groundwater, air and soil). The waste will be compacted and backfilled as and when required. Burning of waste will be carried out on a scheduled basis before 6 am and after 6 pm. The general waste landfill site will be fenced and properly demarcated with proper signage boards. The landfill site will be made safe so as to keep unauthorised people and animals from entering it, and it will be made safe from a physical, biological and chemical perspective. Waste production shall be minimised and waste re-use encouraged on site.

All combustible solid wastes and all hazardous wastes (including process residues, solvents, old oils/hydrocarbon materials etc.) will be incinerated. The incinerator will be located close to the processing plant.

### 3.4.12 Power Supply

It is envisaged that electrical power for the mine and processing infrastructure will be supplied by multiple diesel or heavy fuel oil generators at 400V each, operating in parallel, with step up transformers to a reticulation voltage of 11 kV. The power plant will have an installed capacity of approximately 10MW.

### 3.4.13 Water Management

#### *3.4.13.1 Raw Water Dam*

The Raw Water Dam will contain water from the Marvoe Creek and if required from boreholes, as well as “clean” runoff water. The size of the Raw Water Dam will be at least 900,000 $m^3$, to sustain plant operations during droughts.

#### *3.4.13.2 DC of the Marvoe Creek*

As noted in Section 3.4.7, the Marvoe Creek will be diverted by means of a diversion channel that will run to the north-west of the proposed open pit. The diversion is approximately 3.7 km in length and will join up with the Marvoe Creek at the east end of the pit and WRD.

#### *3.4.13.3 Open pit*

A sump will be required within the pit to collect storm water for pumping out of the pit. The sump will be used to collect nuisance flows with larger flood events over-spilling the sump and collecting in the lower pit bench levels. The assessment has assumed that pit dewatering can be discharged directly back into the environment without any treatment for water quality other than potential sediment removal. The potential for pit dewatering to generate acid mine drainage needs to be assessed as this could significantly impact treatment requirements prior to discharge to the environment.

#### *3.4.13.4 Processing Plant*

Three dams will be provided in association with the processing plant, as follows:

##### *Pollution Control Dam*

The process plant and ROM pad area will drain into the pollution control dam via a storm water collection channel. The channel will be constructed with culverts, to divert water under the roads. The culverts and channel will comply with safety standards. The purpose of this dam will be to catch all rain water landing in the processing plant area, as well as any uncontrolled overflows from the other two dams in the processing plant area, the clear water dam and the process water dam. The size of the pollution control dam is estimated at 4,000 $m^3$.

Water in this dam will be the first source of make-up to the process water dam i.e. should always be emptied first to allow capacity for rain run-off. This dam will be constructed to contain the 50 year storm event.

### *Process Water Dam*

A process water dam (with a preceding silt trap) which will receive thickener overflow water and TSF decant/return water, for use in the plant; as well as overflow from the Clean Water Dam. This water will mainly be used as make-up water and flushing and hosing water in the processing plant. The size is estimated at 1,500 $m^3$. If this dam overflows it will overflow via channels into the processing plant pollution control dam.

### *Clear Water Dam*

The Clear Water Dam will receive Marvoe Creek water and borehole water, for water supply to the processing plant fluidiser, reagent make-up and other facilities within the processing plant – see the water balance flow diagram further on in this section. This dam will overflow its excess water into the process water dam. The size is estimated at 1,500 $m^3$ which is based on the dam holding a minimum of at least three months capacity of water during the dry season and the water treatment plant will be used for human and domestic consumption.

## 3.4.14 Water Use

The proposed water usage associated with the Project is as shown in Table 9.

**Table 9: NLGM Project estimated water usage**

| Project infrastructure | Water volume |
|---|---|
| Process Plant return and make-up water | >107 $m^3$/hr |
| Plant, stores and workshop potable requirement | 5 $m^3$/hr |
| Accommodation camp potable requirement | 3 $m^3$/hr |

The expected volume of raw water usage in the processing plant per day is 2,500 $m^3$.

The design of the process water supply assumes that 30 percent of the operational water will be obtained from the TSF return water. Raw water for both operational and human consumption will be supplied from the Raw Water Dam.

## 3.4.15 Stormwater Management

According to the Environmental Protection and Management Law of the Republic of Liberia, the proposed Project must comply with the requirements of existing Liberian environmental processes and standards as specified by the relevant legislation. Based on an analysis of such standards, it can be noted that presently there is no concrete comprehensive legal framework governing stormwater management in Liberia, therefore the following international standards can be referred to for guidance. These include:

- The IFC's General Environmental, Health and Safety Guidelines (IFC, 2007b);
- The IFC's Environmental Health and Safety Guidelines for Mining (IFC, 2007c);
- Guidance and standards for drinking water quality have been taken from the WHO standards (WHO, 2004); and
- South African Regulation 704 (DWA, National Water Act, 1998).

Key issues associated with stormwater management include separation of clean and dirty water, minimizing run-off, avoiding erosion of exposed ground surfaces, avoiding sedimentation of drainage systems and minimizing exposure of polluted areas to stormwater.

The water management modelling addresses the following:

- Compiling a Stormwater Management Plan for the proposed NLGM area;
- To divert run-off from undisturbed areas around disturbed areas;
- The report proposes a conceptual stormwater system to meet the above objectives.

The results presented are not at a detailed design level. Further hydraulic and geotechnical work will be required to attain the development of specifications to achieve a detailed design.

The proposed NLGM area was discretised into sub-catchments based on the topography of the project site. These sub-catchments were then classified as either clean (blue) or dirty (pink) run-off catchments based on the land usage. The extent of the clean and dirty run-off areas is shown in Figure 7.

The clean run-off areas are:

- Area S1 – Upslope of the eastern portion of the Tailings Storage Facility (TSF);
- Area S3 - Upslope of the western portion of the TSF;
- Area S5 - Area located between the Waste Rock Dump (WRD) and Open Pit (OP);
- Area S10 - Upslope of the Waste Rock Dump (WRD);
- Area S16 - Upslope of the eastern portion of the WRD;
- Area S17 - Upslope of the eastern Open Pit (OP) boundary;
- Area S18 - Upslope of the Process Plant area.

The dirty run-off areas are:

- The dirty run-off generated from the TSF area;
- The dirty runoff originating from the Process Plant areas;
- The dirty run-off generated from the active pit areas; and
- The dirty run-off generated from the WRD.

The clean run-off being generated from the upslope clean run-off catchments will be diverted away from the area producing dirty run-off as shown in Figure 8.

The proposed clean stormwater management is:

- The clean run-off generated upslope of the WRD from S10 area will be diverted by a cut-off trench (C8) west to the Marvoe Creek (outfall point OF1) ;
- The clean water runoff generated upslope of the eastern portion of the WRD from S16 area will be diverted by means of a cut-off trench (C7) around the WRD and routed to discharge into a storage pond, where it will be pumped to the north into the adjacent sub-catchment S17 which ultimately drains towards the Marvoe Creek diversion channel via an excavated channel (C5). This option will require a storage pond and a pump at the outfall point OF2 located in S16 area;
- The clean run-off originating upslope of the eastern open pit boundary from S17 area will be collected in an excavated channel (C5) and diverted towards the Marvoe Creek diversion at the outfall point OF3;
- The clean run-off generated upslope of the Process Plant from S18 area will be diverted by a cut-off trench (C4) north where it will be discharged into the Marvoe Creek channel at the outfall point OF5.

The proposed dirty stormwater management is:

- The dirty run-off generated from the active pit areas will be contained in a pit sump and pumped to a silt trap. Proposed location of the silt trap is on a west-south of the pit. The silt trap has to be designed based on the removal of sand sized particles for the 10 years ARP 6 hour rain event. The pit areas will require berms to be constructed along the perimeter to divert any locally generated stormwater runoff away from the pit area;
- The WRD area will require berms and diversion channels to be constructed along the perimeter to divert generated dirty run-off to a silt trap. The silt trap has to be designed based on the removal of sand sized particles for the 10 years ARP 6 hour rain event. Location of the silt trap will be finalized on a later stage of the project;
- The dirty run-off generated from the TSF area will be contained in a Tailings Storage Pond and pumped to the plant for re-use. The TSF area will require berms and diversion channels (C1 and C2) to be constructed along the perimeter to divert any locally generated stormwater (S1 and S3) runoff away from the TSF;
- The dirty run-off originating at the Process Plant areas will be contained in the Plant Pollution Control Dam located at the plant property. This will eliminate the risk of dirty water runoff being discharged into the environment.

### *Modelling the stormwater management plan*

The PCSWMM model was used as the flood analysis model. PCSWMM is a dynamic rainfall-runoff simulation model used for single event or long-term simulation of runoff quantity. This model was set up for the site and used to size the conveyance structures for separation of clean and dirty stormwater run-off.

The discretisation into sub-catchments is based on the topography of the New Liberty Mine area. The parameters used to model the overland and channel flow are shown in Surface Water Hydrology specialist report (Golder, 2012). Manning's 'n' coefficient used in the model for the impervious areas and pervious areas were 0.013 and 0.10 respectively.

The soils were identified as being in the sandy group (Mine Water Management Report, RPS Aquaterra 2012). The model uses these criteria to incorporate infiltration into the analysis using the Green-Ampt infiltration method. The sandy group resulted in a Suction Head of 55.4 mm, a Hydraulic Conductivity of 120 mm/hr and an Initial Deficit of 0.33 for input into the model.

All diversion channels have been sized to divert the clean and dirty run-off for the 50 year return period flood peak. A freeboard of 0.3 m was included. The proposed clean and dirty water diversion channel layout can be seen in Figure 8. The Manning's roughness assumed for the channels were 0.035 (Vegetation lined channels) and 0.013 (concrete lined channels) (Hicks et al. 1998).

### *Recommendations*

Once the final detailed design for the proposed mining facilities is available, the stormwater management infrastructure designs should be updated to reflect the changes made.

A stormwater channel cleaning program should also be implemented as a standard operating procedure. As a minimum the sediment should be removed from the channels during the dry season and at least once during the wet season. This maintenance program would improve the efficiency of the proposed system by reducing the probability of spills.

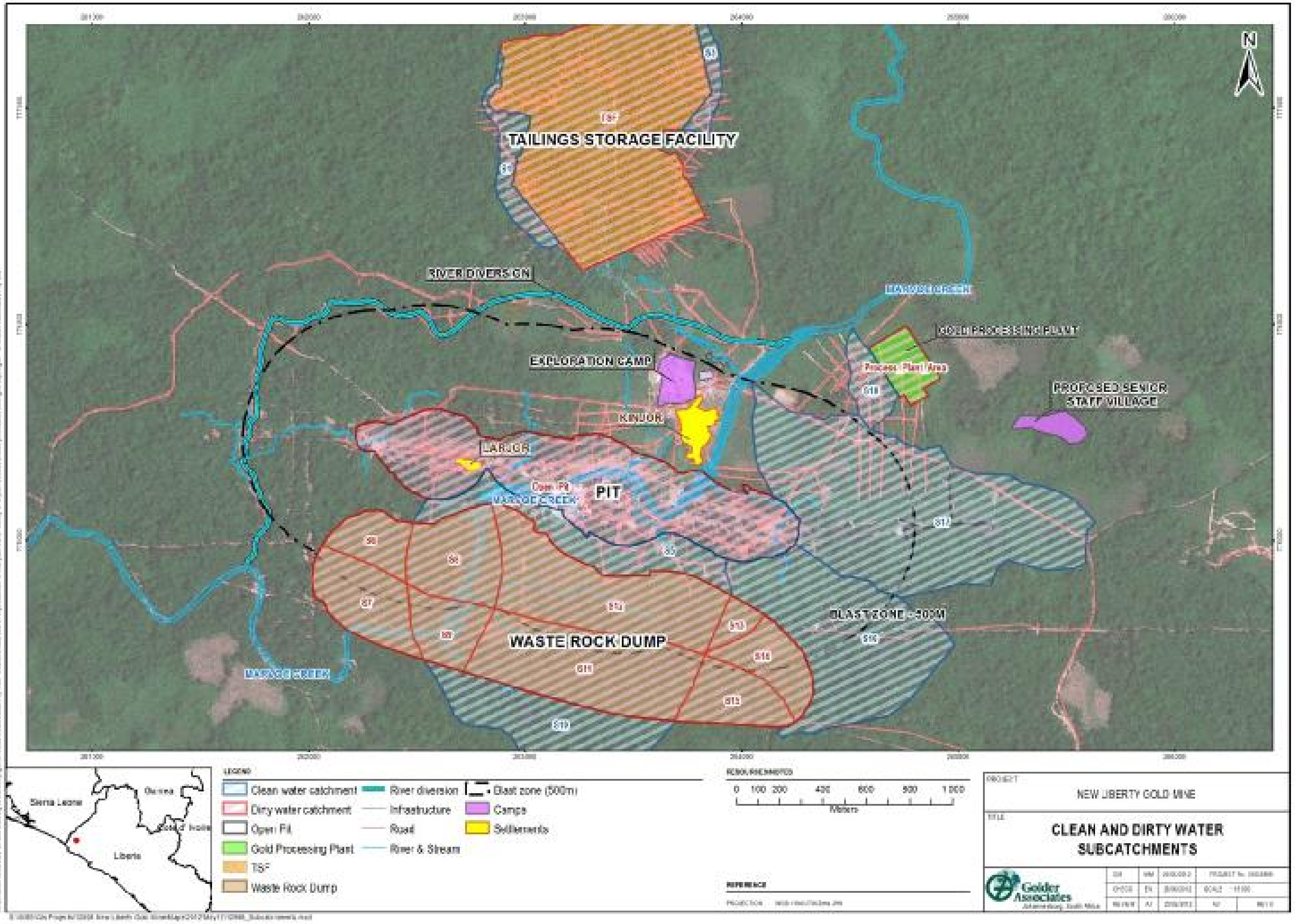


*Figure 7: The Location and extent of the clean and dirty water sub-catchments*

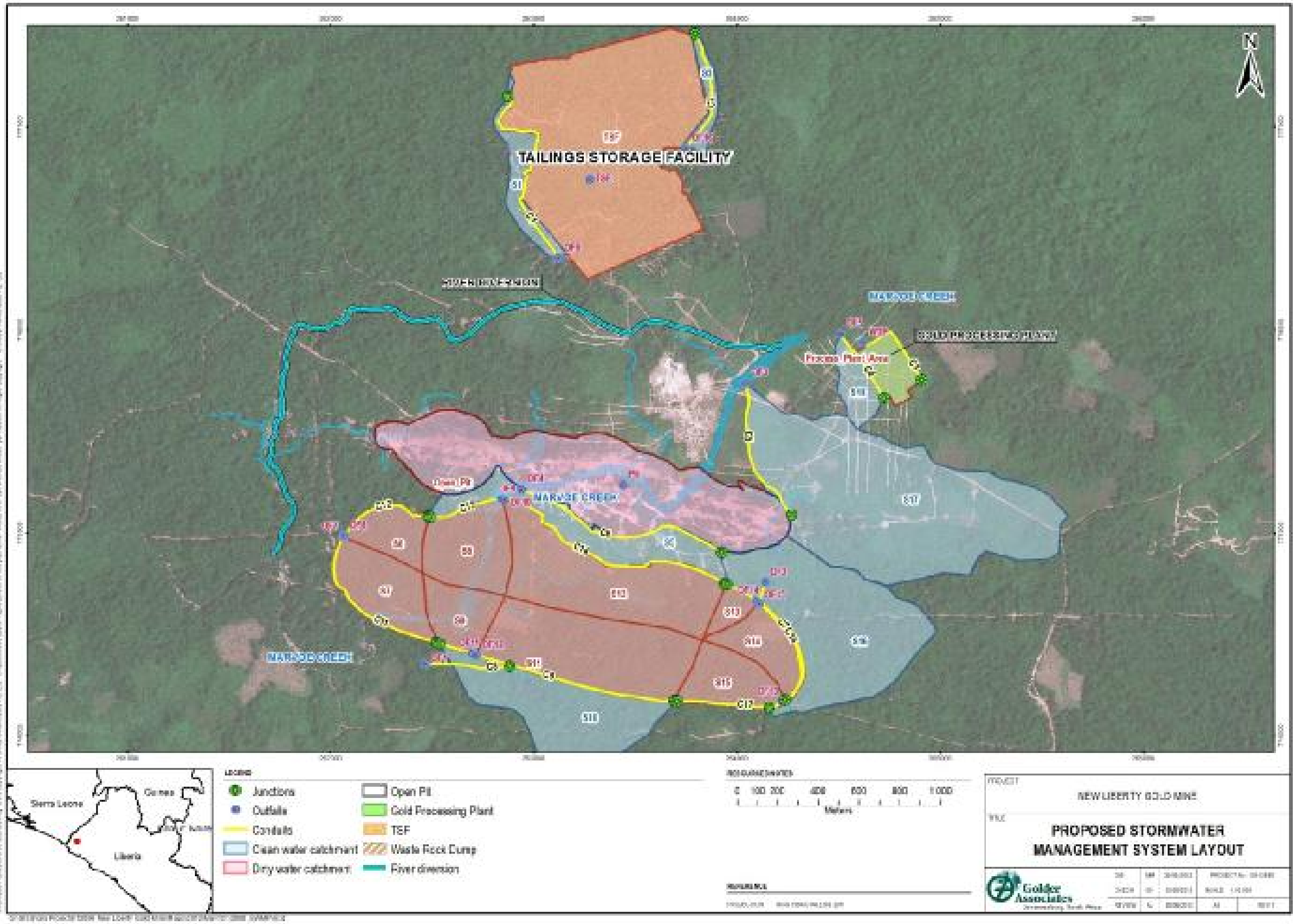


*Figure 8: The proposed stormwater management system layout*

### 3.4.16 Site wide water balance

Mine water management is a fundamental issue that affects most mines worldwide. The risk of surface and groundwater contamination caused by mining activities, and any subsequent environmental consequences, results in the need for careful planning and operation of mine water infrastructure. The need to provide an adequate approximation of process water supply, as well as the assurance of compliance of discharge water quantity and quality with local environmental legislation and best practises is becoming equally important.

A deterministic site wide water balance model has been developed for the end of operations on linked Excel spreadsheets (Golder, 2012).

The water balance model integrates flows between the mine facilities on a monthly basis over a one-year period. The flow modelling is used to establish a water management plan for the mine and to quantify water re-use, water supply requirements and water storage requirements under varying climatic conditions.

#### *3.4.16.1 Modelling objective*

The objective of the water balance is to integrate flows across the mine site and to quantify water re-use, water supply requirements and water storage requirements.

The water demand at the mine can be grouped into the following two major categories:

- Water for ore processing; and
- Water for human consumption.

The supply of water is a combination of re-use and raw make-up, and includes:

- Contaminated stormwater runoff;
- Re-use of process water return flows; and
- Raw water from available surface or groundwater sources.

#### *3.4.16.2 Assumptions*

The following assumptions were made in determining the water balance:

- The Marvoe Creek or wells will be used as the source of raw water for the processing plant;
- The minimum amount of raw water required for the processing plant is 30$m^3$/hr;
- Contact water collected at the open pit and WRD will be pumped to a silt trap;
- The TSF will have a maximum storage capacity of 0.5 M-$m^3$; any water above this will be continuously pumped to the Return Water Dam (RWD) and then to the Process Water Dam (PWD) for re-use;
- Excess contact water collected at the processing plant site will be pumped to the Plant Pollution Control Dam (PCD);
- There will be some water which will be locked within the void spaces of the tailings;
- Water requirements for dust control have been estimated based on an average monthly rate of 2.5 mm/day during the dry season (November-March) and the surface area to be treated. It is assumed that the total dust controlled surface area is 42ha.
- RAW Water Dam storage capacity is 900,000 $m^3$;
- Clear Water Dam storage capacity is 1,500 $m^3$;
- Plant Pollution Control Dam storage capacity is 4,000 $m^3$;
- Process Water Dam storage capacity is 1,500 $m^3$;
- It has been assumed that the rainfall run-off diverted from WRD will require primary treatment by sedimentation (RPS Aquaterra, 2012);

- It has been assumed that pit dewatering can be discharged directly back into the environment without any treatment for water quality other than potential sediment removal (RPS Aquaterra, 2012); and
- Sediment basins have to be sized based on the removal of sand sized particles for the 10 year ARI 6hr rain event (RPS Aquaterra, 2012).

### *3.4.16.3 Model Set-Up*

The water balance model was set up to include:

- Background data including - mill operating data, annual precipitation and evaporation distribution, run-off coefficients, flow logic between the various mine infrastructure, and watershed areas of the mine infrastructure (which is developed by introducing diversion ditches and berms to reduce the volume of the contact water);
- Flows related to the ore and tailings production - water in the tailings discharge; water tied-up in the deposited tailings, fresh make-up water going into the processing plant for reagent mixing etc., moisture going into the processing plant in the ore, losses in the processing plant such as evaporation and spillage; and, water re-circulated to the processing plant from the TSF;
- Inflows related to precipitation - runoff from natural ground, precipitation onto ponds and wetted tailings beach; runoff from dry tailings beach;
- Lake evaporation from ponds and the wetted tailings beach;
- Seepage flows (loss from the TSF and into the open pit); and
- Miscellaneous flows (such as potable water, water for dust control, make-up water to the processing plant supply, treated sewage etc.).

A conceptual flow diagram in plotted in Figure 9.

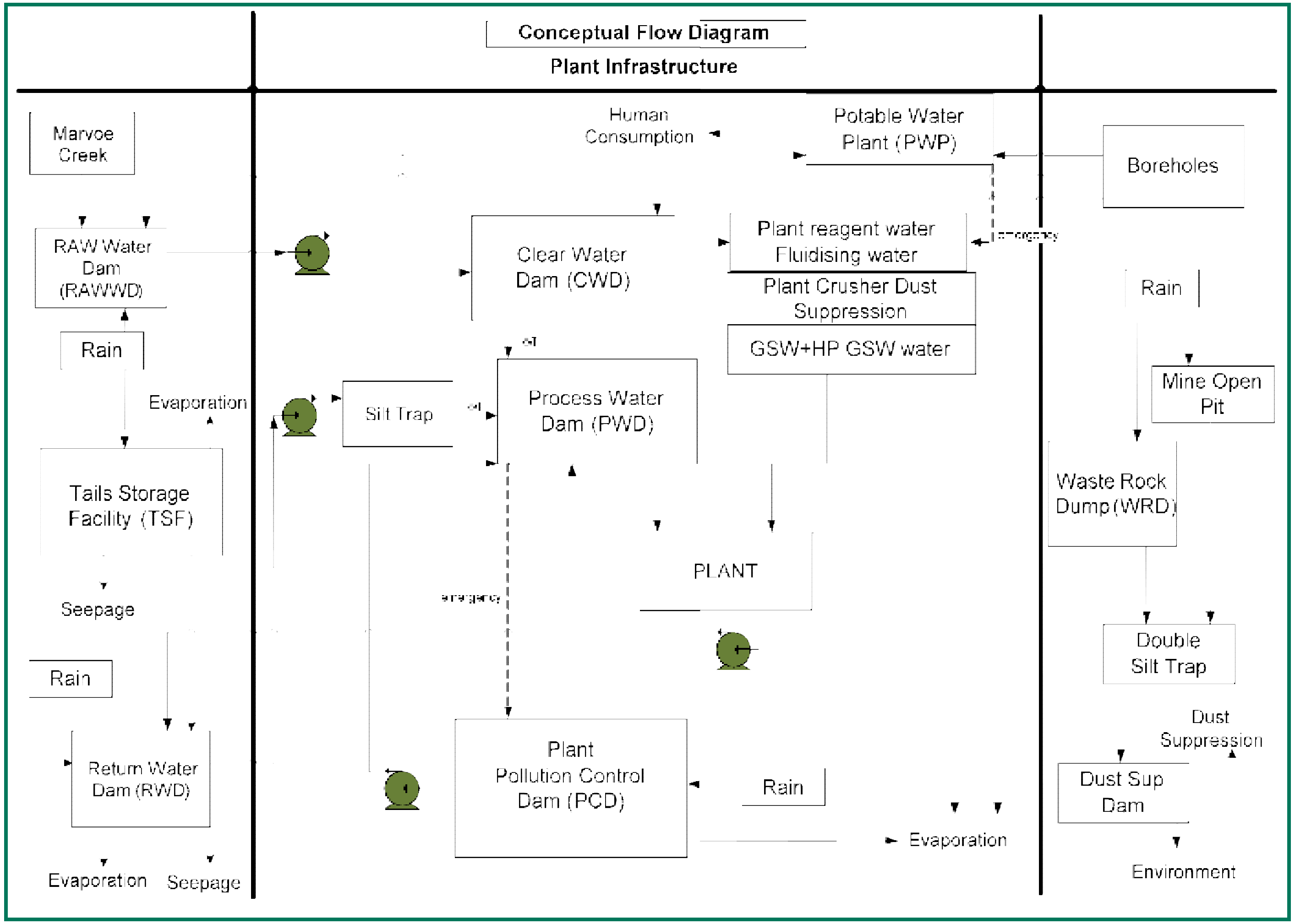


*Figure 9: Conceptual Water Balance Flow Diagram*

### 3.4.16.4 Model inputs

The NLGM mine operating data used in the water balance are given in Table 10.

**Table 10: Mine operating data**

| Parameter | Source | Value | Unit |
|---|---|---|---|
| Ore reserve | Aureus | 8,700,000 | t |
| Design mill production rate | DRA | 3,349 | t/d |
| Mill availability *(% of the year the mill is available to operate)* | DRA | 90.0 | % |
| Factor of safety on the design value | DRA | 0.96 | - |
| Nominal (average) mill production rate | Calculated | 3,140 | t/d |
| Life of mine | Calculated | 7.9 | years |
| Water content of ore going into the mill | Aureus | 10.0 | % |
| Nominal (average) mill fresh water requirements (flocculant) | DRA | 115 | $m^3$/hr |
| Water lost in the mill to evaporation | Assumed | 90 | $m^3$/d |
| Discharge slurry density from plant | Assumed | 40.0 | % solids |
| Tailings / ore ratio | DRA | 1.004 | - |
| Nominal (average) tailings production rate | Calculated | 3,152 | t/d |
| Specific gravity of tailings solids | DRA | 2.90 | - |
| Void ratio of deposited tailings | Assumed | 1.00 | - |
| Dry density of deposited tailings | Calculated | 1.45 | t/$m^3$ |
| Total volume of deposited tailings | Calculated | 6,024,000 | $m^3$ |
| Saturated water content of deposited tailings | Calculated | 34.5 | % |
| Volume of water retained in the tailings | Calculated | 1,087 | $m^3$/d |
| Water required for dust control in the months November to March | Assumed | 1,045 | $m^3$/d |
| Potable water requirements | DRA | 71 | $m^3$/d |
| Sewage *(estimated as 80% of potable water)* | Assumed | 57 | $m^3$/d |

Table 11 presents watershed areas associated with the different facilities on the mine site, and drainage areas for different types of surface in each watershed. These are based on the site drainage plan that was available during the modelling.

**Table 11: Watershed areas**

| Facility | Watershed area (ha) | Type of surface | Percentage of watershed area (%) |
|---|---|---|---|
| Mine Open Pit | 156 | Natural ground | 51.0 |
| | | Open pit wall | 49.0 |
| WRD | 136 | Natural ground | 16.0 |
| | | Waste rock | 84.0 |
| TSF | 126 | Natural ground | 29.4 |
| | | Waste rock | 4.4 |
| | | Unsaturated tailings | 58.4 |
| | | Pond and saturated tailings | 7.8 |
| Plant Site | 15 | Natural ground | 53.0 |
| | | Prepared ground | 46.0 |
| | | Pond | 1.0 |

Runoff coefficients for the estimation of monthly runoff volumes from natural ground were estimated based on local stream flow data collected during the surface water monitoring period, while runoff coefficients for other types of surface are based on published values and professional experience. Runoff coefficients used in the model are presented in Table 12.

**Table 12: Monthly runoff coefficients**

| Month | Natural ground | Prepared ground | Open Pit walls | Waste rock | Tailing | Ponds |
|---|---|---|---|---|---|---|
| Jan | 0.14 | 0.70 | 0.85 | 0.20 | 0.60 | 1.00 |
| Feb | 0.14 | 0.70 | 0.85 | 0.20 | 0.60 | 1.00 |
| Mar | 0.14 | 0.70 | 0.85 | 0.20 | 0.60 | 1.00 |
| Apr | 0.27 | 0.70 | 0.85 | 0.20 | 0.60 | 1.00 |
| May | 0.55 | 0.80 | 0.95 | 0.25 | 0.65 | 1.00 |
| Jun | 0.55 | 0.80 | 0.95 | 0.25 | 0.65 | 1.00 |
| Jul | 0.55 | 0.80 | 0.95 | 0.25 | 0.65 | 1.00 |
| Aug | 0.55 | 0.80 | 0.95 | 0.25 | 0.65 | 1.00 |
| Sep | 0.55 | 0.80 | 0.95 | 0.25 | 0.65 | 1.00 |
| Oct | 0.27 | 0.80 | 0.95 | 0.25 | 0.65 | 1.00 |
| Nov | 0.14 | 0.70 | 0.85 | 0.20 | 0.60 | 1.00 |
| Dec | 0.14 | 0.70 | 0.85 | 0.20 | 0.60 | 1.00 |

### *3.4.16.5 Water Balance Model Results*

The water balance has been performed for the average annual rainfall and the precipitation scenarios listed in Table 13.

**Table 13: Annual precipitation for wet and dry years**

| Annual Return Period (year) | Wet (mm/year) | Dry (mm/year) |
|---|---|---|
| 25 | 5,064 | 2,459 |
| 50 | 5,483 | 2,342 |
| 100 | 5,900 | 2,245 |

Key outputs from the modelling in form of flows are:

- Outflow from the open pit;
- Outflow from the WRD; and
- Outflow from the TSF.

**Table 14: Annual average flows in $m^3$/hr for wet years**

| Outflows | Average | Return period | | |
|---|---|---|---|---|
| | | 25 | 50 | 100 |
| Outflow from the open pit | 513.4 | 705.9 | 758.1 | 810.0 |
| Run-off of the WRD | 151.5 | 219.2 | 237.3 | 255.4 |
| Outflow from the TSF to RWD | 403.4 | 538.7 | 575.0 | 611.0 |
| Raw water for the processing plant | 115.0 | 30.0 | 30.0 | 30.0 |

**Table 15: Annual average flows in $m^3$/hr for dry years**

| Outflows | Average | Return period | | |
|---|---|---|---|---|
| | | 25 | 50 | 100 |
| Outflow from the open pit | 513.4 | 377.9 | 364.2 | 350.5 |
| Run-off of the WRD | 151.5 | 106.4 | 101.8 | 97.2 |
| Outflow from the TSF to RWD | 403.4 | 313.4 | 304.1 | 294.9 |
| Raw water for the processing plant | 115.1 | 30.0 | 30.0 | 30.0 |

### *3.4.16.6 Conclusions*

The following conclusions relating to water management at the NLGM mine site can be made:

- The proposed mine is located in a rainfall positive area, where rainfall exceeds evaporation by approximately 2.5 m;
- The available water at the site exceeds the process plant recycling requirement in the event of a 100 year dry hydrological condition;
- Up to the 100 year dry, water withdrawals from Raw Water Dam are only required for portable water supply (3$m^3$/h) and mill raw water requirements (minimum raw water required for the processing plant is 30$m^3$/hr);
- During the dry season water for the Raw Water Dam will be abstracted from groundwater resources;
- Water withdrawals from the silt trap for dust control during the dry season (November-March) have been estimated as 43.5 $m^3$/s;
- Once detailed designs for the proposed facilities are available the water balance model should be updated to reflect the changes made; and
- Water balance modelling is an on-going process. Calibration will be refined as the knowledge of the system during the operational phase is improved. This should improve the overall water balance accuracy.

## 3.5 Description of present land use

In the Liberian EPA EIA Procedural Guidelines (2006), a description of the present land use is required. The present land use within the NLGM Project area is discussed in Section 4.1.5 of this EIS.

## 3.6 Project size and production rates

Information concerning the size of the Project and its production rates has been noted in earlier sections of this EIS. This section seeks to summarise this information, as follows:

- The approximate size of the Project area is 33 $km^2$;
- Approximately 8.7 million tonnes of ore over a period of approximately eight (8) years;
- Approximately 130 million tonnes of waste rock over a period of approximately eight (8) years;
- Expected annual throughput of ore through the processing plant over the 8 year Project life: 1,100,000 tonnes; and
- Expected volume of tailings to be deposited onto the TSF per day: 2,079 $m^3$.

## 3.7 Activities associated with the development stages from construction to closure

Table 16 below highlights the key activities associated with the Project's development from the construction phase, during mining operations, and through to the rehabilitation and closure phase. (It also includes activities associated with exploration, which is currently on-going).

**Table 16: Summary of key NLGM Project activities**

| Activity | Description |
|---|---|
| Exploration Activities | ■ Mapping and rock chip sampling;<br>■ Stream sediment sampling;<br>■ Opening up tracks and roads to gain access;<br>■ Siting of the drill rigs;<br>■ Soil sampling;<br>■ Digging of borrow pits;<br>■ Trenching – to obtain rock and soil samples;<br>■ Core drilling (on a grid pattern);<br>■ Managing water used in the drilling process;<br>■ Transporting and using diesel and oil for vehicles, drill rigs and mobile generators; and<br>■ Managing the core – transport to core shed, recording and analysing core. |
| Pre-construction Activities | ■ Resettlement of the Kinjor and Larjor communities;<br>■ Construction of the new resettlement village and associated infrastructure; and<br>■ Initial vegetation clearing and ground levelling. |
| Open pit development/earth moving activities | ■ Clearing of vegetation;<br>■ Topsoil stripping and development of stockpiles;<br>■ Development of open pit (by means of drilling and blasting);<br>■ Blasting activities for the ore and waste rock;<br>■ Excavation and loading of ore and waste rock (separately);<br>■ Transportation by truck of the ore to the crushing area of the plant, and waste rock to the waste rock dump; and<br>■ Storage of topsoil. |
| Development of Waste Rock Dump(s) as mining progresses | ■ Hauling of waste rock to the waste rock dump site (by truck);<br>■ Shaping of the waste rock dump according to the design; and<br>■ Progressive rehabilitation of the waste rock dump side slopes as mining progresses. |
| Construction of TSF | ■ Site clearing (i.e. removal of all vegetation from TMF footprint);<br>■ Construction of TSF; and<br>■ Construction of TSF water management facilities. |
| Construction of Ore Processing Plant | ■ Development of roads on site;<br>■ Site clearing and construction of the processing plant;<br>■ Construction of a crusher;<br>■ Construction of a site office and workshops;<br>■ Construction of concreted and bunded areas for diesel storage; |

| Activity | Description |
|---|---|
| | ■ Construction of storage areas;<br>■ Construction of power related infrastructure;<br>■ Construction of water management facilities; and<br>■ Provision of security to the site; also aimed at providing health and safety for BMMC personnel and local people |
| Construction of Diversion Channel of the Marvoe Creek | ■ Clearing and grubbing of the vegetation cover;<br>■ Removal of unsuitable materials, including topsoil;<br>■ Installing of access road around the channel;<br>■ Construction of run-off management ditch or berm around the channel;<br>■ Excavation of the overburden soil and drilling and blasting of bedrock, if encountered;<br>■ Proof rolling the finished soil surface of the channel;<br>■ Installation of non-woven Geotextile over the proof rolled soil surface of the channel;<br>■ Placement of riprap over the Geotextile lined channel;<br>■ Construction of cofferdams upstream of the flood control dykes;<br>■ End dumping of soil upstream of the flood control dykes to create cofferdams; and<br>■ Placement and compaction of fill material at the flood control dykes |
| Construction of staff accommodation area | ■ Construction of a staff accommodation camp near the processing plant;<br>■ Construction of power related infrastructure; and<br>■ Construction of water management facilities |
| Management of Hazardous Materials | ■ Fuel and Lubricant storage; and<br>■ Storage/handling of chemicals |
| Vehicular Movement | ■ Transport of ore to plant by truck and transport of waste rock to waste rock dump by truck;<br>■ Blasting and/or excavating, loading and hauling; and<br>■ Vehicular transport for personnel and materials |
| Management of Waste | ■ Waste disposal and management of waste water; and<br>■ Waste recycling, where possible |
| Maintenance of Infrastructure | ■ Maintenance of processing plant and associated infrastructure;<br>■ Maintenance of roads and other equipment; and<br>■ Maintenance of staff accommodation area and associated infrastructure |
| Monitoring and rehabilitation, which will be ongoing throughout the project's life | ■ Ongoing monitoring and rehabilitation;<br>■ Rehabilitation of final open pit;<br>■ Spreading of sub-soils and topsoil;<br>■ Profiling and contouring of the area to preserve natural drainage lines;<br>■ Re-vegetation of disturbed areas; and<br>■ Rehabilitation of areas disturbed by quarrying and hauling activities |
| Water use | ■ Use of water for the processing plant operations; and<br>■ Use of water in the staff accommodation area. |

| Activity | Description |
|---|---|
| The Liberian Government will take over the mine infrastructure upon closure, as per the MDA | ▪ Vehicle and heavy machinery movement to dismantle and remove infrastructure; and<br>▪ Decommissioning of the processing plant and associated infrastructure |
| Monitoring and Maintenance | ▪ Monitoring of all aspects which had been impacted by the mining activities;<br>▪ Monitoring of rehabilitated areas; and<br>▪ Maintenance of rehabilitated areas. |

## 3.8 Alternatives Considered

Information on the various alternatives that were considered in terms of the Project's development is presented in Section 10.0 of this EIS.

## 3.9 Staffing and Employment

At the NLGM site, Aureus will have a stand-alone Environmental Department. The proposed organisational structure for the environmental responsibilities is shown in Figure 10 below.

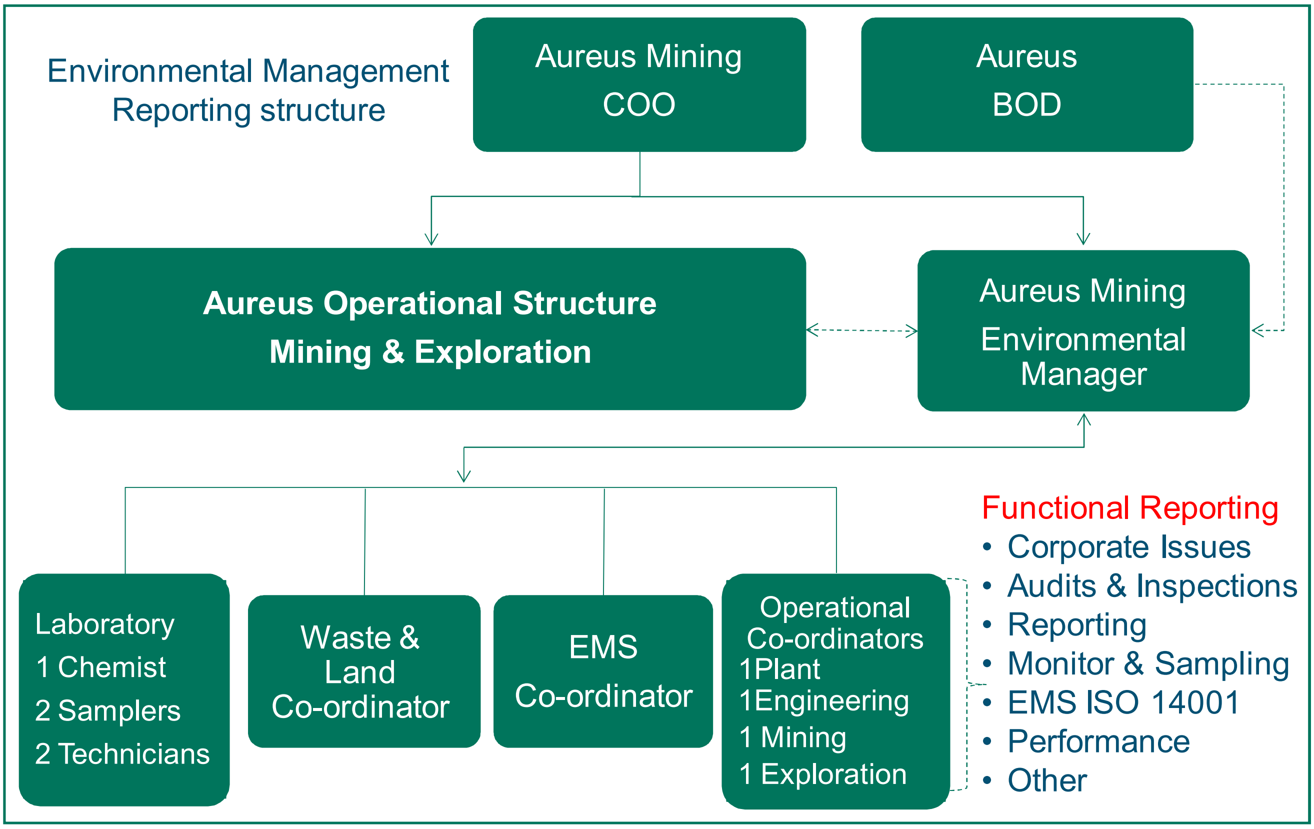


*Figure 10: Proposed organisational structure for the Aureus Environmental Department*

As stated on the Aureus website, Aureus Mining Inc./BMMC operates in an effective and efficient manner, with integrity and with due regard for the interests of all stakeholders. The Board of Directors (BOD) is accountable and responsible to the shareholders and all stakeholders for environmental and social performance of all of Aureus's/BMMC's operations. Aureus/BMMC has a dedicated Environmental Manager whose responsibility is the strategic environmental management for all of the company's operations The Environmental Manager reports to the Chief Operating Officer (COO) with direct linkages to the BOD regarding environmental and social management. This structure means that environmental and social related planning is taken into account at the conception phase of all Project components.

The BMMC Environmental Department will be developed and in place prior to initiating the construction phase of the Project, as per the figure above.

In line with Liberian labour legislation, BMMC has made local hiring and training/capacity building a priority, and this make up a prominent proportion of BMMC's Human Resources (HR) Policy, which is currently being developed.

During the different phases of the Project, BMMC envisages the following employment numbers:

- Construction Phase: Approximately 400 personnel with approximately 65% Liberians; and
- Operational Phase: Approximately 300 personnel will be employed within the mining operations. Approximately 80% of these will be Liberians, which will comprise of skilled, semi-skilled and unskilled personnel.

## 3.10 Emission Characteristics

The key emissions during the Project will mostly be associated with diesel internal combustion engines as these will power both the mining fleet and the generators of the power plant. Both of these will produce emissions in line with the norms and regulations governing diesel engines.

Within the processing plant, diesel burners will be used to heat thermic oil as part of the elution heating circuit and activated carbon as part of the carbon regeneration process. In both of these cases some steam is produced as a by-product of the heating process along with the products of diesel combustion.

In the gold-room during electro-winning a very small quantity of hydrogen gas is given off and during the smelting process fumes are generated by the furnace as the gold and flux mixture melts, these fumes are passed through a bag filter to trap pollutants.

As part of the general site infrastructure an incinerator will be provided to incinerate hazardous waste. An assessment will be conducted when the incinerator is in operation to establish emission values.

The key emissions during the Project will mostly be associated with the processing plant. Table 17 below shows the potential key emission characteristics related to the Project.

**Table 17: Proposed emission characteristics related to the Project**

| Item | Tag No | Process Description | Emission Description | Rate UoM | Max.Rate/ Frequency | Exhaust Gas Flow (m3/min) | NOx mg/nm3 | CO (mg/nm3) | HC (mg/nm3) | PM (mg/nm3) | Stack Diameter (mm) | Discharge Height (m) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 off x 1.2 MVA Gensets | Generating Electricity | Diesel Fumes | Diesel Consumption in Ltr / hr | 1 910.4 | 258.6 | 3 556.4 | 594.4 | 70.8 | 25.3 | 8 off 200 | 5 | Stack Sizes are Typical for containerised units |
| 2 | 500-XH-264 | Heating of Thermic Oil by Diesel Burner - Duty | Diesel Fumes | Diesel Consumption in Ltr / hr | 171.0 | 23.1 | 318.3 | 53.2 | 6.3 | 2.3 | 450 | 11.5 | Only one will be used at a time |
| 3 | 500-XH-295 | Heating of Thermic Oil by Diesel Burner - S/By | Diesel Fumes | Diesel Consumption in Ltr / hr | 171.0 | 23.1 | 318.3 | 53.2 | 6.3 | 2.3 | 450 | 11.5 | |
| 4 | 500-XF-272 | Heating of Activated Carbon by Diesel Burner | Diesel Fumes | Diesel Consumption in Ltr / hr | 58.2 | 7.9 | 108.4 | 18.1 | 2.2 | 0.8 | 350 | 11.5 | |
| 5 | 520-EC-326, 7, 8 & 9 | Electrowinning of Gold Solution, 4 EW Cells | Hydrogen Gas | | Very Low | | | | | | 200 | 9 | |
| 6 | 540-XT-353 | Drying of Gold Sludge | Steam | | Very Low | | | | | | 200 | 7.5 | 12 hrs / week |
| 7 | 540-XF-356 | Smelting of Gold Sludge | Smelt Flux Fumes | | Very Low | | | | | | 500 | 7.5 | Bag Filter is Installed, 12 hrs / week |

Note: Fluxes in use could include:

- Silica
- Borax
- Nitre
- Fluorspar
- Soda Ash

## 3.11 By-products from the process

### 3.11.1 Waste Management

A waste management strategy will be developed. Associated procedures have been developed and are being implemented by BMMC prior to construction activities taking place on site. The procedures in place include those for general waste and hydrocarbon waste.

The procedures aim to:

- Describe the treatment of general waste streams emanating from the site;
- Describe the handling, storage, transport and disposal of waste materials;
- Identify legislation pertaining to general waste; and
- Provide information pertaining to the correct handling, storage and disposal of general waste.

All waste will be accounted for and disposed of as per the waste management strategy based on the following waste disposal criteria as shown in Table 18 below.

**Table 18: Waste Disposal Criteria**

| MOST PREFERRED |
|---|
| Avoid |
| Reduce |
| Reuse |
| Recycle |
| Recover |
| LEAST PREFERRED |
| Treat |
| Dispose |

Hazardous waste will be incinerated via an incinerator and non-hazardous waste will be disposed of at a general waste landfill site close to the accommodation camp. The general waste landfill site will be fenced and access restricted in line with BMMC's health and safety requirements. The waste in the landfill will be compacted and covered with soil. The incinerator will be installed, aimed at reducing potential transport spills, transport costs and the area required for hazardous landfills.

A scrap yard / consignment yard will be fenced for storage of used spare tires, scrap material, redundant neutralized products to be re-used and recyclable materials. Other items not earmarked for re-use will be disposed of at the toe of the WRD and buried immediately with waste rock material.

As noted earlier, waste rock, which is a by product of the mining operations, will be stored on a WRD as well as being back-filled to the open pit. The waste will be classified in NAF and PAF and will be disposed on the WRD as per the WRD design to minimise the potential for ARD run-off and or seepage.

Storm and storm run-off water from the WRD not containing potential ARD will be diverted to a sediment pond and the water will be re-used for dust suppressant purposes.

#### *Hydrocarbon Management*

Used hydrocarbons, for example, old diesel, will be re-used and recycled, where possible. All separator systems will be commissioned and implemented to allow for the recycling of hydrocarbons. Drip trays and pans will be implemented to capture any overflows/spillages during re-fueling.

Diesel will be stored in tanks, above the ground, in a bunded area. The bunded areas will be designed to hold 110% of the capacity of the storage tank. Diesel tanks will be fitted with breathers and will comply with best practice and Liberia legal requirements.

#### *Cyanide Packaging*

The transport of cyanide will be compliant with Safety, Health and International Cyanide Code practices. An emergency plan containing transportation, safety and health issues will be developed prior to operational phase of the mine. Cyanide packaging waste will be incinerated. The Cyanide materials will comply with storage and handling procedures as per the International Cyanide Code. All other potentially hazardous substances will be stored in a warehouse as per Material Supplier Data Sheets. Storage areas will comply with health and safety standards such as ventilation etc.

#### *Waste Water / Effluent / Seepage*

Waste water from the Project will be managed by means of sediment ponds, a pollution control dam, a process water dam, the TSF and septic tanks. All hazardous effluent and discharges will be disposed of at the TSF through the designed reticulation system. Seepage will be diverted to seepage control dams and recycled back into the system.

#### *Sewerage*

The sewerage will be disposed to septic tanks and the sewerage slurry will be disposed of at the TSF. A sewerage treatment plant and system will service the accommodation camp and processing plant areas. The sewerage treatment plant will comprise of an underground tank, and an aerobic treatment unit and sludge disposal.

## 3.12 Additional Projects required as a result of the Project

An additional project that is required as a result of the NLGM Project is the relocation of the Kinjor and Larjor communities and the associated construction of a new resettlement village. The resettlement will take place prior to construction, during the pre-construction phase. An EIA will be conducted prior to the establishment of the “new” village, where the people will be relocated to. (Note that the Project will involve relocating the entire Kinjor and Larjor villages, including houses, the school, water pumps, the mosque etc.).

See the detailed project description section (Section 3), including the proposed site layout plan, earlier on in this EIS, which describes the Project infrastructure including the processing plant, WRD, TSF, DC etc.

## 3.13 Project Phase Activities – Exploration, Pre-construction, Construction, Operations and Closure

The key activities associated with the proposed Project are highlighted in Section 3. 7 (i.e. Activities associated with the development stages from construction to closure). Please refer to this list (Table 16).

# 4.0 DESCRIPTION OF ENVIRONMENT

This section provides a description of the environment and context in which the proposed Project will take place within the NLGM Project area. This is in accordance with the Liberian EPA EIA Procedural Guidelines (2006). (For further detailed information regarding each specialist discipline, refer to **Volume II** of this EIS which contains each of the final specialist assessment reports).

## 4.1 Physical Environment

### 4.1.1 Climate and Meteorology

#### *4.1.1.1 Regional Climate and Meteorology*

The Liberia Hydrological Service (LHS) is responsible for the collection and management of hydro-meteorological data and the calculation of climate statistics. In Liberia, the rainy season begins in April or May, and reaches a peak in July through September, and tapers off again in October. Monrovia and

Buchanan, on the coastal plains, receive a heavy rain earlier in the season, then they experience a period of reduced rainfall called the “middle dries” before heavy rains return in August. In the southeastern part of the country, the rainy season begins in April and lasts for two or three months, and then is followed by a drier period of two or three months. Then a second rainy season begins in September and lasts until November.

The average annual rainfall ranges from about 1 687 mm in Suakoko in the north to about 4 614 mm in Robertsport in the south (Ministry of Agriculture, 2007).

The temperature throughout the country ranges from 27°-32°C during the day and from 21°-24°C at night and has little monthly variation. The highest temperature occurs between January and March and the lowest is between August and September. The low temperatures are mainly caused by the amount of cloud cover (UNDP, 2006).

Relative humidity is generally high throughout the country. Along the coastal belt it does not drop below 80 per cent and on average is above 90 per cent. A relative air humidity of 90-100 per cent is common during the rainy season (UNDP, 2006).

Dominant wind directions in West Africa are the NE and SW Monsoons as well as the Harmattan, which is a dust laden wind from the Sahara Desert. Total wind speed is greatest in the rainy season and lowest in the dry season. Along the coast, the average annual wind speed was 30 km/h.The greatest wind speed is between July and September and the lowest is in December and July. The highest wind speed recorded in Liberia is 72 km/hr recorded in Buchanan (on the coast) in April and May 1988 (UNDP, 2006).

The available published meteorological summary data for Firestone Harbel and Robertsfield stations for the period 1977 to 1982 are presented in Table 19 and Table 20.

**Table 19: Meteorological data for Firestone Harbel**

| Year | Annual average temp (°C) | Annual average relative humidity (%) | Annual average sunshine duration (hours) |
|---|---|---|---|
| 1977 | 26.2 | 83 | 4.0 |
| 1978 | 26.0 | 84 | 3.7 |
| 1979 | 26.3 | 83 | 4.1 |
| 1980 | 26.2 | 83 | 4.0 |
| 1981 | 26.2 | 80 | 4.3 |
| 1982 | 26.2 | 81 | 4.1 |

**Table 20: Meteorological data for Robertsfield (i.e. International Airport)**

| Year | Annual average temp (°C) | Annual average relative humidity (%) | Annual average sunshine duration (hours) |
|---|---|---|---|
| 1977 | 25.9 | 88 | 3.7 |
| 1978 | 25.9 | 88 | 3.6 |
| 1979 | 26.0 | 88 | 3.7 |
| 1980 | 26.2 | 88 | 3.3 |
| 1981 | 26.2 | 87 | 3.6 |
| 1982 | 25.9 | 84 | 3.9 |

#### *4.1.1.2 Project Site Climate and Meteorology*

Meteorological data for the region surrounding NLGM Project site is scarce; however the bulk climate and seasonal variations are distinct.

There are three (3) metrological stations in the region of the NLGM Project site. BMMC has established a meteorological station at the NLGM exploration camp. The next closest weather station to the NLGM site is Goodrich, which is located about 34.5 km southeast of the site, and then at Bomi Hills.

The meteorological station was installed at the NLGM camp between the 2nd and the 6th May 2011 by Golder and consists of a 10 m tilting tower; fully grounded to withstand lightning strikes. To log data, the sensors are connected to a Campbell Scientific CR1000 datalogger, and the station is powered by a 70 W solar panel and 90 Amp-hr backup battery.

(Note: The data from the NLGM met station illustrates the diurnal and seasonal patterns of meteorology at the site location. Although data has only been analysed for the 10.5 month period over which data has been recorded so far, the patterns shown in the data are consistent with observations of the West African climate in general, with good characterisation of the wet and dry seasons and transitional periods. As this is the case, the data from the NLGM met station can be utilised, with confidence, for interpretation of air quality assessment; including modelling and qualitative dust assessment. The continued collection of met data from the NLGM site will provide a reliable baseline from which these assessments will be based, making way for an accurate prediction of the likely impacts on air quality of the mining operation).

Table 21 provides a condensed summary that was produced to give an overall view of the meteorological maximums and minimums for each month monitored using the on-site meteorological station at the NLGM Camp.

**Table 21: Summary of Parameter Extremes for the Period May 2011 - Feb 2012**

| Parameter | Month | Value | Unit |
|---|---|---|---|
| Driest Month | Dec-11 | 0 | mm |
| Wettest Month | Sep-11 | 652.01 | mm |
| Highest Rainfall Rate | Jun-11 | 22.61 | mm (in 10 minutes) |
| Hottest Month | May-11 | 26.71 | °C |
| Coldest Month | Jan-12 | 24.33 | °C |
| Highest Temperature | May-11 | 35.35 | °C |
| Lowest Temperature | Jan-12 | 14.41 | °C |
| Most Humid Month | Aug-11 | 89.84 | % |
| Least Humid Month | Feb-12 | 73.40 | % |
| Highest Humidity | May-11 | 97.50 | % |
| Lowest Humidity | Jan-12 | 13.76 | % |
| Sunniest Month | May-11 | | |
| Least Sunny Month | Aug-11 | | |
| Most Intense Solar Radiation | May-11 | 1221.00 | $W\ m^{-2}$ |

## *Rainfall*

The Project area has a tropical climate with two seasons: wet and dry. The dry season lasts from mid-November to mid-April and the rainy season from mid-April to late October. It does not rain continuously during the rainy season. It is common to have sunny days during the months when the rain is heaviest. This is also true for the dry season; there are some rainy days during the dry season.

In 2010, a rain gauge was installed on site by Golder. Daily rainfall was collected from November 2010 – September 2011. As noted earlier, the meteorological station was installed on site by Golder in May 2011, recording rainfall, temperature, wind speed and direction, pressure and relative humidity. Hourly data for all mentioned parameters is available from May 2011 – March 2012. Table 22 shows that, for the overlapping rainfall record, monthly rainfall depths differed by as much as 427 mm. Given the short period covered by the site records and the high discrepancies between their monthly rainfall depths, it is recommended to base site monthly data on regional estimates.

**Table 22: NLGM site precipitation data**

| Year | Month | Rain Gauge Data (mm) | Met Station Data (mm) | Difference (mm) |
|---|---|---|---|---|
| **2010** | **11** | 54 | | |
| | **12** | 114 | | |
| **2011** | **1** | 58 | | |
| | **2** | 65 | | |
| | **3** | 140 | | |
| | **4** | 81 | | |
| | **5** | 245 | 181.4 | 63.6 |
| | **6** | 495 | 559.3 | -64.3 |
| | **7** | 458 | 343.1 | 114.9 |
| | **8** | 937 | 509.8 | 427.2 |
| | **9** | 546 | 650.3 | -104.3 |
| | **10** | | 261.9 | |
| | **11** | | 148.8 | |
| | **12** | | 0.0 | |
| **2012** | **1** | | 4.8 | |
| | **2** | | 0.3 | |
| | **3** | | 28.7 | |

The annual average rainfall for the site was estimated at 3,500 mm based on distance from regional stations throughout Liberia.

The average monthly rainfall depths distribution determined from the data recorded at Goodrich (the closest station to the site at 35 km to the east) is considered to be representative of the average monthly rainfall distribution for the site. The average monthly rainfall depths are given in Table 23. It can be seen in the table that the highest monthly rainfall occurs in August (701 mm) while the lowest monthly rainfall (24 mm) occurs in January.

**Table 23: Average monthly rainfall estimated for NLGM site**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (mm) | 24 | 44 | 81 | 156 | 239 | 409 | 596 | 701 | 673 | 393 | 146 | 41 | 3,500 |

## *Evaporation*

There is no local evaporation data available for the Project site. Annual lake evaporation was estimated based on annual values presented in the surface water study report. Conservatively, it is estimated that the average annual lake evaporation for the NLGM site is approximately 1000 mm; close to the lower values in the region. Table 24 below shows the monthly evaporation estimated for the NLGM site.

**Table 24: Potential evaporation calculated for NLGM site**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | MAE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Potential Evaporation (mm) | 100 | 89 | 107 | 97 | 84 | 73 | 66 | 65 | 65 | 76 | 82 | 95 | 1,000 |

### Temperature

From the available NLGM meteorological station data, the hottest month (with the highest recorded temperature) was May 2011, which has an average recorded temperature of 26.7°C and maximum recorded temperature of 35.4°C. Conversely the coolest month was January 2012 with an average temperature of 24.3°C and minimum temperature of 14.4°C. Over the course of the monitored period, monthly average temperatures only varied between 24.3°C (January 2012) and 26.7°C (May 2011).

### Relative Humidity

From the available NLGM meteorological station data, the most humid month was August 2011 (mean 89.8%) with the least humid month being February 2012 (mean 73.4%). The highest relative humidity was measured in May 2011 (97.5%) and the lowest in January 2012 (13.8%).

### Wind Direction

Figure 11 displays the summary wind rose generated from the wind speed and direction data gathered at the NLGM met station, by month. Figure 11 shows that during the wet season (May/June to September/October) the wind predominantly blows from between south and southwest. There is a large portion of wind blowing from other directions (mainly from between east and south) during May 2011, however come June 2011 the winds were blowing from between south and southwest, illustrating (along with the rainfall data, 181.4 mm in March 2011 and 559.3 mm in June 2011) that May 2011 appeared to be the transition month between dry to wet season for 2011.

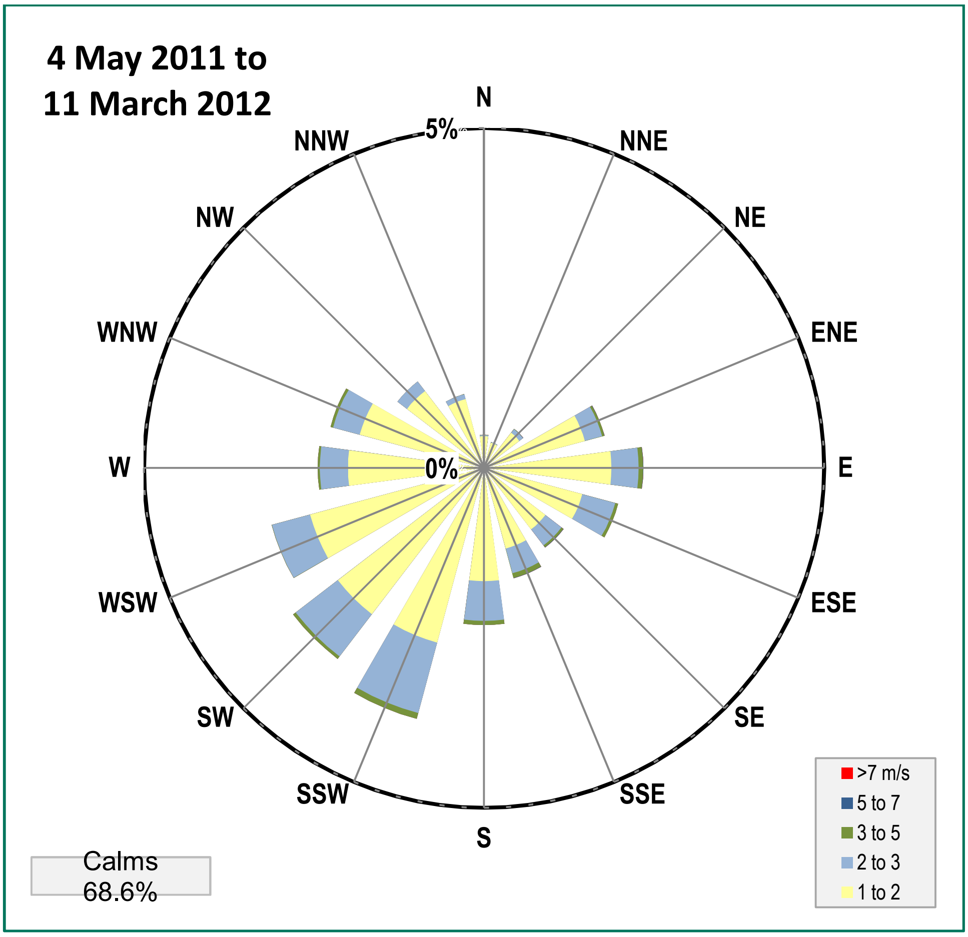


*Figure 11: Summary Wind Rose from NLGM Met Station*

### *Barometric Pressure*

For the time period 4 May 2011 to 11 March 2011, average pressure was 1007.8 mbar; the lowest average being 1006.2 in February 2012 and the highest average being 1009.4 in July 2011. Average pressure seems to be highest at the height of the rainy season (July 2011 – September 2011) at around 1009 mbar and lowest toward the end of the dry season (February 2012, March 2012 and May 2011) at around 1006 mbar.

### *Evapotranspiration*

Calculated evapotranspiration displays a diurnal pattern with peaks around midday, when plant transpiration and evaporation of water from the terrestrial surface will be at its highest due to a peak in incoming solar radiation; and troughs (falling to low negative values) at night time.

## 4.1.2 Topography

Three major physiographic regions occur in Liberia. They lie parallel to the coast, extending landward: coastal plains, rolling hills and the dissected plateau.

The NLGM site is located within the “rolling hills” physiographic region, some 40 km from the coast, where the topography is gently undulating with occasional small hills. Elevation above sea level at the site ranges from 50 m in the south, gradually rising via rolling topography to 80 m in the north. A series of perennial streams segments the rolling topography. Mid-slopes have moderately sloping gradient (8 to 15% slope). There are however some steeper mid-slopes of reduced length (100 m long) having moderately steep slope gradients (15 to 30% slope).

During the specialist studies, no outcrops were noted at the Project site.

North of the Project site are two (2) prominent east-west ridges, referred to as the BMMC Mountain and Tokani Mountain, which have an average elevation of about 300 m above mean sea level.

## 4.1.3 Geology

### *4.1.3.1 Regional Geology*

Liberia is situated within the West African Craton, which has remained stable since about 1.7 Ga. The craton consists of two major basement domains; the Reguibat shield (in the north around Mauritania) and the Man Shield (within which Liberia sits). The two shields are separated by the Taodeni basin of Proterozoic to Paleozoic age, while the Man Shield lies to the west of the Proterzoic Birimian Belts

The west of Liberia is comprised of Liberian age (3.0–2.5 Ga) greenstone belts and granitic gneisses. To the east of the country lies Eburnian age (2.1 Ga) material from the Birimian: a proto-continent that accreted to Africa during the Eburnean Orogeny, 2.1 Ga. Pan African material extends along the southern edge of the country, and represents the formation of Gondwana.

Within the Bea-MDA concession area there is both pan-African material (in the south-west corner) and Liberian age material, covering the majority of the concession area (AMC, 2012).

### *4.1.3.2 Geology of the Bea-MDA Concession Area*

The lithologies underlying the Bea-MDA property consist of a sequence of highly deformed granitic gneisses into which sequences of ultramafic schists have been folded. Most of the felsic gneisses are strongly foliated and layered, and their structural relationship with intercalated iron-formations, quartzite, schist, and amphibolite is highly suggestive that the gneisses are metasedimentary. Granite dykes (aplitic to pegmatite) intrude the schist.

Several small, discrete lenses of the composite gneiss (a local geology description for ultramafic bodies associated with amphibolites and migmatites) have been mapped within the granitic and granodioritic gneisses, representing relict Archean greenstone belts. The belts are elongated parallel to the regional strike, which swings from east-trending to east-northeast across a major shear, while further north the belts trend to the north-east.

The Bea-MDA property contains several known areas of gold mineralisation, concentrated in major imbricate shear zones and associated rotational fold hinges close to greenstone belt contacts. The shears and associated splays acted as structural channel ways for auriferous hydrothermal solutions, which deposited gold in suitable structures or chemical traps (AMC 2012).

#### 4.1.3.3 Geology of the Project area

Within the Project area are three main stratigraphic units (summarised in Table 25 below) which are further subdivided into minor zones of varying mineralogical assemblages. The geology is dominated by tremolite-chlorite-actinolite-talc ± magnetite rich meta-ultramafics, sometimes with phlogopite, and flanked by migmatitic gneisses.

**Table 25: Simplified Stratigraphic Succession (AMC, 2012)**

| Stratigraphic Name | Geological Unit |
|---|---|
| Hanging Wall Complex | HWC |
| Contact Zone (on HW and FW) | GNgp |
| Silicified Metamorphosed Ultrabasics (Mineralised) | SMUS |
| Footwall Complex | FWC |
| Syn to late tectonic aplites, pegmatites and Granitoids | GR series |

The Project area is positioned in a predominantly southerly-dipping schist belt, within a zone of high ductile shear strain oriented $287^0/72^0$, which served as the pathway for the migration of Gold-bearing fluids into the host lithology. The ultramafic unit is bedded and cut by brittle faults and dolerite dykes. Parallel bands and linear basic bodies, interpreted as sills and mafic schists, have also been mapped locally to the north and south of the Project. The most prevalent fabric in the Project's ultramafic rock is a steeply dipping metamorphic banding that is well developed in sheared regions. Small scale (3-5 cm) folds are common throughout the system (AMC, 2012).

Gold mineralisation occurs in zones of variable thickness and is nearly continuous along 2.0 km of strike length. The Project deposits consist of high-grade gold mineralisation, including intersections in excess of 5 g/t Au, contained within lower grade (0.5 to 1.0 g/t Au) material.

#### 4.1.3.4 Seismicity

The Golder engineering team conducted a desk-based seismic hazard assessment and preliminary estimations of the peak horizontal ground motions (PGA) for the NLGM site in March 2012.

The PGA values for various earthquake return periods are summarized in Table 26 below.

**Table 26: Estimated Peak Horizontal Ground Acceleration**

| Return Period (years) | 475 | 1,000 | 2,475 | 5,000 | 10,000 |
|---|---|---|---|---|---|
| PGA (g) | 0.06 | 0.09 | 0.15 | 0.24 | 0.33 |

Based on this analysis a peak ground acceleration (PGA) of 0.075g was used for pseudo-static conditions, half of the Maximum PGA (0.150g, corresponding to a 1 in 2,475 year return period).

### 4.1.4 Soils

A soil survey was carried out in October 2011 as part of the soil study for the EIA. Soil samples were taken of diagnostic horizons from twelve selected modal soil profiles. The modal profiles are considered representative of the range of soil conditions across the Project/study area.

In general, the soils in the Project area show limited variation and are characterised by a shallow layer of topsoil that is low in organic matter content, and deficient in magnesium and calcium Four relatively homogeneous soil groups are recognized and are discussed below. The extent of individual polygons which form part of the four soil groups is presented in Table 27 below.

**Table 27: Extent of individual soil polygons for each map unit**

| Soil group | Individual polygon | Extent (ha) |
|---|---|---|
| A | A1 | 140 |
| | A2 | 13 |
| | A3 | 78 |
| | A4 | 103 |
| | A5 | 130 |
| B | B1 | 8 |
| | B2 | 56 |
| | B3 | 1 |
| | B4 | 23 |
| | B5 | 4 |
| C | C1 | 1 |
| | C2 | 6 |
| D | D | 51 |

The soil observation points from the soil survey on site are shown in Figure 12 below.

Figure 13 below is the NLGM site soil map developed during the soil survey (October 2011).

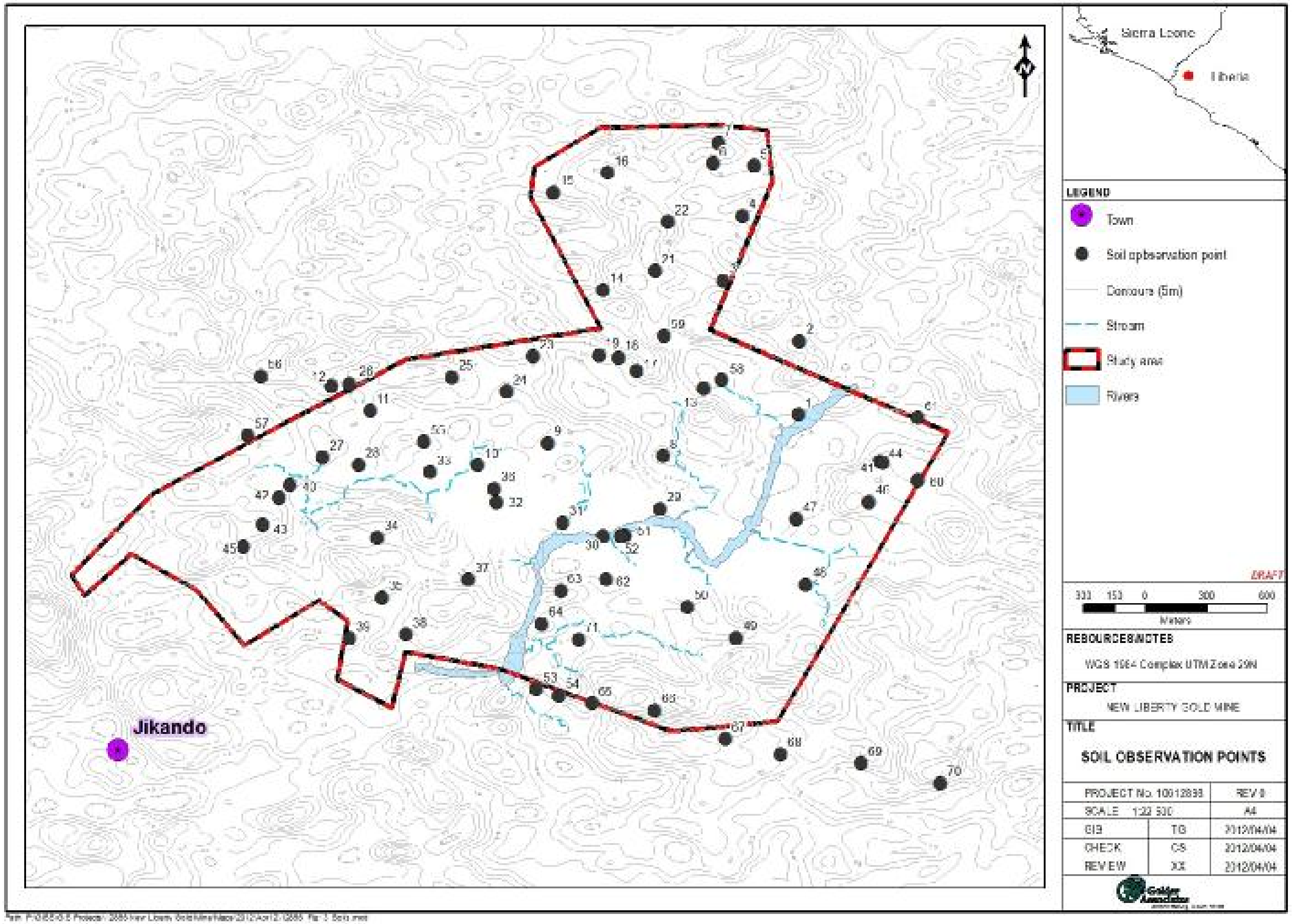


*Figure 12: Soil observation points on contour map of the NLGM site*

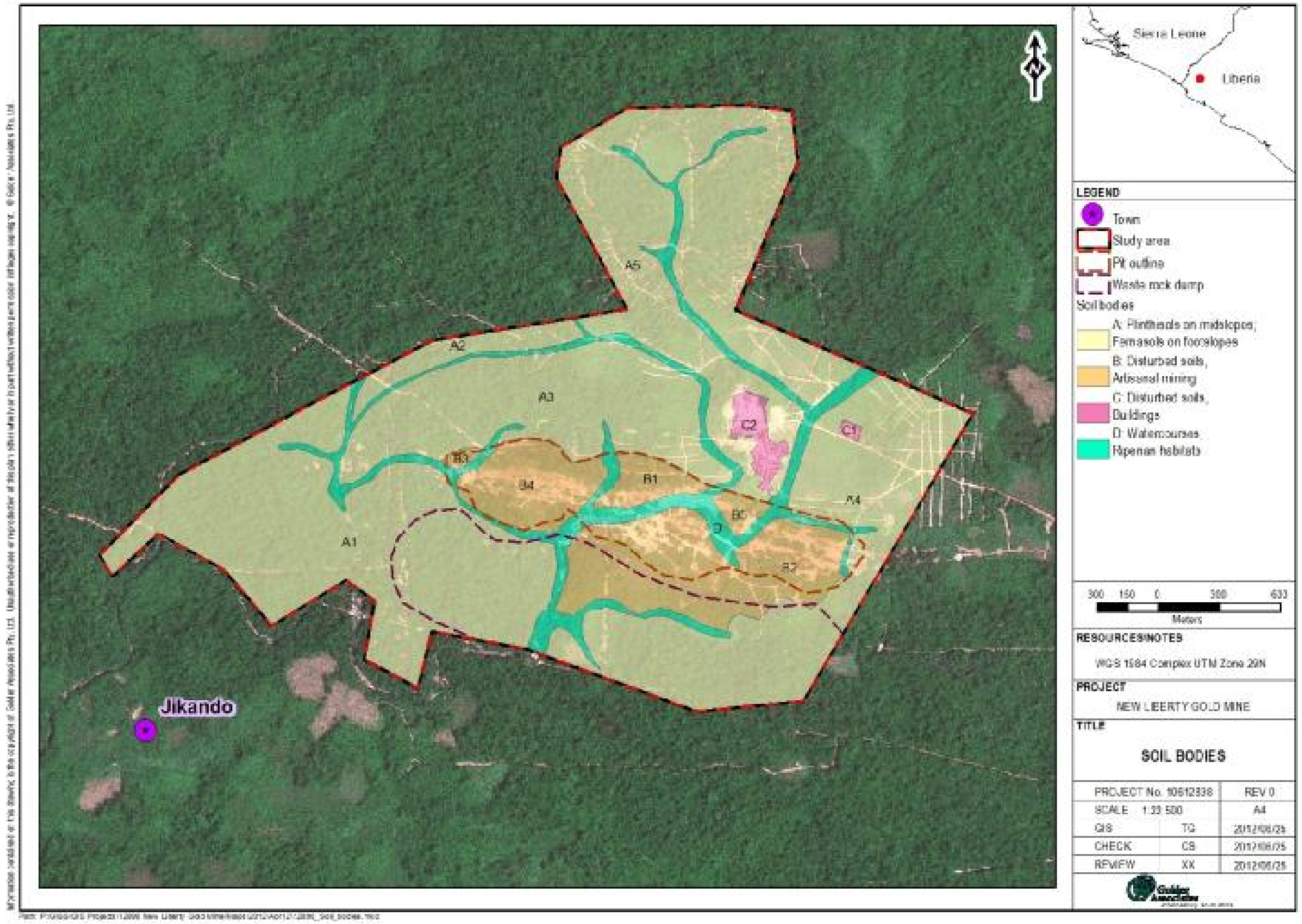


*Figure 13: Soil Map of the NLGM site*

Refer to **Volume II, Section A**, where the specific soil types are described in the Soil Assessment Report.

#### 4.1.4.1 Soil Status

During the soil survey, soil samples were collected and analysed to evaluate the contamination status. The soil analysis results indicate:

- The historic and current artisanal mining activities has resulted in elevated concentrations of a number of trace elements such as Ag, As, Cd, Co, Mo, Sb and Se which are also above soil screening values. Other constituents that are significantly elevated above baseline concentrations but not above screening values are Cr, Cu, Mn, Ni, Ti and V;
- The elevated concentrations of all of these constituents seem to be related to waste material due to the artisanal mining activities and seepage from these areas;
- These concentrations may hold risk to receptors but current and potential impacts as well as offsite impacts are unclear with the available information; and
- Background concentrations of trace elements in the soils are generally low except for Iron (Fe) and Aluminium (Al) which have accumulated naturally in the Plinthosols and Ferralsols.

#### 4.1.4.2 Agricultural Land Potential

During the soil study, agricultural land potential was expressed per delineated soil group. Derivation of agricultural land potential as shown in Table 28 below is based on methodology of Sys *et.al*. (1991), developed for the Food and Agricultural Organisation of the United Nations (FAO), using the site criteria listed above as inputs.

**Table 28: Agricultural Land Potential for the NLGM site**

| Soil group | Soils | Extent (ha) | Extent (%) | Agricultural Land Potential | Arability |
|---|---|---|---|---|---|
| A | Plinthosols on midslopes | 273 | 45 | S3<br>marginally suitable | Marginally arable |
| | Ferralsols on footslopes | 190 | 31 | S1<br>very suitable | Arable |
| B | Disturbed soils mining | 92 | 15 | N1<br>unsuitable but susceptible for correction | Non arable |
| C | Disturbed soils buildings | 7 | 1 | N1<br>unsuitable and non susceptible for correction | Non arable |
| D | Water courses and riparian habitats | 51 | 8 | N2<br>unsuitable | Non arable |

### 4.1.5 Present Land use

Approximately 457 ha of land area (i.e. in the NLGM Project area) formed the soils and land use study area as part of the EIA. The current land use is mainly tall tropical forest or disturbed forest area from on-going logging operations. A significant portion (14%) of the area artisanal mining is being practiced. The mining activity will affect a large portion of the area but about 38% will remain forest area with some access roads.

The current land use of the surrounding area contiguous to the NLGM Project area is for the most part the same as within the Project area itself – current land use is mainly tall tropical forest or disturbed forest area from on-going logging operations and artisanal mining activities.

The current land use within this extent is shown in Table 29 and Figure 14.

**Table 29: Current Land use and its extent in the Project area**

| Current Land Use | Extent (Hectares) | Extent (Percentage) |
|---|---|---|
| Tall tropical forest | 412 | 67 |
| Disturbed vegetation (mainly from timber logging) | 105 | 17 |
| Exploration/Mine camp | 3 | 0.5 |
| Kinjor village | 3 | 0.5 |
| School | 1 | 0.1 |
| Crops | 4 | 0.9 |
| Artisanal mining | 87 | 14 |

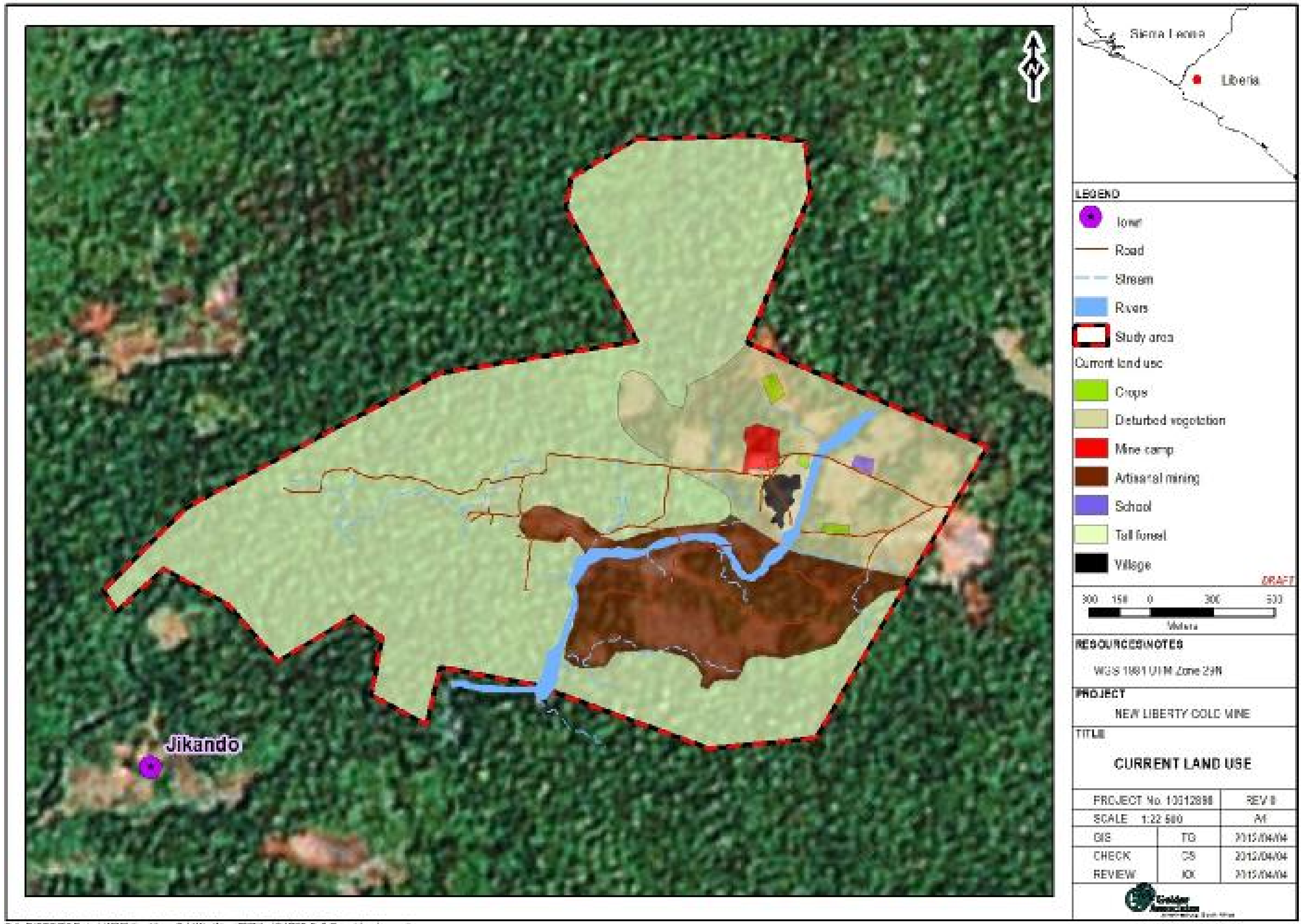


*Figure 14: Current land use within the Project area*

The natural environment (especially the streams and riparian areas) have been impacted upon on a localised scale due to the mining activities of artisanal miners (Figure 15). Relatively large areas of land have been modified by the creation of open pits for artisanal mining (Figure 16) and through the stripping of vegetation and erosion.

A number of forest areas have been altered for subsistence agriculture purposes. The food crops, notably rice and cassava, are cultivated utilising slash and burn agricultural techniques converting large areas of land from primary forest to secondary forest and agricultural land.

*Figure 15: The impact of artisanal mining on the Marvoe Creek*

*Figure 16: Old artisanal mining area near Larjor*

### 4.1.6 Surface Water

Liberia has a total land area of 111369 km$^2$. The country shares seven international catchments with its neighbours: the Mano and Cavalla are shared basins between Sierra Leone and Ivory Coast, respectively, while Lofa, St. Paul and St. John drain parts of Guinea.

The proposed project area is well drained by several small creeks. The dominant drainage feature in the study area is the Marvoe Creek. Numerous small, unnamed creeks that are all largely similar in character feed the Marvoe Creek. The Marvoe Creek is situated within the mining lease area. It is a tributary of the Mafa River, which flows into the Atlantic Ocean at the mouth of Lake Piso in the vicinity of the city of Robertsport.

#### *4.1.6.1 Surface Flow monitoring*

The first hydrology site visit was undertaken from 26 November 2010 to 4 December 2010. The site visit was undertaken to set up flow monitoring stations on the Marvoe Creek and provide training to local BMMC employees on stream flow monitoring. During the site visit, two sites, M1 (upstream of the proposed Project site) and M2 (downstream of the proposed Project site, on the Marvoe Creek were selected for the flow monitoring. The surface water monitoring sites were located upstream (M1) and downstream (M2) of the proposed Project site.

The coordinates of the surface monitoring sites are listed in Table 30. The location of the sites is shown in Figure 17.

**Table 30: Coordinates of selected monitoring sites (UTM Zone 29N)**

| Stream name | Site number | Easting | Northing |
|---|---|---|---|
| Marvoe Creek | M1 | 263851 | 775367 |
| Marvoe Creek | M2 | 262502 | 774553 |

Suitable locations for installation of GPs and cross-sections for flow measurements were selected. The monitoring equipment installed at the surface water monitoring sites is listed in Table 31.

**Table 31: Monitoring equipment installed at the monitoring sites**

| River name | Site number | GP | Water level data logger |
|---|---|---|---|
| Marvoe Creek | M1 | Yes | Yes |
| Marvoe Creek | M2 | Yes | No |

The surface water monitoring work required the following:

- Monitoring data collection included flow and discharge measurements, downloading of water level and rainfall data recorded; and
- Monitoring was conducted on bi-weekly basis.

Initiation of monitoring at the selected surface water monitoring sites requires commencement of data collection, with a view to obtaining of hydrology data prior to the initiation of the impact assessment phase of the EIA for these sites.

The monitoring work required the following:

- Monitoring data collection included discharge measurement, downloading of water level and rainfall data recorded; and
- Monitoring has to be conducted at bi-weekly intervals.

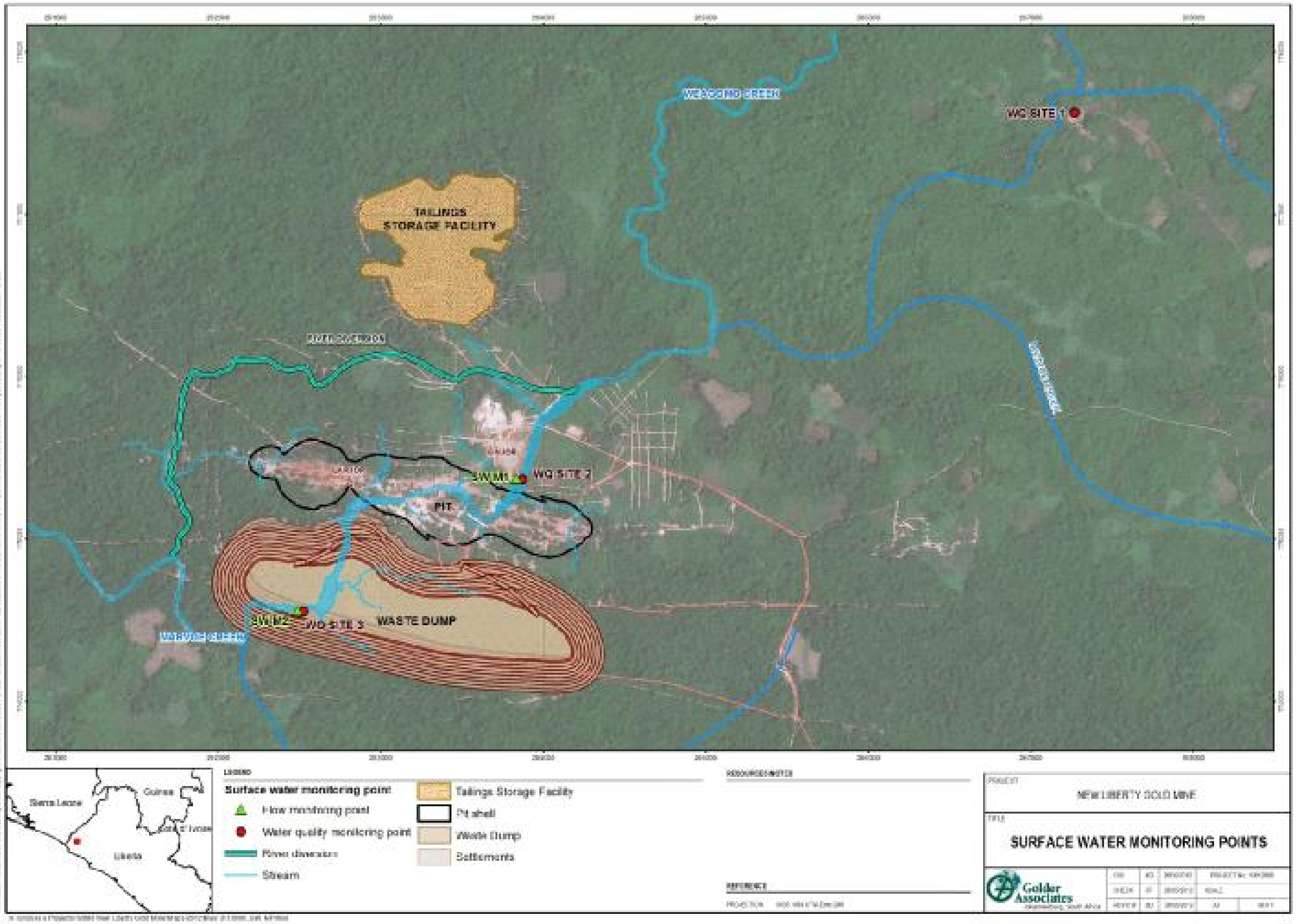


*Figure 17: Marvoe Creek surface water monitoring sites*

#### 4.1.6.2 Runoff coefficients for NLGM area

Limited information on the volumes of runoff for Liberia is available. More specific information regarding the runoff coefficients for Liberia was found in the report entitled "Comprehensive Assessment of the Agriculture Sector in Liberia report" by the Ministry of Agriculture (2007). The report indicates that the United Nations Department of Technical Cooperation and Development (UNDTCD,1987) estimated for catchment areas smaller than 10 km$^2$, low flows could be as low as 2-4 l/m$^2$/s and high flows could be as high as 2,000-4,000 l/m$^2$/s.

Results of other three case studies regarding the runoff estimation are available in UNDTCD (1987).These results presented the estimated average annual runoff coefficients for three catchments are in a range of 0.42 to 0.67.

Local stream data has been being collected at two flow monitoring stations in Marvoe Creek (M1 and M2) from December 2010 up to date.

Both stations have GP and along with it station M1 has a water level data logger which records water level every five minutes. Flow measurements at station M1 and M2 have been performed at monthly basis as average; data have been collected at intervals as short as 1 week and as long as 8 months. Data collecting and flow measurements have been performed by local Aureus employees trained by Golder. Table Table 32 shows the location and drainage area associated with the NLGM stream flow stations.

**Table 32: NLGM Flow monitoring stations**

| Flow Monitoring Station | UTM Coordinates | | Drainage area |
|---|---|---|---|
| | East | North | km$^2$ |
| M1- Marvoe Creek | 263851 | 775367 | 101 |
| M2-Marvoe Creek | 262502 | 774553 | 124 |

Preliminary monthly runoff coefficients were estimated as the ratio of monthly mean direct runoff at stations M1 and M2 and monthly total rainfall at the site. Based on the runoff coefficients based on the monitoring data, regional annual runoff coefficients and professional judgement the suggested runoff coefficients are listed below:

- Wet Season (May – October): 0.55;
- Dry Season (December – March): 0.14; and
- Transition (April and November): 0.27.

#### 4.1.6.3 Water Quality

The water quality monitoring component of the surface water study was initiated in 2011.

Three sites were selected for water quality monitoring at the NLGM site. The co-ordinates and locations of the water quality (WQ) monitoring sites are listed in Table 33.

**Table 33: Coordinates of water quality monitoring sites**

| Monitoring site name | Location | East | North |
|---|---|---|---|
| WQ Site 1 | Jawajei village | 267248 | 777626 |
| WQ Site 2 | SW M1 | 263851 | 775367 |
| WQ Site 3 | SW M2 | 262502 | 774553 |

In 2007 it was published (MLME, 2007) that the World Health Organization (WHO) drinking water standards should be used in Liberia until such time as a country-specific standard is developed. This will be produced according to Section 35 of the Environmental Protection and Management Law of the Republic of Liberia. Based on this, the parameters suggested for the analysis included:

- Cations: Ag, Al, As, Ba, Be, Ca, Cd, Co, $Cr^{6+}$, Cr (Total), Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Si, Sr, Th, Tl, U, V and Zn;
- Anions: Cl, F, $SO_4$, and CN (free, total and wad);
- Physicochemical parameters: pH, Conductivity Electrometric (EC), Total Dissolved Solids (TDS), Alkalinity, Chemical Oxygen Demand (COD), Phenols; and
- Nutrients: Free and saline ammonia, Nitrate ($NO_3$), Nitrite ($NO_2$), Phosphate ($PO_4$).

Five water quality sampling runs have been completed. Water quality data for monitoring sites WQ Site1, WQ Site 2 and WQ Site 3 are provided in the surface water assessment report together with the available Liberian, WHO and South African water quality standards. The results of the water quality analysis show that the water is of good quality (for potable use) and meets the WHO water requirements. However, there are some concentrations, particularly aluminium and iron, which are exceeding the Liberian, WHO (and South African) drinking water requirements.

#### 4.1.6.4 Annual precipitation for NLGM area

The annual average rainfall for the site was estimated at 3,500 mm based on distance from regional stations through Liberia.

There was no locally available annual rainfall data to determine the annual precipitation depths for wet and dry years for different recurrence intervals. The two Liberian stations with multi-annual rainfall records were used to estimate site values: Monrovia (1944 – 1964) and Port Buchanan (1959-1980). Using assumed site mean rainfall (3,500) and the average standard deviation of the Monrovian and Port Buchanan records, site values were estimated using the Gumbel distribution which provided the best fit for Port Buchanan and one of the best for Monrovia with little variation compared to Log Pearson III distribution which was the best fit probability distribution for Monrovia. The monthly distribution estimated for the NLGM site is shown in Table 34, and the values of annual precipitation for wet and dry years are shown in Table 35.

**Table 34: Monthly distribution estimated for the NLGM site**

| Period | Rainfall (mm) | Distribution (%) |
|---|---|---|
| Jan | 24 | 0.7 |
| Feb | 44 | 1.3 |
| Mar | 81 | 2.3 |
| Apr | 156 | 4.5 |
| May | 239 | 6.8 |
| Jun | 409 | 11.7 |
| Jul | 596 | 17.0 |
| Aug | 701 | 20.0 |
| Sep | 673 | 19.2 |
| Oct | 393 | 11.2 |
| Nov | 146 | 4.2 |
| Dec | 41 | 1.2 |
| Year | 3,500 | 100 |

**Table 35: Annual precipitation for wet and dry years**

| Annual Return Period (year) | Wet (mm/year) | Dry (mm/year) |
|---|---|---|
| 5 | 4,050 | 2,872 |
| 10 | 4,498 | 2,658 |
| 25 | 5,064 | 2,459 |
| 50 | 5,483 | 2,342 |
| 100 | 5,900 | 2,245 |
| 200 | 6,314 | 2,161 |

#### *4.1.6.5 Intensity Duration Frequency curves for NLGM area*

Intensity Duration Frequency (IDF) curves describe how rainfall intensities change with storm duration. Short storm durations typically have higher rainfall intensities than storms with longer durations. Two methods, Adamson (1981) and Bell (1969), were applied for development of the IDF curves.

Recommended IDF curves are plotted in Figure 18 and Figure 19.

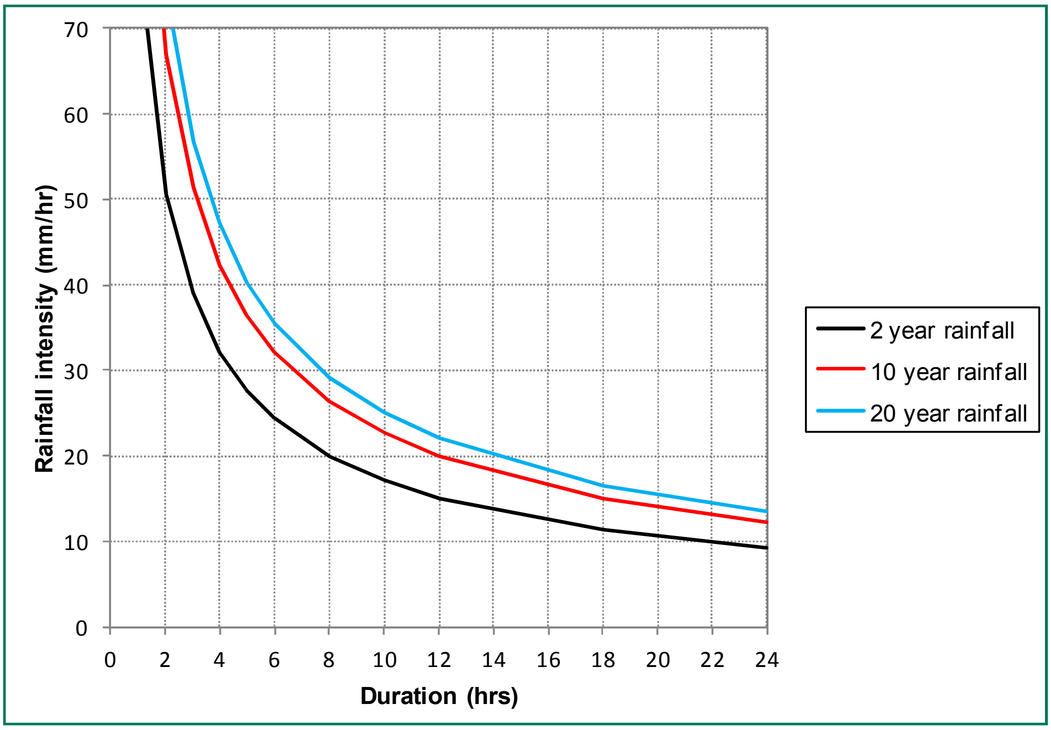


*Figure 18: Recommended IDF curves for the 2, 10 and 20-year recurrence intervals storm*

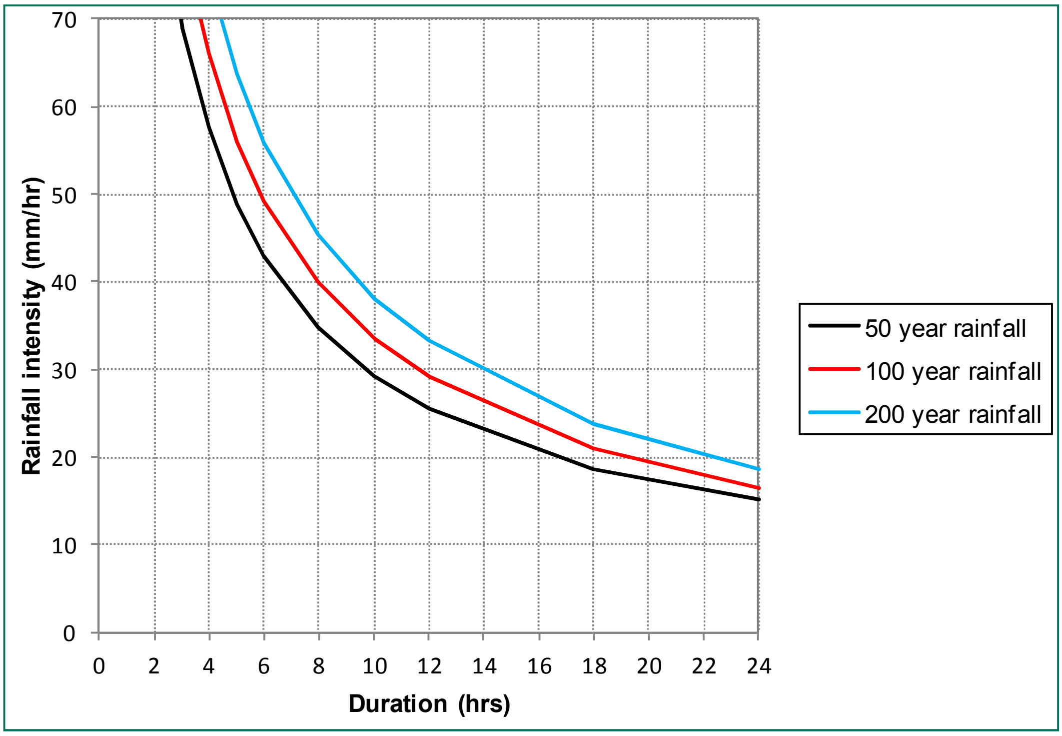


*Figure 19: Recommended IDF curves for the 50, 100 and 200-year recurrence intervals storm*

### *4.1.6.6 Conclusions regarding surface water baseline*

- The NLGM is located in a rainfall positive area, where rainfall exceeds evaporation by approximately 2.5 m;
- Average annual rainfall for the NLGM is estimated to be 3,500 mm;
- Average monthly runoff coefficient of 0.55 for the Wet Season (May-October), 0.14 for the Dry Season (December – March) and 0.27 for the transition between both seasons (April and November);
- The results of the water quality analysis show that the water is of good quality. However, there are some concentrations, particularly aluminium and iron, which are exceeding the Liberian, WHO and South African drinking water limits;
- The values of annual precipitation for wet and dry years were estimated using assumed site mean rainfall (3,500 mm) and the average standard deviation of the Monrovian and Port Buchanan records, and
- Two methods, Adamson (1981) and Bell (1969), were applied for development of the IDF curves.Recommended IDF curves are plotted in Figure 18 and Figure 19.

## 4.1.7 Groundwater

### *4.1.7.1 Aquifers*

The potential aquifer(s) zones underlying the Project area may be classified as:

- Perched water table aquifer zone – which occurs in the saprolite. The presence of the water table aquifer was confirmed by test pit profiling during the DC investigation conducted by Golder's engineering team in 2012. This reported, as seepage in boreholes TP-01 (1.2m), TP-02 (0.7m) TP-03 (0.8m) and TP-04 (0.8 m). Most of the hand dug village water supply wells reach this aquifer.

- A shallow aquifer zone – this potentially occurs along narrow sections where pockets of weathering/fracturing in hard bedrock prevail. Although these aquifer zones seldom produce large quantities of water, they may be developed for local supplies and may play a significant role in maintaining river base flow. The extent may be limited and water quality variable; and
- A deep aquifer zone – this may occur along deeply weathered and fractured contact zones between the strata and ore zone. Such an aquifer system may be highly productive and able to support large abstractions for public supply and other purposes. The groundwater quality is good.

As part of the groundwater study for the EIA, Golder conducted a site visit and hydrocensus in November 2010. (Figure 20 shows the location of various community wells including the mine camp wells, a spring utilised by the Larjor Village and the geotechnical and exploration boreholes sampled during the hydrocensus conducted by Golder in November 2010). During the hydrocensus it was noted that the deep aquifers as outlined above are not being accessed and utilised directly via boreholes at sites surrounding the Project area. This is most likely due to the availability of shallow groundwater and surface water resources throughout the area and the current lack of economic activities necessitating access to deeper groundwater resources.

The informal inspection of cores from several mineral exploration bores, however, allowed the confirmation of the presence of ubiquitous fracture features in the cores between 20 and 150 metres below ground level (mbgl) which may be associated with groundwater occurrence.

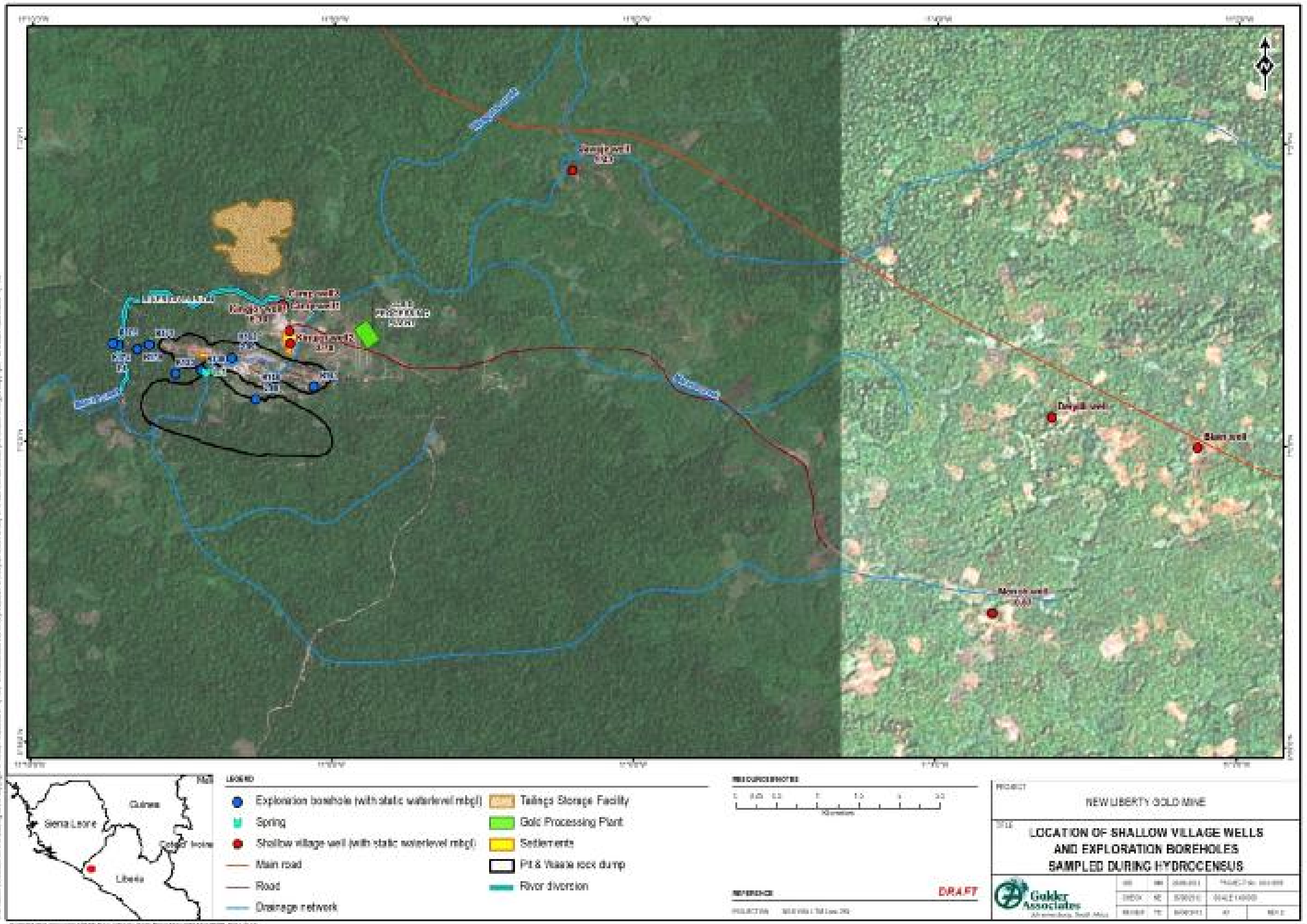


*Figure 20: Location of various wells, springs and boreholes sampled during the hydrocensus in November 2010*

#### *4.1.7.2 Aquifer properties*

Aquaterra (2011) conducted airlift tests in 34 inclined exploration boreholes. In these tests, water was removed from the borehole using an airline and the water level recovery was measured. The water level recovery data was used to estimate the hydraulic conductivity of the underlying materials. Hydraulic conductivity values ranging between $5x10^{-7}$ m/s and $7x10^{-6}$ m/s were estimated from the test results, with an overall average of $1.5x10^{-6}$ m/s. A hydraulic conductivity of 1 x $10^{-6}$ m/s was reported for the deep fractured aquifer in the ore zone (boreholes HYD-02 and HYD-04) and 5 x 10-6 m/s for the saprock.

Falling head tests were also conducted in the TSF site boreholes in January 2012, under Golder's supervision. In this area, hydraulic conductivity values ranging between 2 x $10^{-7}$ m/s and 5 x $10^{-8}$ m/s were calculated.

The hydraulic conductivity values reported here are most likely to be cumulative of all aquifer zones penetrated by drilling.

It is reported that the unweathered bedrock has little or no primary permeability and is devoid of intrinsic porosity (Aquaterra, 2012). The basal zone of the saprock above the fresh bedrock is likely to be permeable when highly fractured. The overall permeability of the fresh bedrock is reported to be low (Aquaterra, 2011).

The study above suggests that the groundwater flow in the saprock is primarily horizontal, moving from recharge areas to discharge zones with limited vertical flow into the deeper bedrock. Saprock is relatively thin on site up to 20m as a result the storage capacity of the unit is limited. It is further indicated that the aquifer system generally has low transmisisvity ranging between 1 $m^2$/d to 5 $m^2$/d with values lower or higher than this by an order of magnitude. Fault zones, fractured and weathered contacts between lithological zones acts as the conduits and pathways for groundwater flow.

#### *4.1.7.3 Groundwater levels and flow directions*

Following on from the hydrocensus conducted by Golder in November 2010, this was followed by four groundwater level monitoring rounds in 2011 conducted by Aquaterra. Based upon the information gathered it is understood that groundwater level fluctuates seasonally and may vary in depth from 0 to 16 mbgl in the area. It is noted that the groundwater flow is from the higher lying area down gradient and discharges in the surface depressions and valleys. The water table is shallower closer to the Marvoe Creek due to the topography and artesian conditions occur in this vicinity.

From the water level data, it is evident that the Marvoe Creek has a controlling influence on the groundwater levels in the area. The groundwater flow is towards the creek, where it discharges as base flow. Figure 21 shows the piezometric groundwater level map and groundwater flow direction.

#### *4.1.7.4 Conceptual Groundwater Model*

As part of the groundwater assessment, a conceptual groundwater model was developed. The conceptual groundwater model presented below (Figure 22) is composed of the surface mine infrastructure, underlying geology, depth to water table, groundwater flow direction and aquifer hydraulic properties. The thickness of the groundwater system was determined from the geological logs of the deep geotechnical boreholes. The position of ore the body, dip direction and angle, and hydraulic conductivity values are as reported by Aquaterra, 2012.

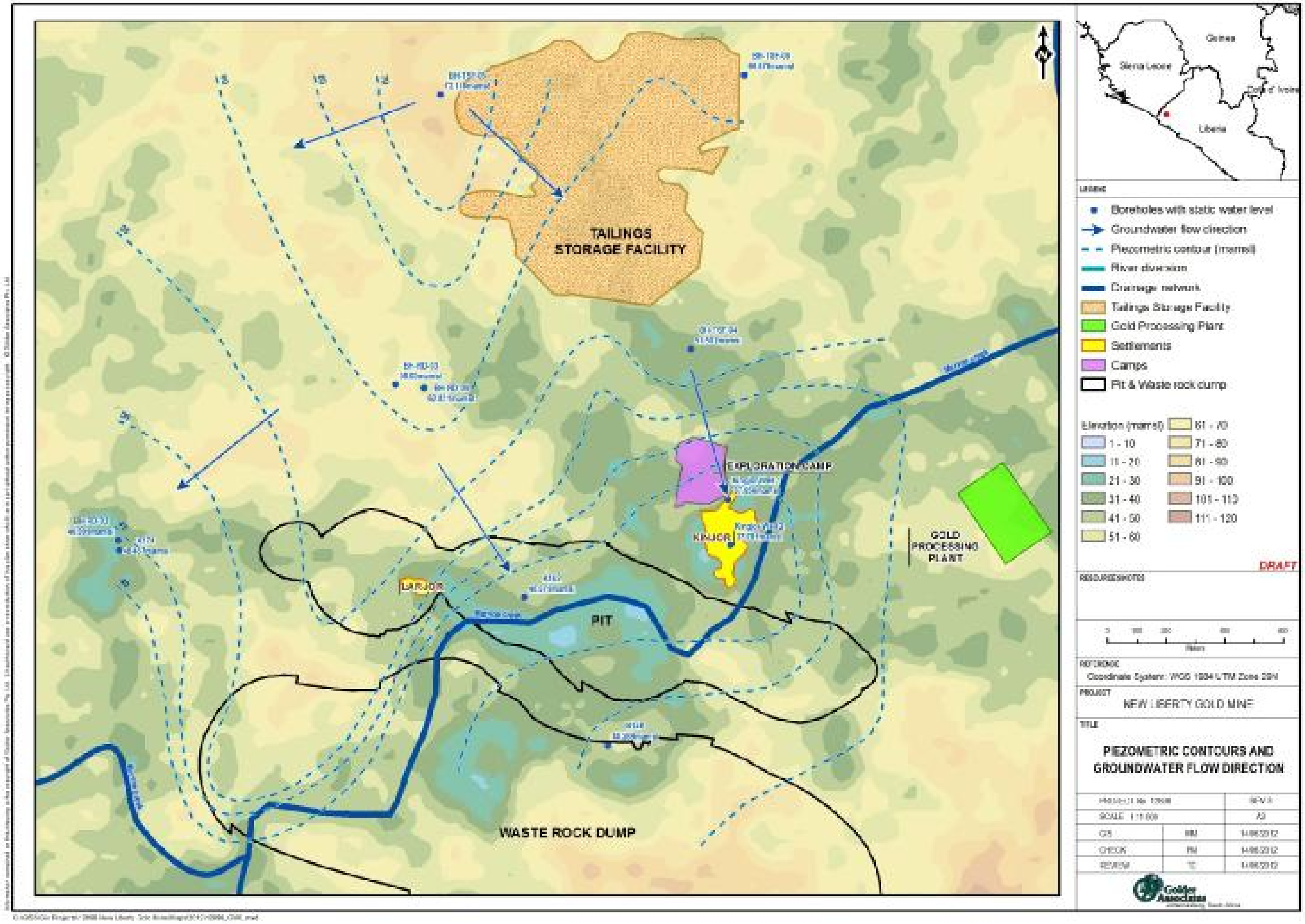


*Figure 21: Piezometric groundwater level map and groundwater flow direction*

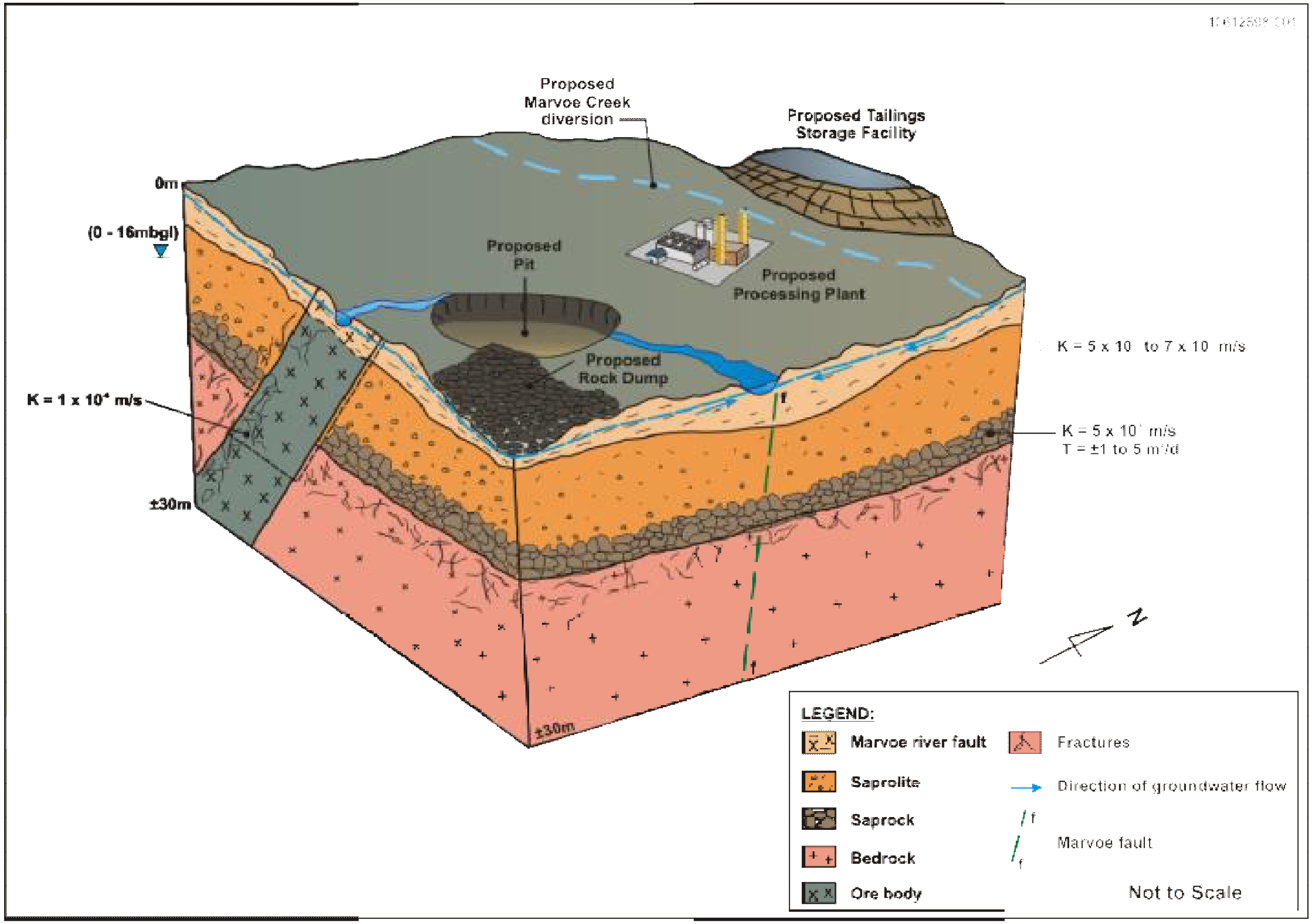


*Figure 22: Conceptual NLGM Groundwater Model*

#### 4.1.7.5 Groundwater Quality

Physio-chemical parameters were measured by Aquaterra during 2011 using a field probe during the airlifting permeability testing. The electrical conductivity of the groundwater is reported low ranging from 10 – 73µS/cm with an average of 26µS/cm. The temperature of the groundwater ranges from 26 – 29$^{o}$C with an average of 27$^{o}$C and pH ranging from 6.7 to 9.0 with an average of 7.8 was reported.

Groundwater samples were collected by Golder from various villages and one of the camp wells during the hydrocensus in November 2010. A sample was taken from a spring near Larjor Village used for village water supply at the time of the hydrocensus. A further groundwater sample was taken from one of the mineral exploration borehole (KDG146) to the south of the Marvoe River. Water samples were submitted to the Eurofins in the Netherlands, an accredited laboratory for cations, and anion analysis.

Hydro-chemical determinants were analysed by Eurofins from the six boreholes and the spring near Larjor. Most of the groundwater samples analysed are within (SANS 241:2006 health and aesthetic requirements) and (WHO Water standards 1993) with the exception of borehole KGD 146 where the values of Arsenic (As) and Iron (Fe) exceeds the maximum allowable limits according to (SANS 241:2006) and (WHO Water standards 1993). The standard limit for drinking water of Arsenic (As) is ≤10 µg/L. The value of Arsenic (As) in borehole KGD 146 is 29µg/L. The limit for drinking water of Iron is (Fe) ≤0.2 mg/L. The value of borehole KGD 146 is 6.3 mg/L.

At depth, naturally occurring poorer water quality associated with the mineralised zone can be expected. It is also important to note that the results of the surface water quality analysis show that the surface water is within the Liberia water quality standard for drinking water and also meets the WHO water quality criteria (Section 5.1.6.3).

From the groundwater quality analysis, it is apparent that the Project area is characterised by one dominant ground water type with bicarbonate ($HCO_3$) the dominant anion and calcium the dominant cation. This is typical of recently recharged groundwater from rainwater.

#### 4.1.7.6 Summary and Conclusion – Groundwater Baseline

The following can be inferred from the NLGM groundwater baseline study:

- The NLGM site is situated in the Archaean Man Shield terrain. Lithologies underlying site consist of ultramafic komatiitic and amphibolite schist that have been highly deformed and infolded into sequences of granitic gneisses. The land surface has been exposed to intense weathering, which has resulting in thick saprolite and residual soil;
- The area is characterized by faulting and folding that are believed to play a great influence in groundwater characterisation of the area. The largest fault is the Marvoe River Fault, which is evident from the displacement of ore zone between the Kinjor and Marvoe zones. Although the lateral extent of this structure is not verified it is sure to transect the opencast workings as well as the Waste Rock Dump. Should this structure represent a preferential groundwater flow zone it will report as significant water make into the mine workings as well as a conduit to the workings from any possible constant head sources that it transects, like the WRD;
- It is reported that groundwater occurs in the fractured saprock and fractured ore body. There are perched aquifers localised in the saprolite at a shallow depth;
- The saprolite layer is characterised by low permeability and can also act as a confining layer over the saprock. The lateral extent and thickness of saprock is not uniform across the site. For this reason, the saprock is considered to constitute localised, productive aquifers;
- The reviewed reports suggest that the highest permeability is found in the fractured ore body and saprock which reduces downwards into the fresh bedrock. Groundwater flow is expected to occur in the fractured zones and through interconnected fissures in the bedrock;

- Hydraulic conductivity ranging between $5x10^{-7}$m/s and $7x10^{-6}$m/s were calculated by Aquaterra (2011) from permeability tests. A hydraulic conductivity of $1 \times 10^{-6}$ m/s was reported for fractured aquifer in the ore zone and $5 \times 10^{-6}$ m/s for the saprock;
- Falling head permeability tests were conducted in the TSF area boreholes in 2011 - 2012. Hydraulic conductivity values ranging between $1.9 \times 10^{-07}$ m/s and $5 \times 10^{-8}$ m/s were calculated;
- The depth to the water table generally ranges between 0 and 16 mbgl. Groundwater levels fluctuate seasonally, generally rising during the wet season and falling during the dry season, although a certain lag time can be expected. Apart from boundary conditions such as no-flow boundaries and preferential flow zones that needs verification, the water level data confirm that the groundwater flow, generally emulates the surface topography from high lying areas to the low lying areas and the natural drainage lines where it reports as base flow;
- Water quality analyses (major cation and anion and metal) of the hydrocensus samples reveal that the groundwater at the site is of good quality, within SANS 241 class I and World Health 1998 drinking water standards. The only exception was the sample obtained from the mineral exploration borehole KGD 146, which has elevated arsenic and iron levels which exceeded both SANS and WHO standards. As previously stated and in contrast to the weathered zone aquifer(s), naturally poorer water quality can be expected within the mineralised zone, especially with increasing depth which also correlates with longer residence times. Apart from the sample from KGD 146, which falls in the very hard category (scaling problems) the rest of the samples can be classified as very soft and will tend to be corrosive in a distribution network. The observed water quality is indicative of both a low sodium and salinity hazard when considering the water for irrigation purposes; and
- The area is characterised by one dominant ground water type, where the major anion is bicarbonate ($HCO_3$) and calcium the dominant cation, typical of recently recharged groundwater from rainwater.

### 4.1.8 Geochemistry

As part of the NLGM EIA, Golder was contracted to conduct a preliminary (Phase 1) geochemical characterisation of the acid rock drainage (ARD) and metal leaching (ML) potential of the geological and mine waste materials that would be exposed, disturbed and/or deposited during the proposed mining operations. The ARD and ML risk from the TSF, open pit and WRD were assessed as an indication of the pollution potential to the receiving environment.

The approach that was followed is based on best practice methodology to characterise mine drainage is presented in the Global Acid Rock Drainage (GARD) Guide (www.gardguide.com). The methodology includes: Review available information, Development of conceptual models of key geochemical and flow processes for each mining facility; Development of a sampling strategy, Sampling of geological materials and mine wastes; Laboratory analysis of waste rock and tailings samples including geochemical (static and kinetic tests of tailings samples), Data interpretation and Reporting.

#### *4.1.8.1 Geochemistry Characterisation Results*

##### *Waste Rock*

##### Whole Rock Elemental Composition

- Elements that are enriched in the waste rock materials compared to crustal abundance indexes are Si followed by Al, Fe, Ca and Mg. Arsenic (As) enrichment in the waster rock (mainly Silicified Metamorphosed Ultrabasic Suite (SMUS) rock units) was found. Antinomy (Sb), As, Ni, Cr, and U were found to exceed the crustal abundance. Elements that have the potential to be leached under both acidic and neutral drainage conditions due to their amphoteric properties include: Major Elements: Ca, Mg, Fe, Si and Al; Trace Elements: As, Ni, Cd, Co, Hg, Cr, Mn, Mo and U;

### Acid Base Accounting (ABA)

- The paste pH of the waste rock samples is indicative of initial drainage/run-off quality and is relatively alkaline (9.1-10) suggesting the presence of reactive alkaline minerals that will likely have an influence on the drainage quality form the Waste Rock Dump. Despite the alkaline paste pH, amphoteric metals such as (Al, Zn, Pb, Sn,Cr, Be, As.Sb, B, Si, Ge, V, Ni, Co Zn and Te) can have increased solubility and exist as dissolved ion species at high pH levels;

- The sulphur speciation results indicated that the sulphide sulphur content ranges from 0.01% to 1.55% .The sulphide content in four rock SMUS samples (WR009, WR024,WR044 and WR045) range from 0.62 % to 1.15% and exhibit different behaviour to the rest of the waste rock samples. The samples were found to have an Au content of 0.05%, 0.16%, 0.19% and 0.13% based on assay result (Aureus, 2012) These samples will not report to the low grade ore stockpile but to the waste rock dump. Oxide waste rock materials have a low ARD potential and will likely be non-acid generating. Waste rock materials from the marginal or transitional ore zones (SMUS and GNgp) have the potential to generate acid drainage with some classifying as likely acid generating (3 of 9 samples) and possibly acid generating (6 out of 9 samples);

- The carbonate and bulk NP was measured to range from 5.2 to 30 kg $CaCO_3$eqv/t and 0.81 to 6.3 $CaCO_3$ eqv/t respectively, indicating the that the samples have available NP to buffer acid generation. The aluminosilicates and carbonates are expected to contribute to the surplus neutralisation potential of the waster rock samples. Mineralogy of the waste rock samples is required to identify the neutralising minerals. The rate of depletion of the neutralising minerals needs to be confirmed by kinetic tests to determine the onset of acidity; and

- According to MEND (2009) classification selected sulphide zone samples (56% of the SMUS samples) have sulphide sulphur greater than 0.22% and NPR less than 2 and are classified as potentially acid generating (PAG) based on the NPR.

## 4.1.9 Air Quality

As part of the EIA, baseline air quality monitoring was conducted on site for a period of six months. Dust samples were collected once the bottles were full and a new sample was taken once the next monitoring period began.

Monitoring was carried out at 10 different sites in the Project area. The monitoring locations are shown in Figure 23 below.

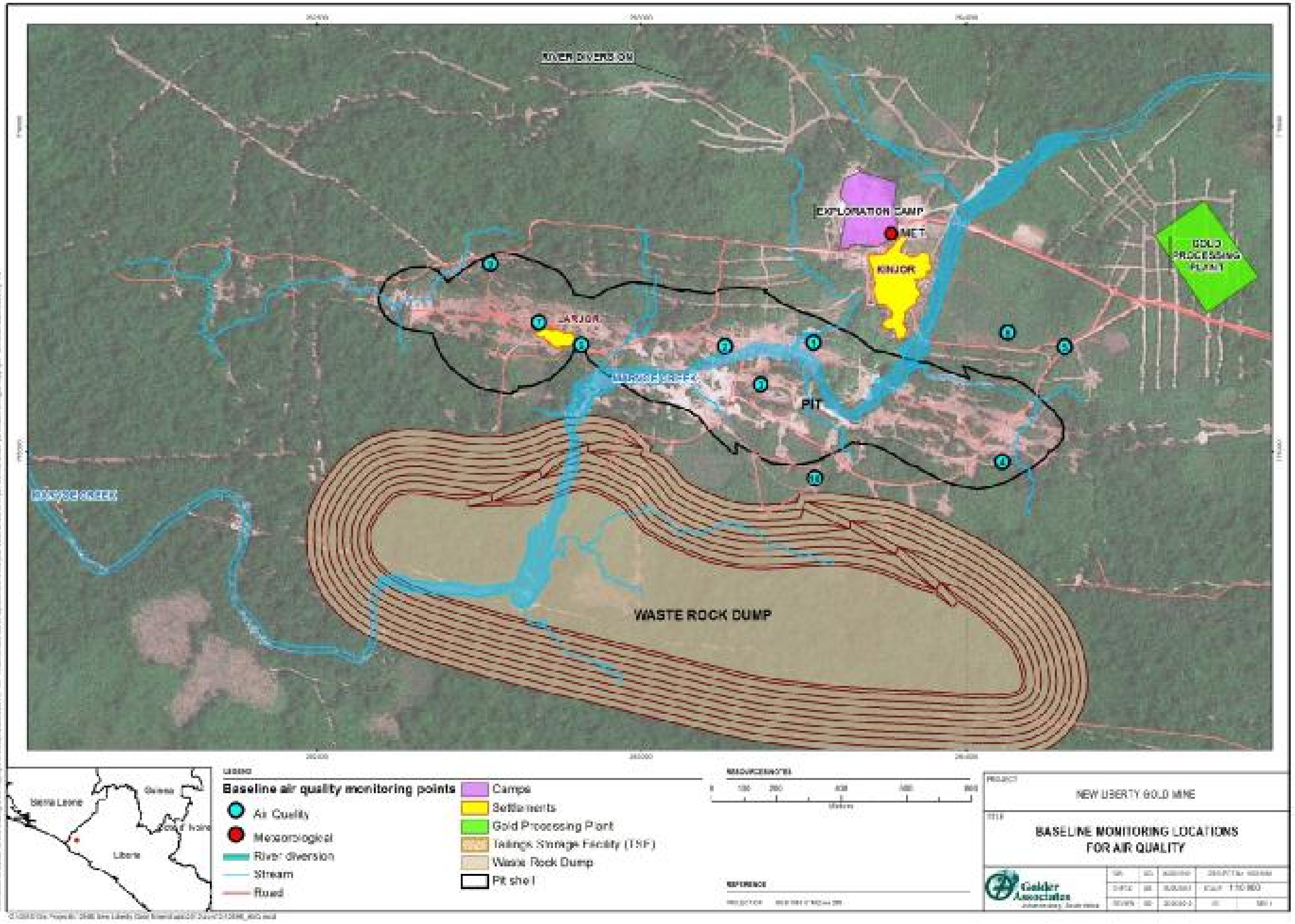


*Figure 23: Air Quality Monitoring Locations*

Currently the existing air quality in the region is influenced by existing artisanal mining activities, mine exploration and associated Aureus workers accommodation (from generators and wood burners), local villages (Kinjor and Lajor) and the local road network.

The baseline air quality in the area is good, based on the six month monitoring which was undertaken as part of the EIA. Annual and 24 hour $NO_2$ concentrations are less than 5% of the relevant WHO standards as is 24 hour $SO_2$. 10/ 15 minute $SO_2$ is slightly higher but still only 6.3% of the relevant WHO standard. The $O_3$ background concentration is higher, but this is still only 53.9% of the WHO standard. Baseline monitoring also indicates that deposited dust is much lower than the recommended levels in both the South African and International guidelines. The baseline monitoring identifies that background air quality is good and concentrations are well below the relevant standards.

### 4.1.10 Noise

For the noise study, ambient noise measurements were carried out according to ISO Code of Practice 1996 (Ref. 1) at seven points on the NLGM site from the 17$^{th}$ – 20$^{th}$ November 2010. To conduct the noise study, the following equipment was used: Bruel and Kjaer Precision Integrating Sound Level Meter, Type 2230, serial number 1483775, fitted with Bruel and Kjaer Type 4155 Microphone, serial number 1507751, and windscreen. Field calibration of the equipment was carried out using a 01dB Sound Level Calibrator Cal01, ser. Nr. 990640.

The noise monitoring positions were chosen for one or more of the following reasons:

- Easily definable and with easy future access in case of need for comparison measurements during or after completion of the project;
- Most likely to continue to exist after completion of the project;
- Representative of the important background noise regimes; and
- Near identified sensitive receptors likely to be affected by construction or operational noise.

From the noise baseline study it was determined that noise levels in the NLGM Project area are similar to those found in rural settings throughout Africa. There is occasional traffic noise on the dirt roads, and noise associated with the BMMC exploration drilling operations, and limited noise from chainsaws used by loggers in the area.

Due to the remote setting of the NLGM site, the thick forest vegetation around villages, the fact that the area is in a rural setting and there are no commercially based industries in the region, the baseline noise levels are relatively low, with no marked impacts on the local population.

## 4.2 Biological Environment

### 4.2.1 Terrestrial Ecology

Terrestrial ecology baseline surveys were conducted in November 2010 (wet season) and in April 2011 (dry season).

The groups of species investigated during the terrestrial ecology study were:

- Vegetation/flora;
- Arthropoda;
- Avifauna;
- Mammals;
- Herpetofauna (Reptiles); and
- Amphibia.

For the purposes of the terrestrial ecology assessment, the local study area was defined as the NLGM project infrastructure area, with a buffer zone of approximate 3 km around this area. Sixteen study sites were selected within this area to cover all vegetation communities with replicates Figure 24. The fauna and flora in each of these study sites were studied during both the wet season and dry season, as noted earlier.

#### 4.2.1.1 Regional Overview of the Vegetation

Liberia lies almost entirely within the Upper Guinea forest block, which forms the western part of the West African Guinean Forests hotspot, one of the 34 biologically richest and most endangered terrestrial ecoregions in the world (White, 1983). The Upper Guinea forest as a whole is threatened, and while most other West African countries have lost the majority of their forest cover (e.g. most of the mature forest in neighbouring Côte d'Ivoire is already gone), Liberia's forest cover still seems to be quite extensive. Liberia was originally more than 90% forested, and is currently still covered in large part by mature forest. Liberia's forests are, however, increasingly threatened by logging, shifting agriculture, and hunting and mining activities, with logging companies, such as the Oriental Timber Company, recently demonstrating that these forests can disappear in just a few years when large areas are not protected from exploitation (White, 1983).

Most Upper Guinea endemics are concentrated in and around Liberia and species composition varies greatly within the Liberian forest. Important differences exist between the very wet coastal forest of central Liberia and the much drier forest near the border with Guinea. Variations in rain-fall patterns with increasing seasonality from southeast to northwest Liberia also have an important influence on the vegetation (White, 1983).

#### 4.2.1.2 Vegetation Communities

Based on physiognomy, moisture regime, rockiness, slope and soil properties, four main communities were recognised within the Project area, namely:

- Natural Forest community;
- Rubber plantation;
- Disturbed forest community; and
- Transformed vegetation community.

A total of 329 plant species were recorded (see **EIS Volume II, Section G**) during the terrestrial ecology surveys. Floral species diversity in the area is high and even the 329 species recorded are not considered to be the total species count for the area. A large proportion of the species recorded are indigenous with few exotic species occurring in the area, although in areas of higher anthropogenic disturbances, notably along roads, some exotic species are more prevalent. In the Rubber plantations, rubber trees (*Hevea brasiliensis*) are the most dominant exotic species. Species occurring in these disturbed areas include *Verbena bonariensis*, *Mimosa pudica* and *Mimosa pigra*.

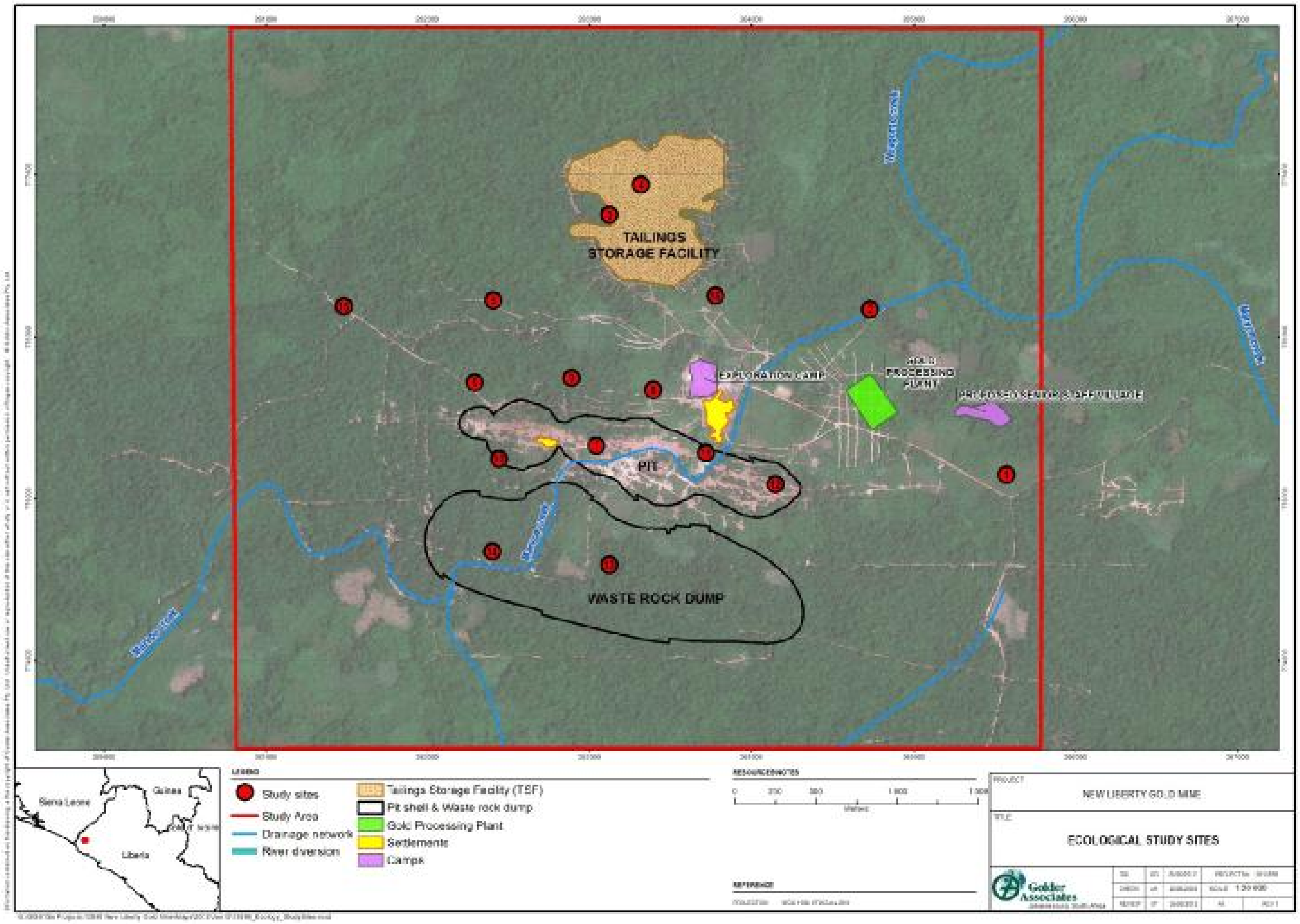


*Figure 24: Study sites selected for fauna and flora studies*

### *Natural Forest community*

This vegetation community consisted of closed and open, species-rich, natural forest with abundant Plagiosiphon emarginatus mixed with many wet evergreen forest species such as:

- *Achyrospermum oblongifolium;*
- *Costus deistelii;*
- *Cryptosepalum tetraphyllum;*
- *Mapania spp.;*
- *Strephonema pseudocola*; and
- *Triphyophyllum peltatum*, the latter mixed with many more widespread forest species.

Slightly uphill from the Marvoe Creek, the vegetation changes to lower forest with scattered large trees, which even harboure characteristic dry-forest species like *Gardenia nitida* and *Grewia pubescens*.

In some places this vegetation gave way to predominantly herbaceous vegetation with several species of *Labiatae* and *Acanthaceae*, such as *Plectranthus epilithicus* that are usually found on seasonally wet, rocky areas and occasionally, the succulent *Sansevieria liberica* and the climbing *Asparagus drepanophyllus*. The seasonally dry wind from the north is clearly much stronger here than at the other two sites, and the shallow soil on rocky substrate found at several places also influences the species composition. On such soil in open forest, the orchid *Habenaria macrandra* was found, once with *Oeceoclades maculata* and a *Nervillia* species. In small, rocky streams *Anubias gracilis* was often encountered, as well as several fern species, such as *Bolbitis salicina*. In low areas between the hills several *Raphia palma-pinus* swamps occurred, with other swamp plants like *Halopegia azurea*. Although listed, *Raphia palma-pinus* is locally common and found throughout these areas.

The NLGM study area is a forested area with good evergreen forest species including *Anisophyllea meniaudii, Cola buntingii, Costus deistelii, Delpydora gracilis, Dicellandra barteri, Diospyros chevalieri, Heinsia crinita, Physacanthus batanganus, P. nematosiphon, Renealmia longifolia, and Strephonema pseudocola*. The primary forest canopy had a closed structure which opened up with an increase in elevation. Lower vegetation was dense in most areas and large lianas were present.

Because of open areas in the forest, many specialised forest undergrowth species, herbs as well as shrubs, occurred. Along the streams the damage to the vegetation caused by rapidly changing water levels was visible. Several species were adapted to this condition; usually shrubs with flexible twigs and narrow leaves like *Rinorea sp*. were recorded along fast-flowing parts of the streams. On rocks in and above the creek the small specialised herb *Argostemma sp* was found in abundance. *Anubias gracilis* and ferns like *Bolbiti salicina* were also abundant on such rocks.

These forest areas are of exceptionally high plant and animal diversity. Floral diversity not only serves to support animal species by providing food, shelter and areas in which to rear their young, but in an area where the hunting of wild animals is rife these forests also offer protection due to the inaccessibility of the forest.

In areas where accessibility has been increased by the construction of roads through these forests, hunting for the bushmeat trade is greatly increased. Furthermore, in these areas of increased accessibility slash and burn techniques are employed in order to clear areas for the cultivation of crops, especially bananas and cassava. A further impact that is very difficult to determine is the effect in the reduction of carbon sequestration that will be caused by the deforestation of areas of this forest.

From a sensitivity perspective, the following can be noted regarding the natural forest community:

- This variation is situated within the Upper Guinean Forest biome, thus it is declared rainforest and considered a sensitive habitat type;
- The vegetation of the area is relatively undisturbed in more inaccessible areas;
- High flora species diversity;
- Floristic status of this variation is very high;

- Suitability of habitat for Red Data flora and faunal species is high;
- Due to the small Project area, relative to the amount of this vegetation community, likely impacts on the vegetation will be highly significant on a local scale , but less significant on a regional or global scale;
- Ecological function of this vegetation community is high; and
- The Conservation importance of this community is moderate to high.

### *Rubber Plantation*

Just south of the village of Kinjor there is a rubber plantation within the NLGM area (on the other side of the Marvoe Creek). At a first glance it looks like a fully grown tropical forest, but among the thick undergrowth, the rubber trees *Hevea brasiliensis* can be seen in the lines in which they were planted. The trunks of these trees are deeply scarred and produce little rubber and are now part of Liberia's estimated 600,000 ha of overgrown and moribund rubber farms.

Natural species have begun to recolonise the area with, *inter alia, Albertisia ferruginea, Kolobopetalum leonense, Penianthus patulinervis, Ficus elasticoides, Ficus umbellata, Antiaris toxicaria, Ficus natalensis, Musanga cecropioides, Streblus usambarensis, Treculia africana, Ochna membranacea, Nephrolepis biserrata* and *Bulbophyllum oreonastes* recorded in this vegetation community.

This vegetation community does support a large number of bird species, however, small mammal and reptile assemblages are reduced compared to what would be expected in a natural forest. This area has been severely impacted in order to facilitate rubber plantations and the natural growth in this vegetation community must be characterised as secondary forest growth.

This rubber plantation will be consumed by the pit area if the project proceeds as is currently envisaged. From a sensitivity perspective, the following can be noted regarding the rubber plantation:

- This variation is characterised as secondary forest growth;
- The vegetation of the area is historically severely disturbed;
- Low species diversity;
- Floristic status of this variation is low;
- Suitability of Red Data flora and fauna species is low;
- Likely impacts on the vegetation will be insignificant on a local to regional scale;
- Ecological function of this community is low; and
- The Conservation importance of this community is low.

### *Disturbed forest community*

Large tracts of forest have been disturbed for a number of reasons such as slash and burn agriculture, creation of grazing, logging and banana, guava, mango or rubber plantations. Some of these areas have been slashed and burnt, but not actually utilised for plantations (i.e are still lying fallow). In these areas secondary forest growth has colonised the areas. In some areas fruit tree plantations have been re-colonised by natural vegetation, also giving rise to secondary forest growth. Artisanal logging is widespread in the area and large trees in many areas are being felled for this purpose. Species composition is a subset of that of natural forests and species recorded in this vegetation community are similar to those found in the secondary growth found in the rubber plantations although the actual species diversity varies depending on the time elapsed since the area was cleared or agriculture ceased.

This vegetation community occurs in areas that have been, historically or recently, disturbed in order to facilitate plantations, logging or other agriculture. The fire regime has intensified through slash and burn methods, or burning to clear undergrowth in order to gain access for logging purposes, resulting in the loss of many dependent animal species. This area is relatively species poor when compared with other vegetation communities.

From a sensitivity perspective, the following can be noted regarding the disturbed forest community:

- This variation is considered secondary forest vegetation;
- The vegetation of the area is, historically or recently, moderately disturbed;
- Moderate species diversity;
- Floristic status of this variation is moderate;
- Suitability of habitat for Red Data flora and fauna species is moderate to low;
- Significance of impacts on this vegetation community will be moderate to low on a local scale and low on a regional scale;
- Ecological function of this community is moderate; and
- The Conservation importance of this community is moderate.

### *Transformed vegetation community*

Transformed vegetation communities occur wherever human activities have cleared natural vegetation or impacted upon for long periods of time. Currently the single largest cause of transformation of natural vegetation occurs due to artisanal mining activities taking place along the Marvoe Creek and into the surrounding forest areas. Other causes of vegetation transformation are the creation of cut lines for mining exploration and the building of roads by BMMC.

From a species composition point of view, these areas are cleared of natural vegetation and kept clear, thus they are quickly colonised by exotic species. The most notable of these species are, *inter alia*, *Bidens pilosa, Cirsium vulgare, Xanthium strumarium, Datura ferox, Mimosa pudica, Mimosa pigra, Solanum terminale* and *Verbena bonariensis*.

Some indigenous grass species, such as *Olyra latifolia, Panicum laxum, Acroceras gabunense, Centotheca lappacea, Setaria megaphylla* and *Streptogyna crinite*, also occur in these areas, due to the increase light after the clearing of the woody species in the area. These areas also sustain large amounts of human traffic which further facilitate the spread of exotic species and further reduce indigenous species.

From a sensitivity perspective, the following can be noted regarding the transformed vegetation community:

- This variation is characterised as transformed vegetation;
- The vegetation of the area is severely degraded;
- Low species diversity;
- Floristic status of this variation is low;
- Suitability of habitat for Red Data flora and faunal species is low;
- Likely impacts on the vegetation will be insignificant on a local to regional scale;
- Ecological function of this community is low; an
- The Conservation importance of this community is low.

Figure 25 shows the vegetation communities in the NLGM Project area.

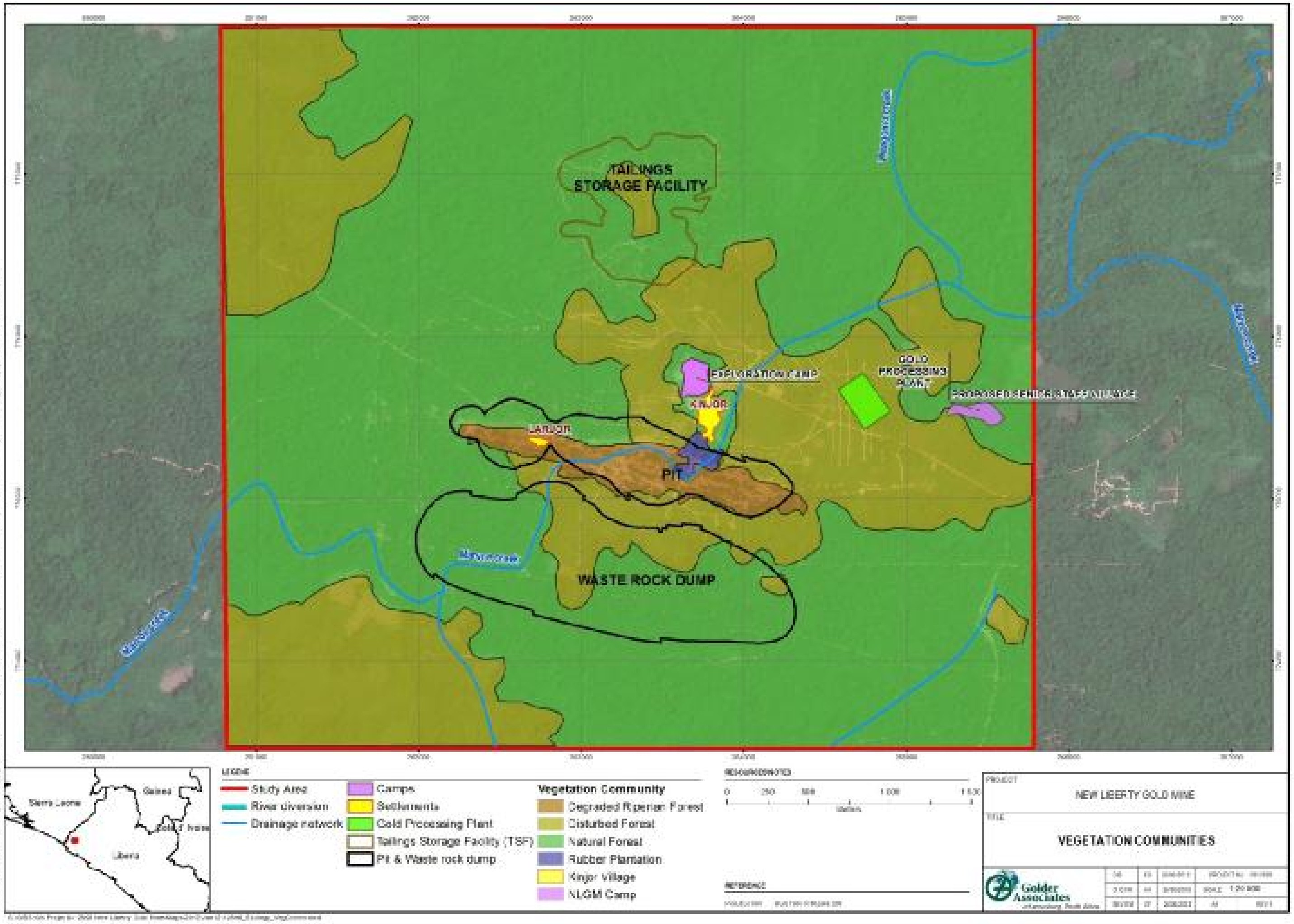


*Figure 25: Vegetation communities in the NLGM Project area*

### *4.2.1.3 Flora species of importance*

During the surveys two Red Data floral species were recorded *Anopyxis klaineana* and *Raphia palma-pinus*. Both species were found within the natural forest areas and are unlikely to occur outside of this vegetation type.

Table 36 below shows the Red Data floral species that were recorded in the NLGM Project area during the terrestrial ecology surveys.

**Table 36: Red Data floral species that may occur in the Project area**

| Colloquial Name | Scientific Name | Group | Status | Probability of Occurrence |
|---|---|---|---|---|
| | *Anopyxis klaineana* | Plantae | VU | Recorded |
| Raphia palm | *Raphia palma-pinus* | Plantae | DD | Recorded |

### *4.2.1.4 Recorded Faunal Species*

#### Arthropoda

Arthropod diversity within the study area was recorded as being high. A total of 216 arthropod species were recorded during the study. Most species were found in the disturbed forest community (98) and in the transformed vegetation community areas (69). The natural forest had surprisingly few arthropod species (37). Common species recorded included *Acrotylus longipes, Calephorus comprisicornis, Gryllotalpa africana Thrips* spp., *Cueta* sp, *Distoleon (bantyutus) lynx, Crocidolomia binotalis, Maruca testulalis, Mymphula depunctalis, Sylepta derogate, Caenides dacela, Papilio demodocus, Dixeia orbona, Eurema b. brigitta, Eurema hapale, Eurema hecabe solifera, Danaus c. chrysippus* form *alcippus, Theretra jugurtha, Theretra perkeo, Anopheles* spp., *Culex* spp.and *Apis mellifera*. Large numbers of lepidoptera species were recorded in the NLGM camp at night accompanied by large numbers of centaurus beetles, *Augosoma centaurus.* The centaurus beetles were collected by local people in the mornings, who utilise them as a food source. None of the species recorded were classified as Red Data species, although a number of specimens and photos were sent to experts for final identification and some of these have not yet been identified.

#### Herpetofauna (Reptiles)

The herpetofauna of the region can be classified as having low to moderate diversity, of the 95 reptile species recorded in Liberia, 16 species were recorded during the 20010/11 surveys. The species recorded are *Kinixys belliana, Crotaphopeltis hotamboeia, Thelotornis kirtlandi, Dasypeltis fasciata, Lycophidion irroratum, Philothamnus semivariegatus, Bitis arietans, Bitis nasicornis, Dendroaspis viridis, Naja nigricollis, Pseudohaje nigra, Varanus niloticus, Varanus ornatus, Hemidactylus angulatus, Agama agama* and *Hemidactylus fasciatus* Although the area shows moderate herpetofaunal species diversity, abundances for all species are low possibly due to hunting and persecution by the local inhabitants. A number of herpetofaunal species are utilized by the local community and are consumed locally or in other areas due to the bushmeat trade. Of the 16 herpetofaunal species recorded during the surveys, none are classified as Red Data species. The status of *Bitis nasicornis* is in question though and although it is not currently on the IUCN list for the area it is currently under revision and may be listed as vulnerable in the near future.

#### Amphibia

The region can be classified as having low - moderate amphibian diversity, of the 60 amphibian species recorded in LIberia, 6 species were recorded during the 2010 &11 surveys. The species recorded are *Amietophrynus maculates, Amietophrynus regularis, Afrixalus dorsalis, Phrynobatrachus natalensis, Xenopus tropicalis and Ptychadena mascareniensis*. Although the area shows low to moderate amphibian species diversity, abundances for most species are high in the wet season with a slight decline in the dry season. The fact that night surveys were not allowed during the visit also hampered the study on this taxon and more species are expected in the area. Amphibian species do not appear to be utilized by the local community for food, although some species are said to have superstitious importance or medicinal uses. Of the 6 herpetofaunal species recorded during the surveys, none are listed on the IUCN Red data list for the area.

## Aveifauna

The avifauna of the region is moderately diverse with 331 species known to occur in the study area. These species include *Anas clypeata, Indicator indicator, Pogoniulus chrysoconus, Ispidina picta, Halcyon leucocephala, Merops hirundineus, Cuculus solitarius, Apus affinis, Scotopelia peli, Caprimulgus climacurus, Turtur brehmeri, Ardeotis arabs, Gallinula chloropus, Calidris temminckii, Sterna paradisaea, Accipiter erythropus, Gyps rueppellii, Haliaeetus vocifer, Plegadis falcinellus, Threskiornis aethiopicus, Hirundo cucullata, Cisticola melanura, Nectarinia rockefelleri, Nectarinia rubescens, Malimbus malimbicus, Vidua regia* and *Emberiza impetuani* just to name a few. The study area for this project is however, much lower in species diversity with an estimated 331 species occurring in the area. Hunting in the forest areas and along the numerous roads and cut-lines in the forests have caused the bird species in the area to be shy of humans. This, together with the fact that visibility of the birds in the canopy and against the sky is limited, made bird identification during the study difficult.

One Red Data avifaunal species was recorded in the study area during the 20010/11 surveys, namely the African Grey Parrot (*Psittacus erithacus timneh*) (Figure 26). This species was recorded in the area of the proposed NLGM mine site and is currently listed as Near Threatened (NT) on the IUCN Red Data List (IUCN, 2011).

*Figure 26: African Grey Parrot (Psittacus erithacus timneh)*

## Mammalia

Mammal species diversity was very low in the study area due to hunting for the bushmeat trade. Hunters were regularly seen or heard during the surveys often with animals ranging from snakes to monkeys. This not only reduces the number of animals and species in the area, but also causes the remaining animals to be shy of humans, which in turn makes accurate surveillance of species occurring in the area difficult.

Of the 85 mammal species known to occur in the Project area, 10 species were recorded during the 20010/11 ecology surveys. The species recorded in the study area are *Aonyx capensis, Atherurus africanus, Cercopithecus petaurista, Phataginus tricuspis (NT), Piliocolobus badius, Dendromus melanotis, Tatera brantsii, Acomys spinosissimus, Rhabdomys pumilio* and *Mastomys natalensis.* Of the recorded species, the Three-cusped Pangolin (*Phataginus tricuspids),* is currently listed on the IUCN Red Data list (IUCN, 2011).

Hunting for the bushmeat trade is a major threat to the larger animal species, although the forest stands are quite impenetrable. The opened up areas as a result of BMMC's exploration activities, as well as roads constructed for the purpose of exploration, are used by hunters as avenues through which to gain access to the forest areas which would have otherwise been difficult to access.

*Figure 27: Three-cusped Pangolin (Phataginus tricuspis)*

### *4.2.1.5 Red Data Faunal Species*

Red Data faunal species that ***may potentially occur*** in the area are listed in Table 37. A total of 43 Red Data faunal species may potentially occur in the Project area, according to the IUCN Red Data list. Some of the animals listed are believed to be locally extinct and suitable habitat for others is not available.

**Table 37: Red Data fauna species that may potentially occur in the Project area**

| Colloquial Name | Scientific Name | Group | Status | Probability of Occurrence |
|---|---|---|---|---|
| African True Toad | *Amietophrynus taiensis* | Amphibia | CR | Low |
| Allen's River Frog | *Phrynobatrachus alleni* | Amphibia | NT | Low |
| Allen's Slippery Frog | *Conraua alleni* | Amphibia | VU | Low |
| Big-eyed Forest Treefrog | *Leptopelis macrotis* | Amphibia | NT | Moderate |
| Cochran's Running Frog | *Kassina cochranae* | Amphibia | NT | Low |
| Guinea River Frog | *Phrynobatrachus guineensis* | Amphibia | NT | Low |
| Liberia River Frog | *Phrynobatrachus liberiensis* | Amphibia | NT | Moderate |
| Sierra Leone Reed Frog | *Hyperolius chlorosteus* | Amphibia | NT | Moderate |
| Sierra Leone Water Frog | *Petropedetes natator* | Amphibia | NT | Low |
| Tai River Frog | *Phrynobatrachus phyllophilus* | Amphibia | NT | Low |
| Togo Toad | *Amietophrynus togoensis* | Amphibia | NT | Low |

| Colloquial Name | Scientific Name | Group | Status | Probability of Occurrence |
|---|---|---|---|---|
| African Grey Parrot | *Psittacus erithacus* | Aves | NT | Recorded |
| African Skimmer | *Rynchops flavirostris* | Aves | NT | Low |
| Black-headed Rufous Warbler | *Bathmocercus cerviniventris* | Aves | NT | Moderate |
| Black-tailed Godwit | *Limosa limosa* | Aves | NT | Low |
| Brown-cheeked Hornbill | *Bycanistes cylindricus* | Aves | NT | Low |
| Copper-tailed Glossy-starling | *Lamprotornis cupreocauda* | Aves | NT | High |
| Eurasian Peregrine Falcon | *Falco peregrinus peregrinus* | Aves | VU | High |
| Gola Malimbe | *Malimbus ballmanni* | Aves | EN | Low |
| Green-tailed Bristlebill | *Bleda eximius* | Aves | VU | Moderate |
| Lagden's Bush-shrike | *Malaconotus lagdeni* | Aves | NT | Moderate |
| Lesser Kestrel | *Falco naumanni* | Aves | VU | High |
| Liberian Greenbul | *Phyllastrephus leucolepis* | Aves | CR | Low |
| Red-fronted Antpecker | *Parmoptila rubrifrons* | Aves | NT | Moderate |
| Rufous Fishing-owl | *Scotopelia ussheri* | Aves | EN | Low |
| Rufous-winged Illadopsis | *Illadopsis rufescens* | Aves | NT | Low |
| Western Wattled Cuckooshrike | *Campephaga lobata* | Aves | VU | Moderate |
| White-eyed Prinia | *Prinia leontica* | Aves | VU | High |
| Yellow-bearded Greenbul | *Criniger olivaceus* | Aves | VU | Moderate |
| Yellow-casqued Wattled Hornbill | *Ceratogymna elata* | Aves | NT | Low |
| Hooded Vulture | *Necrosyrtes monachus* | Aves | EN | Low |
| | *Phyllomacromia funicularioides* | Insecta | NT | Low |
| | *Phyllomacromia occidentalis* | Insecta | DD | Low |
| | *Agriocnemis angustirami* | Insecta | VU | Low |
| | *Sapho infumosa* | Insecta | NT | Low |
| African Golden Cat | *Caracal aurata* | Mammalia | NT | High |
| **African Three-cusped Pangolin** | ***Phataginus tricuspis*** | **Mammalia** | **NT** | **Recorded** |
| Bongo | *Tragelaphus eurycerus* | Mammalia | NT | High |
| Bourlon's Genet | *Genetta bourloni* | Mammalia | NT | Low |
| Dark-brown Serotine | *Pipistrellus brunneus* | Mammalia | NT | Low |
| Diana Monkey | *Cercopithecus diana* | Mammalia | VU | Moderate |
| Giant Ground Pangolin | *Smutsia gigantea* | Mammalia | NT | Moderate |
| Guinean Horseshoe Bat | *Rhinolophus guineensis* | Mammalia | VU | Moderate |
| Jentink's Duiker | *Cephalophus jentinki* | Mammalia | EN | Low |
| Jones' Roundleaf Bat | *Hipposideros jonesi* | Mammalia | NT | Low |
| King Colobus | *Colobus polykomos* | Mammalia | VU | High |

| Colloquial Name | Scientific Name | Group | Status | Probability of Occurrence |
|---|---|---|---|---|
| Leopard | *Panthera pardus* | Mammalia | VU | Moderate |
| Liberian Mongoose | *Liberiictis kuhni* | Mammalia | VU | Moderate |
| Olive Colobus | *Procolobus verus* | Mammalia | NT | Low |
| Pygmy Hippopotamus | *Choeropsis liberiensis* | Mammalia | EN | Low |
| Sooty Mangabey | *Cercocebus atys* | Mammalia | VU | Low |
| Straw-coloured Fruit Bat | *Eidolon helvum* | Mammalia | NT | Low |
| West African Red Colobus | *Colobus badius* | Mammalia | EN | High |
| Zebra Duiker | *Cephalophus zebra* | Mammalia | VU | Low |
| African Slender-snouted Crocodile | *Crocodylus cataphractus* | Reptilia | EN | Low |
| Dwarf Crocodile | *Osteolaemus tetraspis* | Reptilia | VU | Moderate |
| Home's Hinge-back Tortoise | *Kinixys homeana* | Reptilia | EN | Low |

#### *4.2.1.6 Ecological Integrity*

The ecological function of the area can generally be described as high for the majority of the Project area, although this does vary from low (in the highly transformed areas due to slash and burn cropping techniques) to high in the more inaccessible areas. Areas in which prospecting and slash and burn farming has taken place, as well as areas in which settlements have been established are considered as areas where ecological function is reduced. The ecological function of the Project area is indicated in Figure 28.

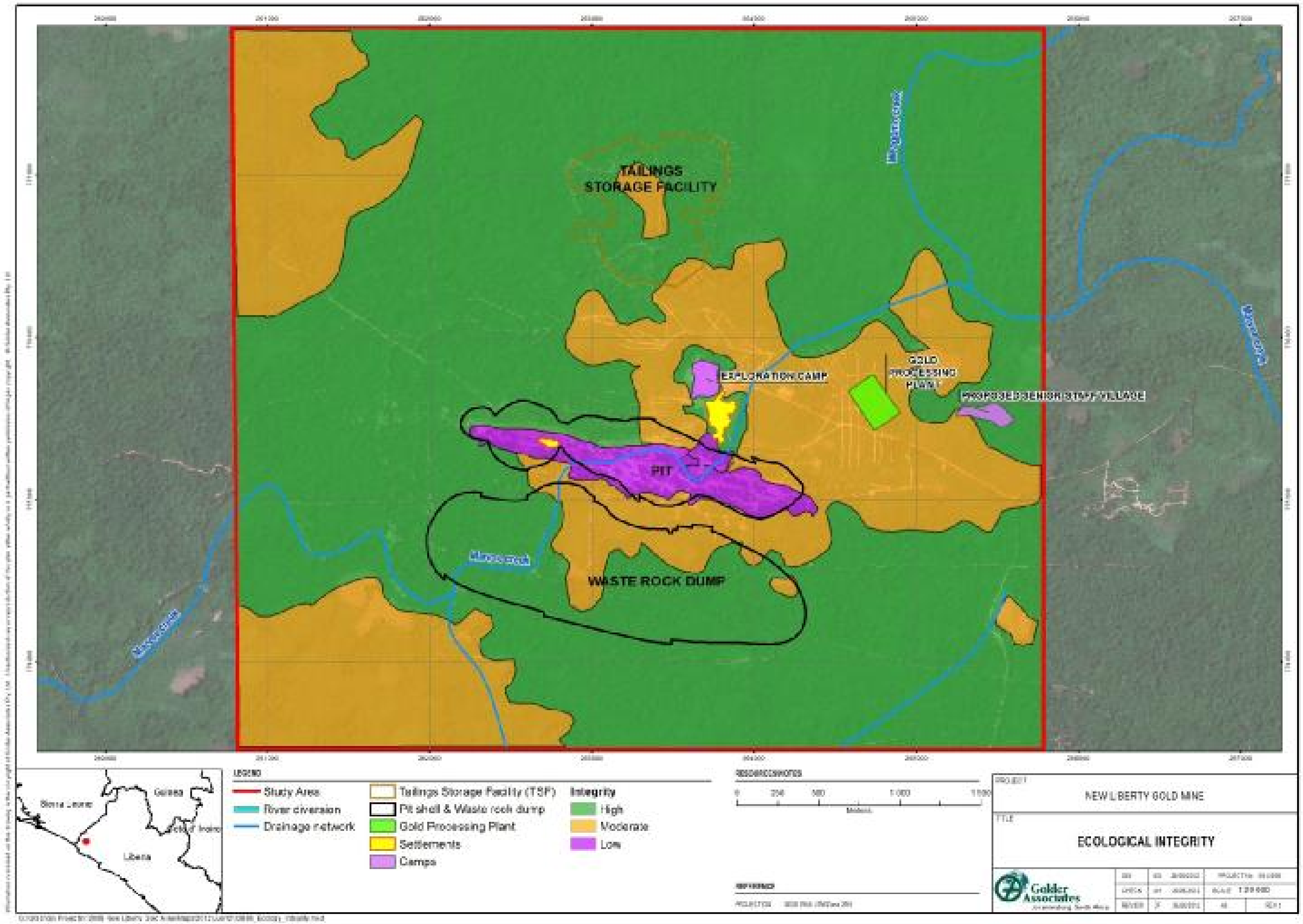


*Figure 28: Ecological integrity within the study area*

### 4.2.2 Aquatic Ecology

In November 2010 and April 2011 aquatic ecology surveys were conducted at the NLGM site. The baseline aquatic ecology surveys included an assessment of *in situ* water quality, general habitat parameters, integrated habitat availability, diatom analysis, ichthyofaunal species diversity and aquatic macro-invertebrate composition.

The objectives of the baseline characterisation included the following:

- Characterization of the aquatic ecosystems associated with the New Liberty Gold Mine project;
- Investigation of the possible occurrence of Red Data fish species in the aquatic ecosystems;
- In order to aid in the interpretation of the biological data, the following was assessed:
  - *In situ* water quality;
  - General Habitat Assessment;
  - Invertebrate Habitat Assessment System (IHAS, *version 2*);
  - Diatom analysis;
  - Aquatic Macro-invertebrates;
  - Fish Species Diversity and Abundance; and
- Identification of areas of particular sensitivity or existing impacts.

Figure 29 shows the aquatic biomonitoring study sites on the Marvoe Creek.

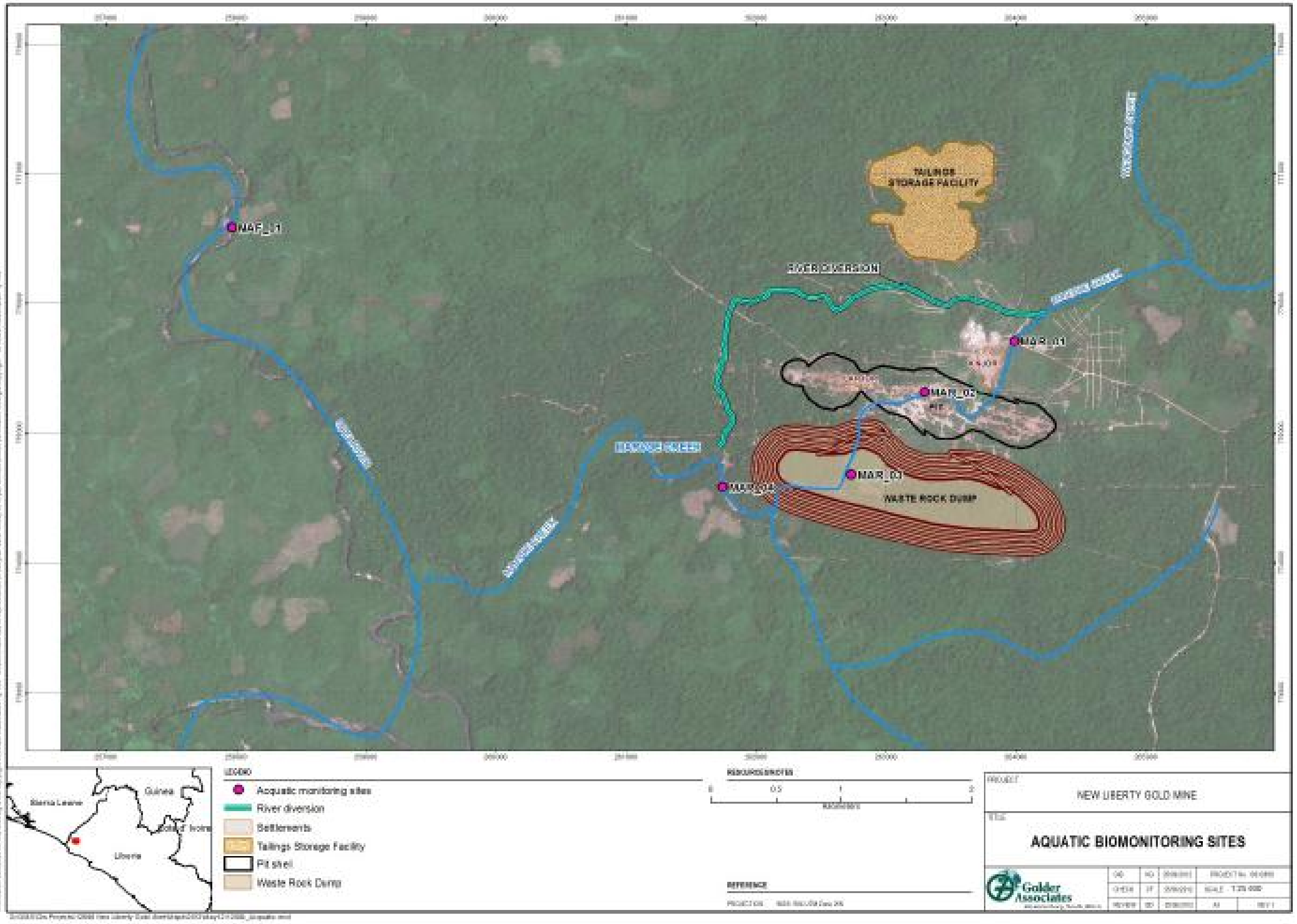


*Figure 29: Aquatic biomonitoring sites on the Marvoe Creek*

The following conclusions were reached based on the results of the baseline characterisation of aquatic ecosystems:

- *In situ* water quality was good during both surveys with the exception of the Dissolved Oxygen (DO) concentration which may have had a limiting effect during the April 2011 survey. (Refer to the surface water baseline description for further information on water quality);
- It was noted during both surveys that turbidity levels in Marvoe Creek decrease during the night and increase steadily during the day due as artisanal mining activities increase. In the medium to long term increased turbidity levels associated with artisanal mining activities can be expected to have a limiting effect on biodiversity in the Marvoe Creek;
- Based on the IHAS results habitat availability and stream condition had a limiting effect on all the sites in the Marvoe Creek except MAR_01. Extensive modification of the instream and riparian habitats by artisanal miners contributed to the poor IHAS results. This was clearly evident at sites MAR_02 and MAR_03 where artisanal mining activities have reduced the instream habitat to a homogenous sandy substrate which doesn't provide any cover for benthic fauna;
- The high percentage contribution (> 30%) of Ephemeroptera, Trichoptera and Plecoptera (EPT taxa) to the overall invertebrate assemblage at sites MAR_01, MAR_04 and MAF_01 indicates that biotic integrity remains high at these sites despite the impacts of artisanal miners upstream of site MAR_04. No EPT taxa were recorded at site MAR_03;
- Based on Margalef's Richness Index the highest aquatic macroinvertebrate taxa richness was recorded at site MAR_01 during the April 2011 survey and the lowest at site MAR_03 during the same survey. The relatively low levels of taxa richness measured at site MAR_03 during both surveys can be attributed to the extensive habitat modification and resultant poor habitat availability associated with artisanal mining activities;
- The cluster analysis and NMDS ordination of quantitative aquatic macro-invertebrate data revealed the important influence of the following factors on aquatic macro-invertebrate community structure:
  - Seasonal variation;
  - Geographical location; and
  - Degree of anthropogenic impact.
- A total of 17 fish species were recorded in the sample area during the November 2010 survey (0 to 8 species per site).The highest fish species diversity (n = 8) was recorded at site MAR_01 upstream of the artisanal mining activities. No fish were recorded at site MAR_02 in the midst of the most intensive artisanal mining activities; both the instream and riparian habitats at this site have been critically modified;
- One Red Data fish species was recorded during the November 2010 survey namely *Malapterurus stiassnyae cf.* (Electric catfish) which is currently listed as Near Threatened (NT) by the IUCN's Red List of Threatened Species (IUCN, 2011). Threats to this species include agricultural activities resulting in deforestation as well as mining and urban development that threaten instream and riparian habitats;
- A total of 18 fish species were recorded in the project area during the April 2011 survey (4 to 8 species per site). The highest diversity (n = 8) was recorded at site MAR_04 in the lower reaches of the Marvoe Creek and downstream of the majority of the artisanal mining activities. The lowest abundance and diversity (n = 5) in the Marvoe Creek was recorded at site MAR_03, a site which is characterised by extensive modification of instream habitats by past and current artisanal mining activities;
- Two Red Listed fish species were recorded during the April 2011 survey namely *Doumea chappuisi* which is listed as Vulnerable and *Malapterurus stiassnyae* which is listed as Near Threatened;

- *D. chappuisi* has a fragmented distribution with populations in Côte d'Ivoire, Guinea, Guinea-Bissau and Liberia. A taxon is classified as Vulnerable when according to the best available evidence it is considered to be facing a high risk of extinction in the wild. The species is threatened by deforestation, agricultural developments and any impacts that contribute to increased sedimentation of fast flowing riffle and rapid habitats;
- *Sicydium crenilabrum cf.* is a small member of the Gobiidae family that was recorded at site MAR_04 in the Marvoe Creek during the April 2011 survey. Its known distributional range extends from Côte d'Ivoire to the Democratic Republic of the Congo. The current record represents a substantial range extension of this species and may represent the 1$^{st}$ record of this species from Liberia;
- The diatom results indicated clean, highly oxygenated, oligotrophic conditions in the upper reaches of the Marvoe Creek and the Mafa River. Based on the diatom results ecological water quality in the upper reaches of the Marvoe Creek and Mafa River was placed in category A (high quality); and
- Further downstream in the Marvoe Creek the diatom results indicated a slight increase in electrolyte and inorganic nutrient concentrations. Ecological water quality in the middle and lower reaches of the Marvoe Creek remained in a category B (good quality) despite the impacts of artisanal miners.

### 4.2.3 Protected Areas

No designated protected areas are located within the Project area (Figure 30).

As illustrated, the closest protected areas to the Project are as follows:

- Gola East Forest Reserve, Sierra Leone, approximately 45 km northwest of the Project;
- Un-named forest reserves, Sierra Leone, approximately 32 km west of the Project;
- Cape Mount Nature Conservation Unit, Liberia, approximately 30 km southwest of the Project;
- Gola National Forest, Liberia, approximately 45 km northeast of the Project; and
- Kpelle National Forest, Liberia, approximately 55 km northwest of the Project.

There are thus no protected areas that are close to the NLGM Project site; the closest is approximately 30 km to the southwest, downstream of the site.

In terms of wetlands of international importance, the wetland area of Lake Piso (near Robertsport), located approximately 30 km south of the Project area, downstream, has been identified as a RAMSAR Wetland. Figure 31 shows the Lake Piso RAMSAR wetland area in relation to the NLGM Project site.

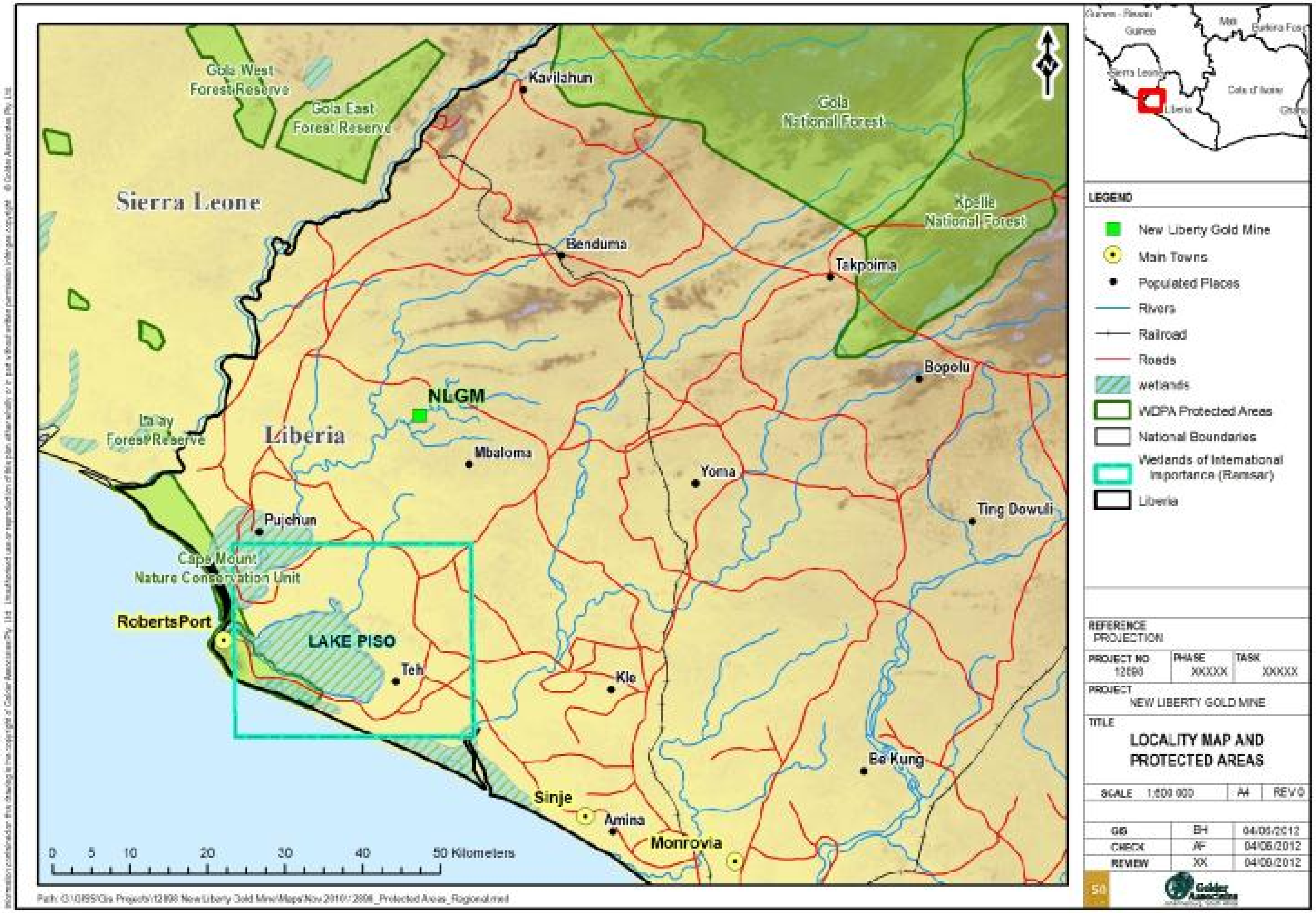


*Figure 30: Protected Areas surrounding Project area*

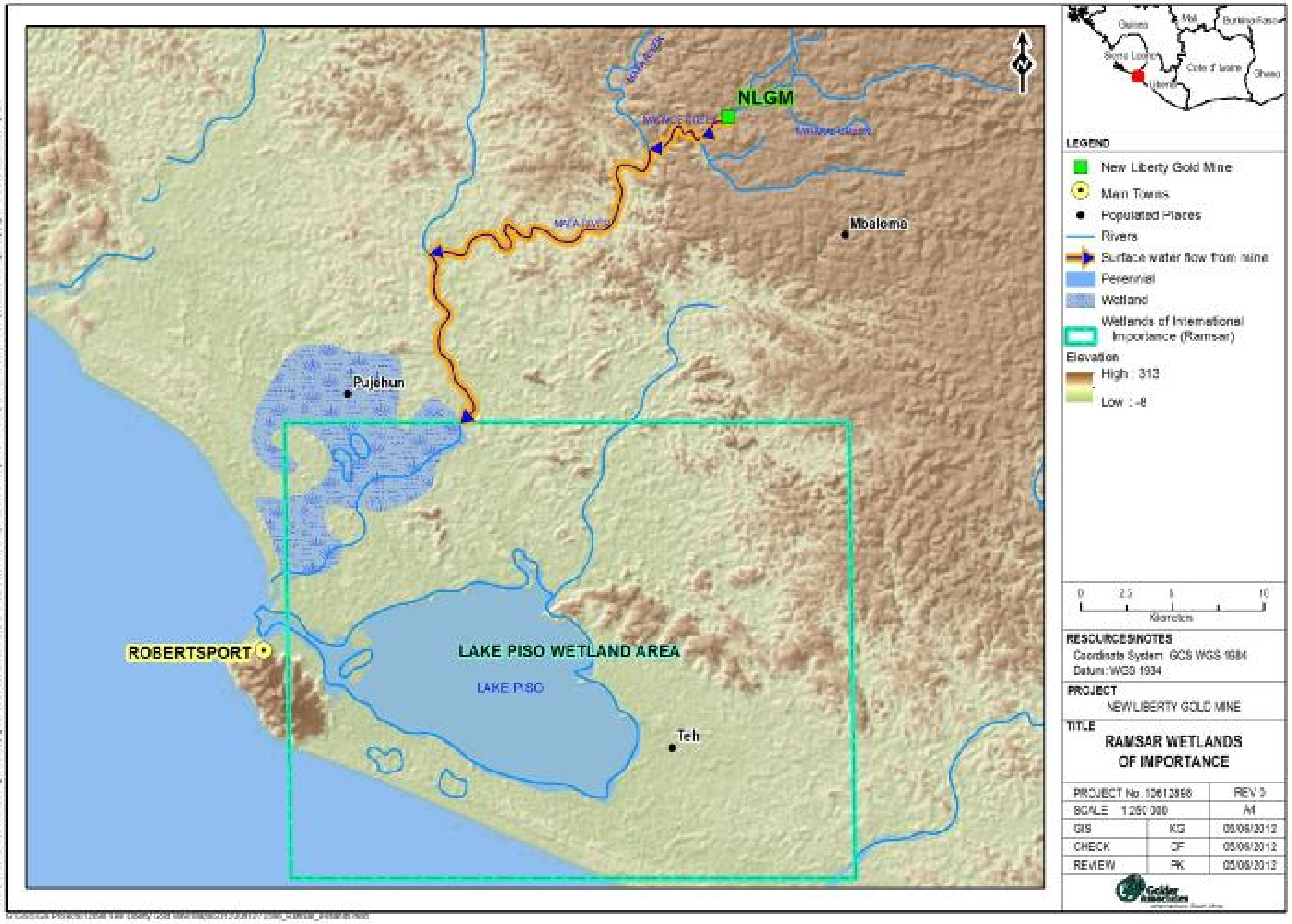


*Figure 31: The Lake Piso RAMSAR Wetland area in relation to the Project area*

## 4.3 Human Environment

### 4.3.1 Socio-economic

Liberia has an approximate population of 3.9 million people. Liberians experienced a long period of conflict from 1989 which had immense social, political, and humanitarian implications. After a series of peace talks the Comprehensive Peace Agreement was signed in 2003 and the country stabilized, beginning the process of rehabilitating its land, systems and people. Hospitals, schools and roads are undergoing reconstruction and the damaged economy is being rebuilt; natural resources including iron ore, diamonds, gold, timber and extensive rubber plantations are an important part of the envisaged growth and development.

A comprehensive social baseline survey was conducted as part of the socio-economic impact assessment (SIA) during the EIA. A preliminary site visit to the project area was conducted in August 2010. Primary data collection was subsequently undertaken during March and April 2011. This included the collection of baseline demographic and socio-economic information through a standardised survey focusing on household composition, education levels, general health status, livelihood strategies, employment, and income and expenditure. In light of potential resettlement requirements, the survey took the form of a census in villages of Kinjor and Larjor (a requirement of the IFC's Performance Standard 5 for population displacement), and a sample survey in surrounding villages of Jikandou, Jawajei, Zolu, Bayima and Mono. A survey of businesses was also undertaken in Daniels Town and Sinjé, the closest towns to the project site, to gain insight into local economic opportunities and the availability of goods and services.

Qualitative research was undertaken to compliment the quantitative data collection and gain contextual understanding of the social environment and deeper meaning of observed daily practices. This took the form of five focus group discussions, three held in Kinjor separated into male and female groups, and mixed sex discussion groups in Jawajei and Janeh Brown, and key informant interviews with artisanal miners and community members. Discussions centred on the origins and movements of the local population, the life of miners; contrasts between artisanal mining and BMMC opportunities, administrative and hierarchical systems within the community, land ownership, and social concerns in relation to the proposed development. Informal stakeholder interviews were also held with the District Commissioner and county administration representatives.

Five fieldworkers (residents of Kinjor) were trained and deployed to administer the survey questionnaire, assist with facilitation and translation during focus group discussions and interviews, and undertake qualitative research at household level into topics such as daily diets. Quality control measures were put in place to monitor the data collection process with regular checking of surveys and household numbering. Data was captured offsite into an MS Access database, analysed, and then used to describe and interpret the socio-economic and cultural environment for the project affected areas.

The Project area is surrounded by a number of small, agricultural villages and an artisanal mining community spread across the villages of Kinjor and the smaller Larjor. Communities have not escaped the conflicts of the civil war, nor the disruption to infrastructure and services, population displacement, and resulting poverty. Many left the established older villages in the area for a time, only returning in the last five years to reclaim and rebuild their homesteads and land. Damages to previously existing infrastructure and loss of subsistence patterns of life have impacted the potential to regain former livelihoods. The lack of development or job opportunities has encouraged many of the younger generation to leave agricultural-based villages in search of better education and livelihood opportunities, often in Monrovia. According to residents in Jawajei, a significant proportion of households moved to Monrovia during and prior to the war and have not returned, reducing the former town to a small village.

Mining prospects however, have had the greatest impact on the immediate area, both artisanal mining and exploration activities of BMMC. The area surrounding the proposed mining site originally consisted of dense forest areas and small, rural villages supported by agricultural activities. Artisanal miners are thought to have entered the area in the 1960s, and residents of Kinjor told the team that the town was established in 1970.

The villages of Larjor and Kinjor have developed considerably in the last 10 – 12 years with the establishment of BMMC's mine camp in 1998, attracting families with potential opportunities for formal and informal employment, and with ongoing artisanal mining prospects. Kinjor has experienced significant growth, with many households moving in over the last 6 - 7 years. More recently, a large proportion of households in Larjor have migrated to Kinjor, attracted by the employment opportunities of BMMC and the services Kinjor has to offer.

Mining developments have assisted the recovery from the effects of civil war with a subsequent emergence of two villages established around artisanal mining activities, Kinjor and Larjor, and the subsistence communities of the surrounding villages. Households in these latter villages have access to agricultural land, comprising some 6125 acres extending from the village of Jeneh Brown to the Mafa River. Land customarily owned by families in these villages was transferred to the Marvoe Development Association (MDA) in 1978 under the new deeds system. The development association was then officially initiated in 1996 to protect this land. The oldest customary landowners established the villages of Jawajei, then Jeneh Brown, Deyhalin and Blang approximately 15km to 20km away from the Project site. Elders of these villages were responsible for distributing land to ‘visitors’ who established Jikandou, approximately 3km south west of the site, Mono, Zolu and Bayima between 5km and 10km along the road leading away from the site, and later to the villages of Kinjor and Larjor.

#### *4.3.1.1 Household Demographics*

Households have an average of eight members, 47 percent of whom are female, 53 percent of whom are male. Gender distribution varies amongst villages, presenting some anomalies in Jikandou and Zolu, potentially due to small sample sizes. However, in many cases, young males have left subsistence agricultural villages in search of employment opportunities, either locally in Kinjor, or further afield, leaving females and the older generation at the homestead. The male population in the age category of 18 – 55 years is especially high in the mining villages and household heads are up to 20 years younger in the villages than in agricultural villages of Jawajei and Zolu.

#### *4.3.1.2 Housing and Services*

Although demographic and livelihood differences can be seen between households in mining and agricultural villages, the service deficiencies and dependence of natural resources is a common theme throughout. Structures within the project area reflect this dependence on natural, local resources and the lack of access to or ability to purchase external, more durable, man-made construction materials. Structures predominantly have walls made from mud, reeds and poles and roofs of thatch, and as such require frequent maintenance and upkeep, with the majority of structures being less than 10 years old. The average age of structures also reflects the country’s history of conflict as many structures needed re-building following the civil war.

Households own an average of 1.5 structures, often separated according to purpose. Approximately 30 percent of the total survey population also own structures to keep livestock. Homesteads in agricultural villages tend to own more structures than those in the mining villages, more frequently having stronger, zinc roofs.

As seen across Liberia, energy needs are largely serviced by natural available resources, primarily by wood or charcoal. Differences between mining and agricultural villages are apparent: charcoal, a cash commodity, is more frequently used in mining villages dependent on a cash-economy, whereas all households in agricultural villages with subsistence economies rely on locally gathered firewood.

The absence of services and development in rural communities is noticed in the lack of safe drinking water in many villages, leaving residents reliant on streams and rivers for water supply. The impact of BMMC can be seen in the water pumps they have installed in Kinjor, Jikandou, Jawajei and Mono villages. However, less than 20 percent of households in Mono use the water pump. Larjor is dependent on the water pump in Kinjor, and although one or two households indicated using this, the distance between the villages means the majority rely on natural resources, as do households in Bayima and Zolu.

#### *4.3.1.3 Agriculture and Household Nutrition*

Dependence on natural resources extends to a large extent to food supply, although more so in agricultural villages than mining ones. Whilst farming is the basis of livelihoods in many of the older villages, forming ‘a whole year business’ and supplying the majority of food supplies, a far lesser number of households in Kinjor and Larjor have access to farming land. Households in mining villages more commonly purchase food either from surrounding farmers or from Monrovia. Fields are cultivated on an annual basis, with a plot of land being cleared most years on a rotational basis. Clearing land is an arduous process, often taking up to two months, using hired labour to cut trees with a hand saw, before burning the secondary growth before preparing the cleared land for cultivation.

Crops are grown for household consumption and as cash crops (sold to local artisanal mining villages). The most common crop grown is the staple cassava, planted by approximately one quarter of households, followed by rice and chilli pepper. Okra, yams, beans, greens and eggplant are grown by approximately 10 percent of households and a few households also have crops such as bananas, pineapples, plantains, tomatoes, potatoes and bitterballs.

Natural resources such as wild fruit, mushrooms and herbs may supplement meals. These are collected by individual households although some individuals in Jawajei, Jikandou and Mono hunt wild animals to sell for bushmeat.

#### *4.3.1.4 Health*

Access restrictions to safe drinking water and insufficient fulfilment of nutritional requirements have a significant influence on the health status of the local population. This is further exacerbated by the shortage of medical facilities within the project area. There is a midwife in Kinjor who treats local women, and many households buy medicine from Monrovia for self-medication. However, the nearest clinic on foot from Kinjor is Kpeneje Clinic, established in August 2010, approximately 15km away and consequently too far for many households without transport. The clinic deals mainly with malaria and STIs, and attends to approximately 75 patients each day. A larger clinic is based in Sinjé, and is the closest by road. BMMC are also in the process of constructing a clinic at the mine site, although availability of this facility to the local population is as yet unknown.

Malaria is the most common illness, affecting at least one household member in 95 percent of households in the last 12 months (February 2010 – February 2011). Respiratory illnesses were also reported by 23 percent of households. Although malaria is undoubtedly common, the distance to any clinic and lack of available transport suggests that many households are unable to visit a doctor and obtain tests for illnesses, instead self-diagnosing and medicating in times of poor health. Table X below shows the incidence of Illnesses in surrounding communities (February 2010 – February 2011), which was obtained during the social baseline surveys.

**Table 38: Incidence of Illnesses in surrounding communities (February 2010 – February 2011)**

| Illness | Bayima | Jawajei | Jikandou | Kinjor | Larjor | Mono | Zolu | Total Population |
|---|---|---|---|---|---|---|---|---|
| TB | 0% | 10% | 0% | 1% | 0% | 0% | 0% | **2%** |
| Malaria | 100% | 95% | 100% | 95% | 100% | 89% | 100% | **95%** |
| Skin rash | 100% | 14% | 0% | 12% | 17% | 15% | 0% | **13%** |
| Diarrhea | 100% | 29% | 0% | 10% | 0% | 7% | 0% | **12%** |
| Bilharzia | 0% | 0% | 0% | 1% | 0% | 0% | 0% | **1%** |
| Typhoid | 0% | 14% | 0% | 11% | 17% | 41% | 0% | **15%** |
| Cholera | 100% | 14% | 0% | 11% | 0% | 7% | 0% | **11%** |
| Respiratory Illness | 100% | 14% | 100% | 15% | 33% | 33% | 50% | **23%** |

#### *4.3.1.5 Education*

Despite government and NGO efforts to improve primary education across Liberia, access to educational facilities remains a challenge in the rural project area. Financial support of infrastructure, basic teaching resources, and teacher's salaries are limited. BMMC have been financing two teachers' salaries in Kinjor, allowing a small primary school to operate. This school is a rudimentary structure teaching approximately 150 pupils from Kinjor, Larjor and Jikandou in two classrooms. Another 30 children ranging between 4 and 12 years of age are also taught by a teacher in Jawajei village community hall.

Approximately 68 percent of the population aged 5 – 18 years are in school, predominantly at primary level. However, the distance from many of the more remote, agricultural villages to educational facilities means primary school attendance is often low. Children not in school remain at the homestead assisting with household tasks. In addition, a reported 2 percent of children in Kinjor are involved in artisanal mining. The distance from villages surrounding the Project area to secondary education in Sinje means only 7 percent of children attend school beyond primary level.

Educational attainment for population over 18 years of age is low; 53 percent of adults have no education and only 10 percent have completed secondary school. Educational attainment amongst adults is also dependent on the proximity of households to schools, with differences between mining and agricultural villages again being reflected.

#### *4.3.1.6 Livelihood Strategies*

Educational limitations restrict the potential for the local population to occupy employment positions. However, although opportunities with BMMC are predominantly informal, temporary labour roles, confined to exploration and development of the camp, these have had a significant impact on the local area, as seen from the demographic differences between villages, and levels of health, nutrition, education and service delivery. Approximately three percent of the population has formal employment and a further 18 percent are informally employed. Employment levels, both formal and informal, are highest in Kinjor, where 27 percent of the population over the age of 18 are employed, most commonly as casual labourers, security and masonry personnel.

Table 39below shows the employment status of the population over 18 years.

**Table 39: Employment Status of Population Over 18 Years**

| | Bayima | Jawajei | Jikandou | Kinjor | Larjor | Mono | Zolu | Total Population |
|---|---|---|---|---|---|---|---|---|
| Student | 0% | 2% | 0% | 7% | 8% | 18% | 0% | **8%** |
| Self employed | 50% | 27% | 100% | 10% | 0% | 43% | 67% | **21%** |
| Artisanal miner | 0% | 2% | 0% | 21% | 64% | 0% | 0% | **16%** |
| Employed | 0% | 2% | 0% | 3% | 0% | 3% | 0% | **3%** |
| Informal employment | 50% | 8% | 0% | 24% | 8% | 5% | 0% | **18%** |
| Unemployed | 0% | 6% | 0% | 5% | 0% | 3% | 0% | **4%** |
| Home/not seeking work | 0% | 39% | 0% | 27% | 16% | 30% | 33% | **27%** |
| Disabled | 0% | 14% | 0% | 0% | 0% | 0% | 0% | **2%** |
| Unknown | 0% | 0% | 0% | 3% | 4% | 0% | 0% | **2%** |

#### *4.3.1.7 Artisinal Mining*

Artisanal miners usually work daily and in groups, with license owners employing a number of diggers. Although predominantly a male activity, 20 percent of miners in Kinjor and Larjor are female. Women generally assist by pouring water at the stage when the gravel is jigged and during gravel washing, or by preparing food for male miners. Two types of mining are undertaken; mining in sandy areas, whereby a wet paste is created before washing in which stones taken out of diggings are sifted, using ‘flotation’ to identify gold; and mining in the rock clay river, breaking rock to about 4-5m deep and washing the diggings with the aid of a pump. Rock produces better quality gold than sand, although this requires more strenuous effort. Miners may find 1.2 – 1.5g of gold during a day’s work, sold at approximately US$ 50 per gram.

Artisinal miners commonly have issues with inadequate tools and equipment, unavailability of credit and difficult working conditions. Table 40 below shows the artisanal mining figures for the NLGM Project area.

**Table 40: Artisanal Mining Figures for the NLGM Project area**

| Village | Percentage of Households | Total Number of Persons | Gender Distribution | | Number of Employees | | | Frequency of Mining | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | None | 1 to 5 | 5 or more | Daily | Weekly |
| Jawajei | 7% | 4 | 50% | 50% | 0% | 100% | 0% | 100% | 0% |
| Kinjor | 46% | 182 | 79% | 21% | 14% | 82% | 4% | 96% | 4% |
| Larjor | 86% | 15 | 80% | 20% | 0% | 83% | 17% | 67% | 33% |

Figure 32 shows artisanal mining near Kinjor, within the Project area.

*Figure 32: Artisanal mining near Kinjor*

#### 4.3.1.8 Small Businesses

In addition to artisanal mining and subsistence agriculture, half of surveyed households run some form of small business. These include the sale of vegetables or fish (both locally caught and transported from the coast), oil, spices, tinned, non-perishable, and household goods. There are also two bakeries and two bars in Kinjor, and one household has recently bought a refrigerator and sells chilled water.

### 4.3.2 Cultural Heritage

A baseline cultural heritage survey was conducted in October 2011 as part of the EIA. The work was undertaken in accordance with Performance Standard (PS) 8, Guidance Note 8: Cultural Heritage, prepared by the International Finance Corporation (IFC 2012) and with the Environmental Assessment Sourcebook Update No. 8, 'Cultural Heritage in Environmental Assessment' (The World Bank 1994).

The cultural heritage team undertook archaeological field walkover surveys of those areas of land to be affected by the Project that were accessible and amenable to survey. These included areas cleared for drilling and access, and exploration routes that had been cut through the forest for the purposes of establishing the DC of the Marvoe Creek.

In addition, interviews were conducted by the team with the village elders of the surrounding villages of Kinjor, Larjor, Jawajei and Jakindor to identify sites of cultural significance and with their permission the team were taken to their most sacred sites to record their location and form.

No archaeological remains or sites were identified. The archaeological survey was limited to recording above-ground visible remains. The vast majority of archaeological sites will survive as buried remains. Dense vegetation cover will also mask the potential discovery of archaeological remains. However, it can be noted that the lack of identification of any archaeological remains from the baseline survey is likely to correlate to a corresponding limitation in the evidence for earlier occupation or settlement in and adjacent to the NLGM Project area.

A total of 26 cultural heritage sites were identified during the baseline survey. Table 41 below summarily describes the location of each site identified from the baseline survey.

**Table 41: Identified Cultural Heritage Sites**

| Site No. | Site Name | Easting (UTM 29N) | Northing (UTM 29N) | Field Notes |
|---|---|---|---|---|
| **1** | Sekpendeh-Woni guyoh (prayer site, man/woman representation rocks) - associated with Jawajei | 261723 | 775772 | Two rocks standing in close proximity of each other. The larger one (Sekpendeh) is supposed to be the male and the smaller (Woni Guyoh) the female. Site is used for ancestral worship. |
| **2** | Larjor cemetery | 262751 | 775064 | Site is located within the forest a short distance from the village of Larjor, close to the banks of the River Marvoe. It is located in an area of less dense tree cover and demarcated by the remains of mounds of earth defining the locations of approximately 6 individuals. The graves themselves are not evidently marked. |
| **3** | Kinjor cemetery | 263667 | 775563 | Site is located on the western edge of Kinjor village, to the south of the Kinjor-Larjor track. The site is just on the edge of where new village houses are being constructed and is contained with an area of forest. The graveyard extends for some 100m and a number of the graves are defined by above ground markers made of a short tree branch, c. 0.5m high. |
| **4** | Kinjor church | 263722 | 775589 | A white rectangular building located opposite the south gate of the mine camp on the western edge of Kinjor. Worship takes place on Sundays, and is also the location where Sunday School classes are held, for both adults and children. |
| **5** | Kinjor mosque | 263801 | 775544 | A white building, with blue painted shutters, located within the centre of Kinjor. |

| Site No. | Site Name | Easting (UTM 29N) | Northing (UTM 29N) | Field Notes |
|---|---|---|---|---|
| **6** | Kinjor townhouse | 263809 | 775494 | The townhouse for Kinjor, comprising an open sided rectangular roofed structure, situated to the south of the mosque. The building was adapted as the polling station during the 11 October elections. |
| **7** | Jawajei cemetery | 267332 | 777608 | On the approach road into Jawajei, the grave yard is located in forest to the east of the village on the opposite side to the church. |
| **8** | Jawajei church | 267322 | 777614 | Rectangular built structure located at the eastern end of the village. |
| **9** | Jawajei mosque | 267260 | 777613 | Located in the centre of the village, comprising a rectangular building. |
| **10** | Jawajei townhouse | 267254 | 777589 | An open plan rectangular building located in the centre of the village, which is also used as the village school. |
| **11** | Old Jawajei (ghost town) | 267415 | 778434 | Site of the original Jawajei settlement. It was abandoned as the founder (Dindo Gbeduwa) relocated near to the Marvoe stream. Considered the ancestral homeland of the people of Jawajei, where important sacrifices are made to the dead. |
| **12** | Tombo bai-ja (prayer site men+women) at Jawajei | 267465 | 778398 | Another site for ancestral worship. |
| **13** | Wijuasien (witch creek) at Jawajei | 267621 | 778435 | In the olden days, when people suspected of withcraft died or were killed, their gall bladder (considered to harbour the witch) was removed and thrown into this stream. The people believed in reincarnation and the fear was that a witch might return with all the original powers and continue harming the people. This was why the 'witch' was removed prior to the deceased person being buried. |
| **14** | Sande bush prayer site (women) at Jawajei | 267221 | 777453 | Located in the forest on the outskirts of the village. |
| **15** | Sande bush prayer site (part of site 14) at Jawajei | 267143 | 777347 | A further sande prayer site, located in the forest. |
| **16** | Gumah Beyah (ancestral worship/prayer site for women) at Jawajei | 267022 | 777342 | A prayer site for the women of Jawajei located on the banks of the River Marvoe. An old story recalls when a young man was told not to fish in this part of the river but went alone one day and decided to try and catch fish. He cast his line and a fish took the bait, |

| Site No. | Site Name | Easting (UTM 29N) | Northing (UTM 29N) | Field Notes |
|---|---|---|---|---|
| | | | | but as he tried to land it, the fish got bigger and bigger coming out of the water and was a massive size coming over the head of the fisherman. He let go of the line and subsequently went mad. Tradition is now that this part of the river, a very deep part, is never fished. |
| **17** | Poro bush prayer site (men) at Jawajei | 267143 | 777680 | Located in the forest on the outskirts of the village, near to the river. |
| **18** | Marvoh Laa (meeting place for Jawajei by River Marvoe) | 267188 | 777659 | Riverbank location on the Marvoe, with rock outcrop used as a community meeting area. [Approx location - site by river bank] |
| **19** | Bea Mountain (cave site used for prayer) - associated with Jawajei | N/A | N/A | Bea Mountain is located c.3 hour walk to the north east of Jawajei and the ancestral worship site comprises a cave(s). Site not visited due to distance and access through the bush. |
| **20** | Jakindor mosque | 260705 | 774289 | |
| **21** | Grave of Boima Kamara | 260713 | 774289 | Founder of Jakindor in c. 1942/44. |
| **22** | Public prayer area at Jakindor | 260730 | 774291 | |
| **23** | Ancestor worship site (foundation stone laid) at Jakindor | 260692 | 774290 | |
| **24** | Jakindor townhouse | 260687 | 774290 | |
| **25** | Sande bush prayer site (women) at Jakindor | 260624 | 774324 | Located in forest. |
| **26** | Jakindor cemetery | 260756 | 774185 | Located in forest outside the village. |

Figure 33 shows the location of the cultural heritage sites identified within the greater NLGM area.

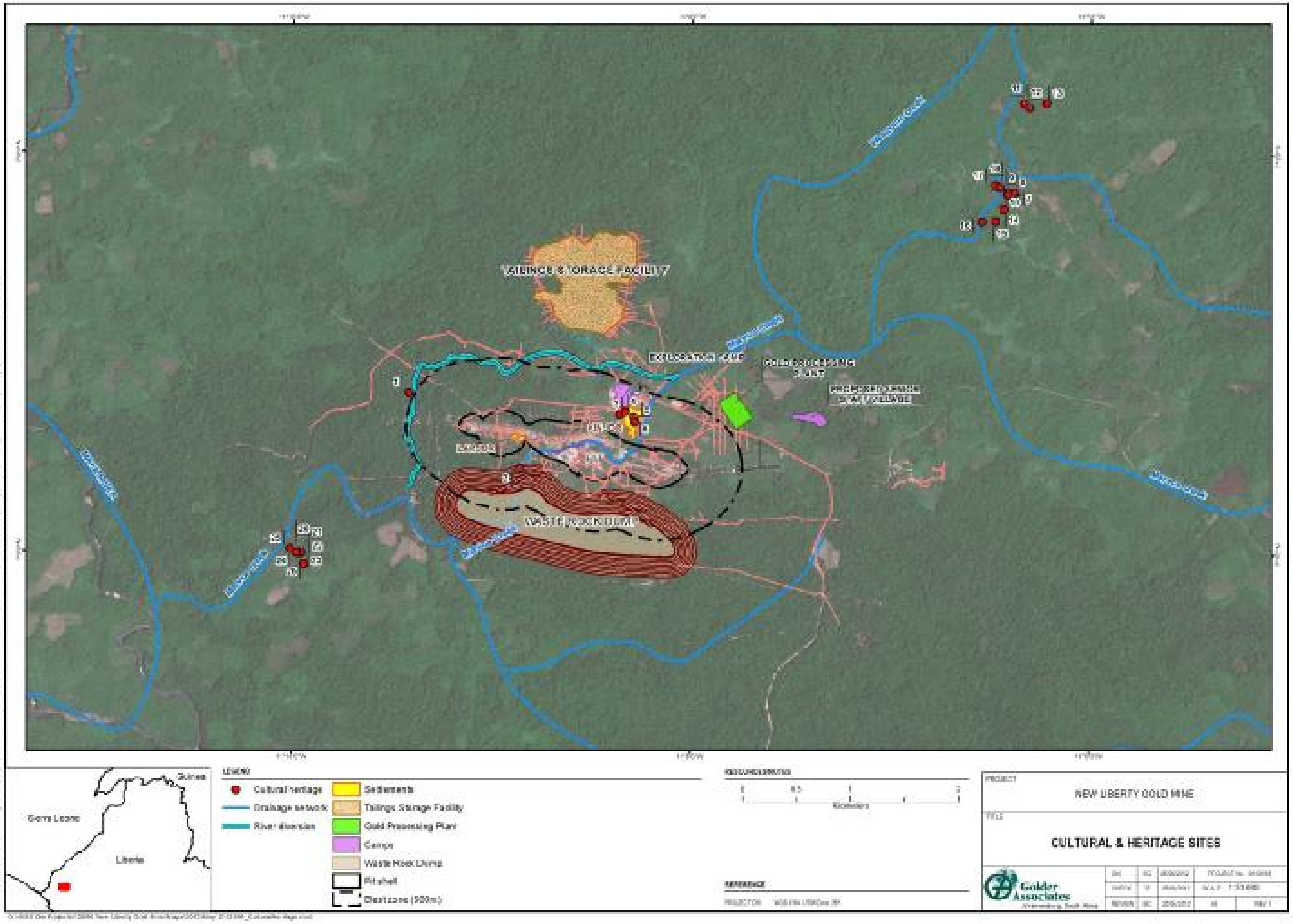


*Figure 33: The location of the cultural heritage sites within the greater NLGM Project area*

#### *4.3.2.1 Historical Context*

Kinjor, Larjor and Jakindor all have a fairly recent history. They are probably less than sixty years old. The residents of Jawajei claim that their settlement was founded during the presidency of Charles D. B. King (1920-30). King was the 17th President of Liberia. Kinjor, Larjor and Jakindor have had a more or less transient population, mainly because of the mining activities. The population of Jawajei, on the other hand, seems to be more settled and permanent.

The settlements have a close affinity with Jawajei, which they consider as their cultural centre. Jawajei, which in the Gola dialect means ‘New Town’, was founded by a hunter named Dindo Gbeduwa. His wife was called Tenneh. Dindo was a famous hunter who killed wild game, including elephants. Because of shortage of water in his surroundings, he decided to relocate and found a new settlement on the banks of the Marvoe and subsequently called the settlement Jawajei-Marvoe (to distinguish it from the ancient Jawajei village - Site 11).

The original Jawajei, which is now considered a ghost town by the villagers, is situated about two kilometres from the present Jawajei. However, the people still have very strong links with old Jawajei, for it is their ancestral homeland where important sacrifices and ceremonies are regularly performed today.

#### *4.3.2.2 Cultural Practices*

Like many African communities, cultural practices are prevalent in the Kinjor, Larjor, Jawajei and Jakindor villages. However, these cultural practices have been affected in contemporary times by two main factors:

- The two Liberian civil wars of 1989-1996 and 1999-2003 led to massive population movements. Some people escaped the conflict as refugees to Sierra Leone while others found their way into Côte d’Ivoire and Guinea (Conakry). Sacred cultural areas were desecrated. It was also impossible for people on the move to regularly practice their culture, for example, the initiation of young boys and girls into the Poro and Sande bush societies, respectively; and
- The heterogeneous populations especially in Kinjor and Larjor make it difficult if not impossible to do initiation ceremonies in these villages. These cultural activities have the tendency to create friction and scare away non-indigenes from the area.

### 4.3.3 Visual Aesthetics

#### *4.3.3.1 Natural character*

##### Topography

The topography of the study area can be described as varying from hilly to gently rolling, but is not characterised by dramatic or prominent landforms. In the vicinity of the site the land generally slopes towards the Marvoe Creek, which roughly bisects this area from northeast to southwest. The lowest parts of the study area occur to the west, where the topography slopes towards the Mafa River. Figure 34 shows the topography of the Project area.

*Figure 34: Topography of the Project area*

### Surface water

The Marvoe Creek passes through the centre of the site and joins up with the Mafa River to the west, which is the largest watercourse in the study area. The dense vegetation cover means that the Marvoe Creek is only visible from relatively close by, although significant deforestation has taken place along and west of the Mafa River. Numerous smaller streams criss-cross the landscape, some of which only flow after downpours, however most of these are only visible over very short distances. The larger watercourses most likely swell during the rainy season, increasing their visual prominence when compared to dryer periods. Figure 35 shows the Marvoe Creek and small streams.

*Figure 35: The Marvoe Creek and numerous smaller streams also present in the Project area*

### Vegetation

The natural vegetation cover in the region is almost exclusively dense rainforest, which consists of a complex and dense understory dominated by tall, evergreen trees. Subsistence farming, rural villages and uncontrolled artisanal mining have significantly impacted on the natural vegetation cover, especially to the east and west of the site. Nevertheless large tracts of undisturbed forest still occur within the study area, especially to the south and north of the site.

*Figure 36: Vegetation cover in the Project area including dense natural rainforest (left), extensive clearings by artisanal miners (centre) and rice fields (right)*

### Habitation and human made character

The Project area is not located near any large towns or cities. Jikando is a small town located approximately 2.5 km southwest of the project area and villages in the immediate vicinity of the proposed mine site include Kinjor, Larjor, and Jawajei. Apart from these small villages human habitation in the vicinity of the mine site is limited. Roads in the area are unpaved and few other human elements exist. As mentioned before extensive agriculture and farming activity takes place further east and west of the site.

## *4.3.3.2 Visual quality*

This aspect of the study is primarily subjective, based on the professional opinion of the consultant and industry-accepted standards in visual assessment, based primarily on the photographic information at hand. The landscape is discussed in terms of its value as a visual resource, as well as its perceived ability to absorb or “hide” visual change.

### Visual resource value

- Topographic ruggedness and landforms – The topography of the study area is not characterised by prominent features and is therefore not considered to contribute to its aesthetic appeal or visual resource value. The only exception in this regard is the northernmost part of the study area where the low ridgeline occurs, which is of slightly greater significance.

- Presence of water bodies – The Marvoe Creek contributes greatly to the visual resource value of the site area, although only over short distances, as it is heavily screened by vegetation. This is also true of the Mafa River west of the site and the numerous smaller streams and water bodies found throughout the study area.

- Prevalence of natural landscapes and human-made elements – The largest part of the study area is characterised by very low levels of human development, which greatly contributes to its visual resource value. In the areas to the east and west where greater levels of human activity occur the visual resource value is compromised somewhat, although the rural character of the area is still appealing.

- Land use compatibility – The existing level of land use compatibility is high for most of the study area, which is characterised mainly by rural activities and subsistence agriculture. However localised artisanal mining that takes place in parts of the proposed mining site is considered to be intrusive in terms of the visual context, due to the level of transformation that it causes.

- Sense of place / *genus loci* – Sense of place describes the extent to which a site is visually unique or distinctive and can be distinguished from other places, regardless of whether it is considered to be scenically beautiful or not.

  The proposed mining area has an unmistakable and appealing sense of place, due to the low levels of human development, the tropical rain forest vegetation and the river which snakes through the area. Uncontrolled mining and to a lesser extent agriculture and settlement areas only have a localised impact on the genus loci of the study area. The uniqueness of the visual setting in which mining is proposed is accentuated by the fact that large parts of the region has already been extensively impacted on by agriculture and other human activities.

Based on the above visual attributes assessment, it is estimated that the majority of the study area is of high visual resource value, particularly in the vicinity of the Marvoe Creek. Areas of moderate and low value occur where extensive farming and uncontrolled mining respectively takes place.

#### *4.3.3.3 Visual absorption capacity (VAC)*

The VAC of an area is a function of the visual complexity of the landscape, whether natural or artificial; and is determined by the elements that it is composed of. Landscapes characterised by a greater diversity of shapes, textures and colours have a greater degree of VAC, regardless of whether they are perceived as visually pleasing or not. Landscapes with dense vegetation cover and pronounced topography generally also have a somewhat higher level of visual absorption cover.

Based on this premise, the study area is considered to have a moderate VAC. The dense vegetation cover tends to screen most other elements over a short distance; however the tapestry of greens formed by the forest canopy tends to contrast strongly with other colours, artificial shapes and elements.

#### *4.3.3.4 Receptor sensitivity*

Receptor sensitivity refers to the degree to which an activity could visually impact on stakeholders, and depends on the number of people that may potentially view the activity, as well as by whom and their perceptions regarding aesthetics. Taking these factors into consideration, the sensitivity of the receptors can be classified for high, moderate or low visual sensitivity.

The majority of visual receptors of the proposed project are expected to be local villagers, as the site is not located along any major transport routes or near major tourist attractions. The low levels of development therefore mean that relatively few people are expected to be exposed to the project. It is difficult to accurately estimate their perceptions of the landscape as a visual resource, as many of the locals are responsible for the artisanal mining currently taking place on site. Nevertheless it is reasonable to assume that the subsistence farmers and others living in nearby villages attach at least some value to the appearance of the landscape. For this reason, visual receptor value in terms of the study area is estimated to be moderate.

# 5.0 IMPACT PREDICTION AND EVALUATION

The aim of this section is to identify/predict and evaluate the potential positive and negative impacts that are likely to arise as a result of the proposed Project.

## 5.1 Impact Assessment Methodology

In line with the Liberian EPA EIA Procedural Guidelines (2006), the impact assessment was done according to the following methodology:

- **Direction of an impact** may be positive, neutral or negative with respect to the particular impact (e.g., a habitat gain for a key species would be classed as positive, whereas a habitat loss would be considered negative).
- **Magnitude** is a measure of the degree of change in a measurement or analysis (e.g., the area of pasture, or the concentration of a metal in water compared to the water quality guideline value for the metal), and is classified as none/negligible, low, moderate or high. The categorization of the impact magnitude may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment) pertinent to each of the discipline areas and key questions analysed. The specialist study must attempt to quantify the magnitude and outline the rationale used. Appropriate, widely-recognised standards are used as a measure of the level of impact.
- **Duration** refers to the length of time over which an environmental impact may occur: i.e. transient (less than 1 year), short-term (0 to 5 years), medium term (5 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project) or permanent.
- **Scale/Geographic extent** refers to the area that could be affected by the impact and is classified as site, local, regional, national, or international.
- **Probability of occurrence** is a description of the probability of the impact actually occurring as either improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40 % to 60 % chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur).
- **Impact significance** was rated by the specialists using the scoring system shown in the box below.

(Refer to Figure Figure 37 below).

| Magnitude | Duration | Scale | Probability |
|---|---|---|---|
| 10 Very high/ don't know | 5 Permanent/ Irreversible | 5 International | 5 Definite/don't know |
| 8 High | 4 Long-term *(impact ceases after closure of activity)* | 4 National | 4 Highly probable |
| 6 Moderate | 3 Medium-term (5 to 15 years) | 3 Regional | 3 Medium probability |
| 4 Low | 2 Short-term (0 to 5 years) | 2 Local | 2 Low probability |
| 2 Minor | 1 Transient | 1 Site only | 1 Improbable |
| 1 None | | | 0 None |

Maximum SP is 100 points
SP>75 High environmental significance
SP 30 to 75 Moderate environmental significance
SP<30 Low environmental significance

*Figure 37: Scoring System for the Assessment of Significance*

In the EPA EIA Guidelines (2006), the impact assessment matrix provided as a guide, is similar to and embedded in the one normally used by Golder as shown in Figure 37 above.

After ranking these factors for each impact, the significance of the two aspects, occurrence and severity, was assessed using the following formula:

**SP (significance points) = (magnitude + duration + scale) x probability**

The maximum value is 100 significance points (SP). The potential environmental impacts were then rated as of **High** (SP >75), **Moderate** (SP 30 – 75) or **Low** (SP <30) significance, both with and without mitigation measures on the following basis:

| | | |
|---|---|---|
| **SP >75** | Indicates **high** environmental significance | Where it would influence the decision regardless of any possible mitigation. An impact which could influence the decision about whether or not to proceed with the project. |
| **SP 30 - 75** | Indicates **moderate** environmental significance | Where it could have an influence on the decision unless it is mitigated. An impact or benefit which is sufficiently important to require management. Of moderate significance - could influence the decisions about the project if left unmanaged. |
| **SP <30** | Indicates **low** environmental significance | Where it will not have an influence on the decision. Impacts with little real effect and which should not have an influence on or require modification of the project design or alternative mitigation. |
| **+** | **Positive impact** | An impact that is likely to result in positive consequences / effects. |

## 5.2 Construction Phase and Operational Phase Impact Assessment

Table 42 summarises the potential impacts that are related to the proposed Project for the construction and operational phases, and provides a significance rating for each impact before and after mitigation.

**Table 42: Environmental Impact Assessment Matrix for the proposed NLGM Project**

| Potential Environmental Impact (Proposed NLGM Project) | ENVIRONMENTAL SIGNIFICANCE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before mitigation | | | | | | After mitigation | | | | | |
| | M | D | S | P | Total | SP | M | D | S | P | Total | SP |
| **1. Soils** | | | | | | | | | | | | |
| Disturbance of soils, erosion (Topsoil stripping and stockpiling for construction) | 6 | 2 | 1 | 5 | 45 | M | 4 | 2 | 1 | 3 | 21 | L |
| Loss of agricultural productivity (Topsoil stripping and stockpiling for construction) | 4 | 5 | 1 | 5 | 50 | M | 4 | 5 | 1 | 5 | 50 | M |
| Pollution of streams (increased suspended sediment) (Topsoil stripping and stockpiling for construction) | 4 | 2 | 2 | 3 | 24 | L | 4 | 2 | 2 | 3 | 24 | L |
| Disturbance of soils, erosion (Earthworks creating terraces by cuts and fills) | 8 | 4 | 2 | 4 | 56 | M | 4 | 2 | 2 | 3 | 24 | L |
| Loss of agricultural productivity (Earthworks creating terraces by cuts and fills) | 4 | 5 | 1 | 5 | 50 | M | 4 | 5 | 1 | 5 | 50 | M |
| Change in topography/ landscape character (Earthworks creating terraces by cuts and fills) | 4 | 5 | 1 | 5 | 45 | M | 4 | 5 | 1 | 5 | 45 | M |
| Pollution of streams (increased suspended sediment) (Earthworks creating terraces by cuts and fills) | 4 | 2 | 2 | 3 | 24 | L | 4 | 2 | 2 | 3 | 24 | L |
| Disturbance of soils, erosion (Pipeline installation) | 6 | 2 | 1 | 5 | 45 | M | 4 | 2 | 1 | 3 | 21 | L |
| Loss of agricultural productivity (Pipeline installation) | 4 | 5 | 1 | 5 | 50 | M | 4 | 5 | 1 | 5 | 50 | M |
| Disturbance of soils, erosion (Tailings dam wall construction) | 8 | 4 | 1 | 5 | 70 | M | 4 | 3 | 1 | 3 | 24 | L |
| Loss of agricultural productivity (Tailings dam wall construction) | 4 | 5 | 1 | 5 | 50 | M | 4 | 5 | 1 | 5 | 50 | M |
| Sterilisation of soil/ land (Construction of buildings) | 6 | 4 | 1 | 5 | 55 | M | 6 | 4 | 1 | 5 | 55 | M |
| Contamination of soils by cement pollutants (Cement mixing) | 8 | 2 | 1 | 3 | 33 | M | 6 | 2 | 1 | 2 | 18 | L |
| Contamination of soils by hydrocarbon pollutants (Greases, oils and fuel spills and leakages from machinery and fugitive wastes) | 6 | 2 | 1 | 4 | 36 | M | 6 | 2 | 1 | 2 | 18 | L |
| **2. Surface water** | | | | | | | | | | | | |
| Erosion and sedimentation due to stripping of vegetation | 8 | 2 | 1 | 5 | 55 | M | 4 | 2 | 1 | 3 | 21 | L |
| Construction of road river crossings on water course banks and bed | 8 | 2 | 2 | 5 | 60 | M | 6 | 2 | 2 | 3 | 30 | L+ |
| Erosion sedimentation during construction of river diversion | 8 | 2 | 2 | 5 | 60 | M | 6 | 2 | 2 | 3 | 30 | L+ |
| Impact of local stormwater runoff on river diversion construction | 8 | 2 | 2 | 5 | 60 | M | 6 | 2 | 2 | 3 | 30 | L+ |
| Impact of excess mine water generated on the site on the water quality of the receiving stream. | 10 | 3 | 2 | 5 | 75 | M+ | 4 | 3 | 2 | 2 | 18 | L |
| Flooding of pit if flood peak exceeds the design capacity of the river diversion | 10 | 3 | 2 | 5 | 75 | M+ | 4 | 3 | 2 | 2 | 18 | L |
| Impact of catchment reduction on the Lake Piso RAMSAR wetland | 2 | 3 | 4 | 2 | **18** | L | 2 | 3 | 4 | 2 | **18** | L |

| Potential Environmental Impact (Proposed NLGM Project) | ENVIRONMENTAL SIGNIFICANCE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before mitigation | | | | | | After mitigation | | | | | |
| | M | D | S | P | Total | SP | M | D | S | P | Total | SP |
| **3. Groundwater** | | | | | | | | | | | | |
| Inflows of significant volumes of water into the pre-production mine workings | 9 | 2 | 2 | 5 | 65 | M | 5 | 2 | 2 | 5 | 45 | M |
| Lowering of the groundwater table | 5 | 2 | 2 | 5 | 45 | M | 5 | 2 | 2 | 5 | 45 | M |
| Contamination of surrounding aquifers | 1 | 2 | 2 | 0 | 0 | L | 1 | 2 | 2 | 0 | 0 | L |
| Contamination of contact / mine water | 10 | 5 | 3 | 5 | 90 | H | 8 | 3 | 2 | 5 | 65 | M |
| Lowering and impact of the groundwater table as a result of the TSF | 6 | 3 | 2 | 5 | 55 | M | 6 | 3 | 2 | 5 | 55 | M |
| Contamination of underlying aquifers from TSF | 10 | 5 | 3 | 5 | 90 | H | 7 | 3 | 2 | 4 | 48 | M |
| Impact on the groundwater table from WRD – enhanced artificial recharge | 6 | 2 | 2 | 4 | 40 | M | 7 | 3 | 2 | 4 | 48 | M |
| Contamination of underlying aquifers from WRD | 10 | 5 | 3 | 5 | 90 | H | 6 | 3 | 2 | 4 | 44 | M |
| **4. Air Quality** | | | | | | | | | | | | |
| Potential impacts of dust releases from preparatory earthworks including soil stripping and earth excavations | 6 | 2 | 2 | 4 | 40 | M | 6 | 2 | 2 | 3 | 30 | M |
| Potential Impacts of dust releases during construction/ building activities | 6 | 2 | 2 | 4 | 40 | M | 6 | 2 | 2 | 3 | 30 | M |
| Potential impacts of dust releases from any stockpiled materials (including soil, overburden and storage materials) | 6 | 2 | 2 | 4 | 40 | M | 6 | 2 | 2 | 3 | 30 | M |
| Potential impacts of dust releases from erosion following area clearing (stripping of vegetation) | 6 | 2 | 2 | 4 | 40 | M | 6 | 2 | 2 | 3 | 30 | M |
| Potential impacts of dust releases from haul road traffic | 6 | 2 | 2 | 4 | 40 | M | 6 | 2 | 2 | 3 | 30 | M |
| Potential impacts from Site construction vehicle exhaust emissions | 4 | 2 | 2 | 3 | 24 | L | 4 | 2 | 2 | 3 | 24 | L |
| Potential combustion emissions from power generation – Stack heights will be at least 25 m (e.g. above the height of the building which may be between 15-25 m) and have a diameter of 254 mm | 8 | 2 | 2 | 4 | 48 | M | 6 | 2 | 2 | 3 | 30 | M |
| Dust generated from the working face during open pit mining | 10 | 3 | 2 | 5 | 75 | H | 8 | 3 | 2 | 4 | 52 | M |
| Dust will be generated from barren areas at the top of the TSF before re-vegetation is successfully completed. | 8 | 3 | 2 | 3 | 39 | M | 4 | 3 | 2 | 2 | 18 | L |
| Potential impacts of dust releases from haul road traffic | 6 | 3 | 2 | 4 | 44 | M | 6 | 3 | 2 | 3 | 33 | M |
| Potential for dust from smelting | 8 | 3 | 2 | 4 | 52 | M | 4 | 3 | 2 | 3 | 27 | L |
| Dust may be generated from the crushing of ore | 8 | 3 | 2 | 4 | 52 | M | 6 | 3 | 2 | 3 | 33 | M |
| Potential emissions from ore processing | 10 | 3 | 2 | 5 | 75 | H | 8 | 3 | 2 | 4 | 52 | M |
| **5. Noise** | | | | | | | | | | | | |
| Noise at nearest sensitive receptors – from pit and processing plant | 6 | 2 | 2 | 5 | 50 | M | 6 | 3 | 2 | 5 | 55 | M |
| **6. Terrestrial Ecology** | | | | | | | | | | | | |
| Loss of or alteration to plant communities and reduction in biodiversity on-site – this refers mainly to vegetation within project footprints, along new roads that may be cleared, the plant site and the waste dump. | 8 | 5 | 2 | 4 | 60 | M | 6 | 4 | 2 | 4 | 48 | M |

| Potential Environmental Impact (Proposed NLGM Project) | ENVIRONMENTAL SIGNIFICANCE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before mitigation | | | | | | After mitigation | | | | | |
| | M | D | S | P | Total | SP | M | D | S | P | Total | SP |
| Spillage, leakage or release of harmful or toxic substances during transport or at areas where they are stored or used such as filling stations and the processing plant. | 4 | 1 | 1 | 5 | 30 | M | 2 | 1 | 1 | 2 | 8 | L |
| Disturbance of biodiversity due to vibration and noise, in the vicinity of the pit, processing plant and along roads. | 2 | 1 | 1 | 5 | 20 | L | 1 | 1 | 1 | 5 | 15 | L |
| Habitat degradation due to dust at the pit , TSF, WRD and along roads | 2 | 4 | 1 | 5 | 35 | M | 2 | 2 | 2 | 4 | 24 | L |
| Effects on local migrations at the pit , TSF, WRD and along roads | 2 | 4 | 1 | 5 | 35 | M | 2 | 4 | 1 | 3 | 21 | L |
| Increased access to previously inaccessible areas. | 6 | 4 | 2 | 4 | 48 | M | 2 | 4 | 2 | 3 | 24 | M |
| **7. Aquatic Ecology** | | | | | | | | | | | | |
| Increased sedimentation in aquatic ecosystems | 6 | 2 | 2 | 4 | 40 | M | 4 | 2 | 2 | 3 | 24 | L |
| Decreased water quality due to accidental spills of fuels and oils during the construction phase | 8 | 2 | 2 | 2 | 24 | L | 4 | 2 | 2 | 2 | 16 | L |
| Increased sediment runoff due to site preparation, clearing, grading and ground preparation associated with site preparation, and infrastructure construction | 6 | 2 | 2 | 4 | 40 | M | 4 | 2 | 2 | 2 | 16 | L |
| Loss of biodiversity due to habitat loss associated with the diversion of the Marvoe Creek | 4 | 5 | 2 | 5 | 55 | M | 2 | 5 | 2 | 2 | 18 | L |
| Water quality contamination due to run-off from the tailings storage facility | 8 | 5 | 2 | 3 | 45 | M | 6 | 5 | 2 | 2 | 26 | L |
| Alteration of natural flow regimes in the Marvoe Creek due to discharge of pit water | 6 | 4 | 2 | 5 | 60 | M | 3 | 4 | 2 | 3 | 27 | L |
| Increased pressure on aquatic resources due to the influx of people into the area | 8 | 4 | 3 | 4 | 60 | M | 6 | 4 | 4 | 4 | 56 | M |

The following sections describe the potential impacts associated with the NLGM Project construction and operational phases, as summarised in the table above.

### 5.2.1 Soils

The soil study and associated analysis shows that the potential soil impacts are related to:

- Disturbance of soils;
- Sterilisation of soil;
- Loss of soil due to erosion;
- Increased turbidity;
- Soil contamination due to leaching of soluble chemical pollutants; and
- Loss of current and potential agricultural land.

#### *5.2.1.1 Disturbance of soil and erosion*

During construction and the mobile aspects of operation, land clearance and earthworks for the pit, plant, mine infrastructure, TSF, haul roads and WRD will disturb soils and affect the landscape character. Soil structure (fabric) will be altered due to compaction, reduced infiltration and increased erosion potential. This will affect about 285 ha. The Plinthosols and Ferralsols on site contain between 30 and 80% coarse fragments in the form of plinthic nodules and concretions. Soil volume is thus reduced and although the actual soil (fine material) is stable and fairly erosion tolerant, the high coarse fragment increases the propensity of the soils to erosion. This is a major concern and will have a profound effect on soil stability and management thereof.

Quantity of soil available for rehabilitation at this stage is estimated as follows:

- The tailings dam, processing plant and waste rock dump occupy 218 ha;
- Within the 218 ha, Site “A” Ferralsols having a reduced quantity of coarse fragments on foot slopes and lower midslopes occupy 41% or 90 ha;
- Removal of 0.5 m topsoil from the 90 ha will provide 451250 m³ of soil material;
- Assuming a 50% recovery, 226000 m³ of topsoil is available for rehabilitation purposes.

The disturbance of soils and associated erosion was assessed to be of ***moderate*** significance before mitigation and of ***low*** significance after mitigation.

#### 5.2.1.2 Sterilisation of soil/land

Development of the TSF, diversion creek, WRD, and processing plant will result in some soil sterilisation. Some 285 ha of land will be impacted upon via:

- Sterilisation of land for other and future potential uses, mainly via compaction.
- Loss of Soil Body “A” where some soils have a favorable agricultural production potential.

The sterilisation of soil/land due to the construction of mine related infrastructure and operational sterilisation, from for example, the expanding TSF and WRD was assessed to be of ***moderate*** significance before mitigation and of ***moderate*** significance after mitigation, as these mine structures/footprints will remain in place.

#### 5.2.1.3 Loss of Potential Arable Crop Land

The TSF, WRD and processing plant will cover approximately 218 ha of Soil Body “A”. Within Soil Body “A”, the Ferralsols on footslopes and lower midlopes have “very suitable” agricultural land capability and are arable. The Ferralsols occupy 41% of Soil Body “A” at the tailings, rock dump and processing plant, implying that 89 ha of arable land will be lost to potential agriculture, should mining proceed.

The loss of potential arable crop land/agricultural productivity was assessed to be of ***moderate*** significance before mitigation and of ***moderate*** significance after mitigation, because the agricultural potential once lost will not be able to be restored.

#### 5.2.1.4 Loss of Actual Arable Crop Land

Mining operations will impact on 4 ha (approximate extent) of subsistence cassava, pineapple and maize cultivated within the mine extent (615 ha). The loss of actual arable crop land was assessed to be of ***moderate*** significance before mitigation and of ***moderate*** significance after mitigation, because the crops will be lost.

#### 5.2.1.5 Soil Erosion and Pollution of the Marvoe Creek and Attribute Streams Due to Increased Turbidity

Exposure of soils in the mine lease area, notably on haul roads, around the mine pit, tailings dam, diversion creek and processing plant will increase soil erosion via storm water runoff. Fine tailings discharging into water courses will result in increased suspended sediment loads. Increased turbidity in the Marvoe Creek will impact on downstream users via poor quality drinking water. However, with the diversion of the Marvoe

Creek and the control and mitigation measures that will be put into place, it is expected that the water quality for downstream users will not be worse than the current status.

The soil erosion and associated pollution of streams was assessed to be of ***low*** significance before mitigation and of ***low*** significance after mitigation.

#### 5.2.1.6 Soil Contamination Due to Leaching of Soluble Chemical Pollutants

Contamination of soils by petrol, diesel, other soluble mine contaminants and cement is likely to occur, especially along haulage roads and within the vicinity of the pit and workshops.

Contamination of soils around the TSF and WRD are also areas of concern due to ARD.

The soil contamination due to leaching of soluble chemical pollutants was assessed to be of ***moderate*** significance before mitigation and of ***low*** significance after mitigation.

### 5.2.2 Surface water

#### 5.2.2.1 Erosion sedimentation due to stripping of vegetation

During the construction phase, large areas of the site will be stripped of vegetation which will increase erosion and sedimentation. This has been scored as a moderate impact as the scale of the impact will be restricted to the site. The mitigation of the impact is the construction of stormwater collection channels conveying the runoff to sediment control dams. The sediment control dams will settle out the sediment before the runoff is discharged to the environment. If the sediment control mitigation is put in place then the impact is ranked as ***low***.

#### 5.2.2.2 Impact of road river crossings on river banks and bed

This impact has been ranked assuming that there will be river crossings. The construction of the crossings will change and alter the river banks and the river bed. There is the potential for erosion downstream of the crossings, backwater upstream of the crossings and erosion at the entrance to the crossing structures. This impact was ranked as medium. The mitigation measure is a properly designed culvert crossing to pass the design flood with minimum backwater. The approaches and exits from the river crossings must be protected to prevent erosion. If this applied then the impact is ranked as a ***low***.

#### 5.2.2.3 Erosion and sedimentation during construction of diversion channel

The excavation of the diversion channel and construction and the flood control dyke in the Marvoe Creek will increase the potential for erosion and sedimentation. Construction of the river diversion will require construction of a coffer dam. The sediment generated in the channel will be transported into the downstream river channel. The impact was ranked as medium. The mitigation is to construct the diversion channel during the dry season and to provide a sediment control dam at the diversion channel exit to settle out and reduce the sediment loads leaving the site. If this applied then the impact is ranked as a ***low***.

#### 5.2.2.4 Impact of local stormwater runoff on diversion channel

The diversion channel intercepts local streams. The runoff from these streams could cause flooding of the diversion channel during construction. This impact was ranked as medium. The mitigation measure proposed is to construct the diversion in the dry season and to schedule the construction to start at the downstream end to the upstream end with the flood control dyke constructed last. In this way the channel can drain and flood water will not interrupt construction. With the implementation of this mitigation measure the impact is ranked as a ***low***.

#### 5.2.2.5 Impact of excess mine water discharge on receiving stream water quality

The site wide water balance shows that the mine will generate significant volumes of excess mine water. This water may not meet the WHO drinking water standards. The discharge is therefore considered to be polluted and will impact of the water quality of the receiving streams and the downstream users. The impact was ranked as medium. The mitigation measure is to collect and treat the water in a form of sedimentation pond to meet the WHO drinking water standards. This mitigation measure will reduce the impact rank to ***low***.

#### *5.2.2.6 Impact of discharge of dirty stormwater to environment*

The discharge of dirty stormwater will impact of the water quality of the receiving streams and the downstream users. The impact was ranked as medium. The mitigation measure is to implement stormwater management system. This mitigation measure will reduce the impact rank to ***low***.

#### *5.2.2.7 Impact of flooding of pit*

The discharge of flooding pit, if the water is not pumped out immediately, is considered to be polluted and will impact of the water quality of the receiving streams and the downstream users. However the water will be diluted therefore the impact was ranked as medium. The mitigation measure is to collect and treat the water in a form of sedimentation pond to meet the WHO drinking water standards. This mitigation measure will reduce the impact rank to ***low***.

#### *5.2.2.8 Impact of catchment reduction on the Lake Piso RAMSAR wetland*

The impact in terms of streamflow reduction will be caused by the reduction of the catchment area. The critical areas which need to be assessed depend on the percentage of a particular area that will be isolated and the consequence of isolating the areas. The areas with an isolated area in excess of 10% can be considered to start having an influence on the flow patterns and volumes in the receiving catchment. The impact of the mine and water management infrastructure will contribute to the reduction in the physical catchment area run-off via the Mafa River that ends up in the  Lake Piso, a RAMSAR wetland located downstream of the proposed Project (Figure 31 in Protected Areas Section)Since the catchment areas are reduced by less than 10 %, the streamflow reduction will be insignificant. The impact was ranked as ***low***. No mitigation measures are required.

### 5.2.3 Groundwater

#### *5.2.3.1 Assessment of potential impacts associated with mining*

**Mine water balance – open pit mining**

Given the bulleted summary below the potential mine water balance impacts during the construction phase were assessed to be of ***moderate*** significance. With mitigation, which include dewatering prior to mining, in-pit sumps and stormwater diversion, the rating although reduced remains ***moderate***. This is largely due to the unavoidable impact on the surrounding water table, the contact water quality to a lesser extent and the ever present threat to production security:

- The main components of the opencast water balances were identified as groundwater inflow and direct rainfall recharge on the various mining areas;
- Aquaterra indicates the total groundwater inflow after the first year of pre-production as 8 L/s;
- Aquaterra (2012) indicates the total groundwater inflow rises to a maximum of 22 L/s towards the end of the mine life;
- It is estimated that the total inflows (groundwater and rainfall runoff) for the entire pit typically range from approximately 25 L/s in the drier months, derived primarily from groundwater, to over 100 L/s in the wet months consisting primarily of rainfall runoff;
- Seasonal variations were not taken into account;
- It is also possible that predicted groundwater inflow may be exceeded for short periods (during the initial stages of mining, or during excessively wet rainfall periods);
- Localised higher inflows could be effectively managed by dewatering in advance (prior to mining). Alternatively drains could be constructed to drain the more significant flows to in-pit sumps; and
- Total maximum inflows (groundwater and rainfall runoff) for the first year of pre-production may be as high as 32 L/s based on the available information.

### Impact on groundwater levels

From the summary below it is evident that the impact on the water table is unavoidable and even with a low to moderate magnitude rating the environmental impacts were assessed to be of ***moderate*** significance, both before and after mitigation. Relocation of the communities within the mining area is taken as a given and the rating with mitigation stays the same due to the reversed groundwater gradient and reduction in base flow contributions:

- During mining, groundwater levels in the immediate vicinity of the open pit will be influenced;
- The maximum lateral extent of the local groundwater level drawdown after the first year of pre-production reaches a maximum of some 400 m from the pit centre (first approximation - RSP Aquaterra, 2012);
- There is potential for some drawdown in water levels in existing wells (possible decrease in yielding capacity) as well as some reduction in base flow to rivers and streams within the zones of influence;
- One community borehole surveyed during the hydrocensus, namely “Kinjor Well 2”, falls within the mentioned 400 m zone of influence;
- The groundwater level drawdown extends outside the pit and towards the end of the mine life is expected to reach some 1.3 km from the pit centre (first approximation - RSP Aquaterra, 2012);
- Within the zone of influence there is potential for some drawdown in water levels in existing wells (potential decrease in yielding capacity) as well as a reduction in base flow to rivers; and
- Two community boreholes surveyed during the hydrocensus namely “Kinjor Well 2” and “Kinjor Well 1” as well as the two mine camp wells fall within the 1.3 km zone of influence.

### Impact on the groundwater quality of the surrounding aquifer(s)

- Due to groundwater flowing toward the dewatered mining areas, the surrounding aquifers are not expected to be impacted in terms of groundwater quality during the pre-production construction phase and this impact is considered as ***insignificant***;
- The expected on-going dewatering of the pit and subsequently increasing cone of groundwater depression will induce flow towards the pit. Due to groundwater flowing towards the dewatered mining areas, the surrounding aquifers are not expected to be impacted on in terms of groundwater quality by the mining activities in the pit and the impact is therefore considered as ***insignificant***;
- The operational impact on the contact / mine water is essentially the same as discussed for the pre-production mine working (construction Phase) apart from the fact that naturally poorer quality groundwater inflows with increasing depth cannot be discounted. Reference is made to the sample from exploration borehole KGD 146 (Section 5.1.7) where the values of Arsenic (As) and Iron (Fe) exceed the maximum allowable limits according to (SANS 241:2006) and (WHO Water standards 1993). A built-up of the salt load in the pit can also be expected;
- SPLP test results suggest that the weathering of SMUS materials on exposure, either in the pit walls or within the backfill material, will result in a greater rate of release of major ion constituents (notably alkalinity, SO4, Al, Fe, Ca, Mg, Na, K and Si) and trace elements (As, Ba, Co, Cr, Cu, Mn, Ni, Pb, U and Zn). It is important to note that the SPLP test results represent an underestimate of the leachability of the rock materials, since the samples were not allowed to oxidze. Hence the static test results also represent instantaneous release of constituents rather than long term material leach characteristics, which are best determined by conducting kinetic geochemical tests;
- Once in contact with the various materials within the mine, the water quality can be expected to deteriorate over time. In light of the fact that all in-pit water will be pumped out, groundwater concentrations are expected be diluted significantly by the rain water during the wet season and significant fluctuations are expected seasonally;

- Where feasible, the placement of collection sumps off the mineralized zone on exposed waste rock (granite or footwall gneiss) will decrease contact / exposure time and leachate generation;
- Again if feasible, especially during the rainy season the lowest bench level should be in the footwall; and
- During the dry season it may be necessary to return the poor quality water to the TSF.

Assuming no hydraulic containment, a 0.3m thick compacted clayey soil liner is provided at the base of the TSF to control seepage. Where applicable, the locally sourced clayey soil will be used to act as an impermeable liner. Prior to the construction of the clayey liner, the topsoil and all weak, loose, compressible and otherwise unsuitable soils within the basin will be excavated and removed.

A system of gravel drains are provided below the compacted clay liner at the valley bottom of the TSF basin Water collected by the underdrain system will be conveyed to a manhole equipped with a pump, which will be located downstream of the TSF main dam. The quality of the water collected in the manhole will be continuously monitored. If the quality is acceptable for discharge it will be pumped to the DC; if not, it will be pumped back to the TSF.

Seepage through the TSF main dam, at the start-up and final configuration, was estimated from a two dimensional finite element seepage model that was prepared using the commercially available seepage modelling software SEEP/W (GeoStudio 2007, Version 7.13). The average seepage rate through the TSF dams will vary from 0.1 L/s to 0.7 L/s.

The TSF perimeter dyke is a pervious structure. Seepage through the perimeter dyke will be collected through a seepage ditch along the dyke and captured in sumps and pumped back to the TSF reclaim pond. However, small seepage losses through the dam foundations and the pond will occur.

### Impact on contact / mine water

With cognisance of the summary below the impacts on the contact / mine water quality were rated to be of ***high*** significance. With mitigation, this significance rating is reduced to ***moderate***:

- Groundwater flow into the opencast workings is expected to be of similar quality as the background (baseline) groundwater quality;
- As the storm water intercepted by the pit is essentially rainwater, it is appropriate to discharge the water back into the environment to minimise the environmental impact of the interception, providing the receiving environment is not adversely impacted;
- Similarly dewatering prior to mining will decrease the contact water and can be applied as water supply elsewhere;
- Whilst the collection sumps at the bottom of the pit will act to remove some sediment, additional sediment removal is likely to be required prior to discharge. Sediment settlement/removal would require the construction of sediment deposition basins;
- Nitrate contamination of groundwater can occur due to leaching of ammonium nitrate and fuel oil (ANFO) explosives. Emulsion explosives, which do not contain ANFO, will be used and therefore lowering this risk;
- Assuming a hydrocarbon spills management plan is in place within each open pit, it is not expected that there would be any contamination issues with regard to hydrocarbons; and
- Acid generating and metal leaching is not foreseen as problematic with regard to the pre-production mine workings.

### 5.2.3.2 Assessment of potential impacts associated with the TSF

#### Impact on groundwater levels

The potential environmental impacts on the water table which can be summarised as reduction in base flow and rainfall recharge were assessed to be of a ***moderate*** significance. With mitigation which basically deals with the management of the groundwater intercepted, the significance rating is ***low***.

- A system of gravel drains are provided below the compacted clay liner at the valley bottom of the TSF basin to intercept groundwater from springs and to provide dry working surface for the construction of the compacted clay liner; and
- Water collected by the underdrain system will be conveyed to a manhole equipped with a pump, which will be located downstream of the TSF main dam; and
- The compacted clayey soil liner and underdrain system should intercept a significant portion of the seepage through the base of the TSF reducing recharge to the underlying aquifer(s). This is seen as a positive impact due to contaminant spread retardation. Given the reduced recharge to the underlying aquifers and the resultant base flow reduction the operational phase impact was assessed as of ***moderate*** significance, both before and after mitigation.

#### Impact on the groundwater quality

The potential impact on the groundwater quality was assessed to be of a ***high*** significance. With mitigation, as listed below, this significance rating is reduced to ***moderate***:

- Assuming a hydrocarbon spills management plan is in place, it is not expected that there would be any contamination issues with regard to hydrocarbons; and
- The tailings is not expected to be acid generating, however a much stronger Na-Cl-$SO_4$ signature can be expected as well as metal leaching;
- Contamination can be expected from seepage through the base of the TSF liner as well as from toe seepages and percolation from the base of contact water drainage ditches;
- Within the zones of influence some contamination can be expected from base flow to rivers and streams (MSDC); and
- An increase in the contaminant load can be expected throughout the operational phase.

### 5.2.3.3 Assessment of potential impacts associated with the WRD

One of the key design principles is to keep the drainage from the WRD and drainage from the surrounding catchments as two separate water streams. It may be necessary to provide treatment in the form of sedimentation ponds for the rainfall runoff from the WRD.

#### Impact on groundwater levels:

The construction phase impacts on the water table, which relates largely to design implementation and the engineering of water management facilities / structures, were assessed to be of a ***moderate*** significance. With mitigation which basically constitutes the engineering of water management structures / facilities, including lining this significance remains ***moderate***:

- Internal surface water runoff containment could lead to seepage from the toe and slope face as well as enhanced (artificial) recharge to the underlying aquifers;
- Transecting groundwater preferential flow zones could lead to additional water make in the opencast workings;
- To reduce infiltration to the unsaturated (vadose) zone it is recommended that area underneath the waste rock dump should be compacted and lined using a natural clay liner or geotextile barrier material;

- Enhanced artificial recharge to the underlying aquifer(s) can be expected;
- Due to the proximity of the WRD to the mine quarrying operations and with the water level gradient being towards the dewatered mining areas, enhanced inflows in the mining areas cannot be discounted especially in light of possible interconnecting preferential flow zones; and
- To reduce infiltration to the unsaturated (vadose) zone it is recommended that area underneath the waste rock dump should be compacted and lined using a natural clay liner or geotextile barrier material. To limit infiltration and runoff from the waste rock dump, compaction of the waste rock and concurrent rehabilitation will minimise ARD/ML risks.

**Impact on the groundwater quality:**

The impacts on the groundwater quality, which relates largely to design implementation and the engineering of water management facilities / structures, were assessed to be of a ***high*** significance. With mitigation, which basically constitutes the engineering of water management structures / facilities, including lining, this significance rating is reduced to ***moderate***:

- Assuming a hydrocarbon spills management plan is in place, it is not expected that there would be any contamination issues with regard to hydrocarbons;
- Seepage quality from the waste rock dump could exceed background groundwater quality and contain the following elements of concern at levels which exceed Liberian guidelines As, Ba, Co, Cr, Cu, Mn, Ni, Pb, U and Zn. Kinetic testing would be required to confirm the rate at which these metals are actually mobilised from the waste rock over time. A first order estimate of the salt load of contaminated seepage to groundwater is calculated based on the TDS range of 70 to 150 mg/l. Approximately 20 to 100 kg/a of salt is estimated to be mobilised from the waste rock dump as the footprint area develops during the LOM (Section 6.5.4);
- To limit infiltration and runoff from the waste rock dump, compaction of the waste rock and concurrent rehabilitation will minimise ARD/ML risks;
- As previously stated and with reference to Section 6.5.4, seepage quality from the waste rock dump could exceed background groundwater quality and contain the following elements of concern at levels which exceed Liberian guidelines As, Ba, Co, Cr, Cu, Mn, Ni, Pb, U and Zn. Kinetic testing would be required to confirm the rate at which these metals are actually mobilised from the waste rock over time. A first order estimate of the salt load of contaminated seepage to groundwater is calculated based on the TDS range of 70 to 150 mg/l. Approximately 20 to 100 kg/a of salt is estimated to be mobilised from the waste rock dump as the footprint area develops during the LOM;
- Within the zones of influence contamination of the underlying aquifer(s) can be expected which will report on the receiving environment as base flow to rivers and streams as well as from groundwater flow towards the mine workings; and
- An increase in the contaminant load can be expected throughout the operational phase.

### 5.2.4 Air Quality

From an air quality perspective, the largest potential impact of the Project site would be expected from the dust release from the working face during the open pit mining process. At the NLGM site, mining will take place by means of open pit methods in the vicinity of existing artisanal pits. Dust emissions may be generated during mechanical disturbance of rock and soil materials, blasting and crushing, as well as wind blowing over bare ground stockpiles and tailings. The impact from dust will be greatest during the dry winter months of operation. The significance score for impacts before mitigation from preparatory earthworks is ***high***. This is because the magnitude is expected to be very high, it is during the operational period, therefore the duration is expected to be medium term, potential effects will be in the local area and potential emission from this activity are definite. After mitigation the significance score is reduced to ***moderate*** as the magnitude of the release reduced to high and the probability reduced to highly probable.

Whilst the TSF is un- vegetated there is a potential for dust releases due to soil stripping. Any fine particles could be easily disturbed and dispersed, especially during dry and windy conditions. The significance score for impacts before mitigation from preparatory earthworks is ***moderate***. This is because the magnitude is expected to be high, therefore the duration is expected to be medium term, potential effects will be in the local area and potential emission from this activity are medium. After mitigation the significance score is reduced to ***low***, as the magnitude of the release is reduced to low and the probability is also reduced to low.

Dust releases may also occur from construction/ building activities directly such as material handling, cutting, grinding, sawing, scabbling (grinding concrete), filling of skips and using chutes. Stockpiled materials in particular are often subject to wind erosion if not managed appropriately which may have the potential to cause dust releases. Before the start of any earthworks, affected areas would be stripped of vegetation and thus cleared. This can lead to erosion and associated dust release, especially under dry conditions. The significance score for impacts from dust releases from construction and building, stockpiling and vegetation stripping before mitigation is ***moderate***. This is because as the magnitude is expected to be moderate, it is during construction and therefore the duration is expected to be short term, potential effects will be in the local area and potential emission from this activity are highly probable. After mitigation the significance score is reduced to ***low***, as the probability of the release reduced to medium.

Whilst the TSF is un- vegetated there is a potential for dust releases due to soil stripping. Any fine particles could be easily disturbed and dispersed, especially during dry and windy conditions. The significance score for impacts before mitigation from preparatory earthworks is ***moderate***. This is because the magnitude is expected to be high, it is during the operational period therefore the duration is expected to be medium term, potential effects will be in the local area and potential emission from this activity are medium. After mitigation the significance score is reduced to ***low***, as the magnitude of the release is reduced to low and the probability is also reduced to low.

Haul road traffic is often a major dust source through the re-suspension of any dust on the haul roads and dispersion of materials from vehicle tyres. The significance score for impacts from dust releases from haul roads before mitigation is ***moderate***. This is because the magnitude is expected to be moderate, it is during the operational period therefore the duration is expected to be medium term, potential effects will be in the local area and potential emission from this activity are highly probable. After mitigation the significance score is reduced, but still remains ***moderate*** as the probability of the release reduced to medium.

The impact of the above activities will vary depending on their location. Dust impacts from the NLGM Project will be most significant during south westerly winds, which tend to occur during the summer months. However, during these months precipitation is likely to dampen dust and naturally suppress it. Impacts from construction are likely to be most significant when easterly winds prevail i.e. in the winter. At this time, no precipitation is likely to occur that may dampen dusty activities therefore it may be beneficial to undertake these tasks outside of the winter months.

Vehicle exhaust emissions are predominantly NOx and PM10 and studies have shown that the concentrations of these decrease rapidly from the kerbside and that from beyond 200 m the contribution of vehicle emissions to local pollution levels is not significant. The potential impact on local air quality from traffic therefore needs to be assessed where there wilbe a significant change in vehicle movements and there are sensitive receptors located within 200 m of the road network. The significance score for impacts on air quality from vehicle emissions before mitigation is ***low***. This is because as the magnitude is expected to be low, it is during construction and therefore the duration is expected to be short term, potential effects will be in the local area and potential emission from this activity are of medium probability. After mitigation the significance score remains the same as there is no way of reducing the magnitude, duration, scale or probability of the emissions, only monitoring them to ensure they become no worse.

The smelting on site also has the potential to create windblown dust. While smelter flue dust collected before stack emissions is recycled at most active smelters there is a potential for windblown flue dust if this process is not carried out efficiently. The significance score for impacts from dust releases from smelting before mitigation is ***moderate***. This is because the magnitude is expected to be high, it is during the operational period and the duration is expected to be medium term, potential effects will be in the local area and potential emission from this activity are highly probable. After mitigation the significance score is reduced to ***low***, as the probability of the release reduced to low and the probability to medium.

The crushing of ore is likely to generate dust emissions. The significance score for impacts from dust releases from the crushing of ore before mitigation is ***moderate***. This is because the magnitude is expected to be high, it is during the operational period and the duration is expected to be medium term, potential effects will be in the local area and potential emission from this activity are highly probable. After mitigation the significance score is reduced, but remains ***moderate*** as the probability of the release is reduced to moderate and the probability to medium.

The power plant consideration is based on the assumption that there are eight Caterpillar engines/generators, with specifications as per the process sheets (temperature of 410 degrees). Stack heights of at least 25 m (e.g. above the height of the building which may be between 15-25 m) and diameter of 254 mm. Likely emissions include NOx, $SO_2$, PM10, HC, CO and (emission factors of most of which are provided in the specification sheet.power generation will be required throughout the construction process. The significance score for impacts on air quality from power generation before mitigation is ***moderate***. This is because as the magnitude is expected to be high, it is during construction and therefore the duration is expected to be short term, potential effects will be in the local area and potential emission from this activity are highly probable. After mitigation the significance score reduces, but still remains ***moderate*** as the magnitude is reduced to moderate and the probability reduced to medium.

The gold processing plant is based on the assumption that there are two stacks of at least 15 m in height, stack diameter or less than 300 mm and gas temperature of less than 300 degrees. It is not clear that these data are correct unless the plant is already proposed with mitigation included. Likely emissions from the smelter and the gold processing facility include $NO_2$, $SO_2$, $PM_{10}$, HCN, $NH_3$, $A_s$ and other metals but these will depend on the processing and mitigation detailed design, which are not yet available. The significance score for impacts on air quality from ore smelting and processing before mitigation is ***high***. This is because the magnitude is expected to be very high, it is during the operational period and the duration is expected to be medium term, potential effects will be in the regional area and potential emission from this activity are definite. After mitigation the significance score reduces to ***moderate*** as the magnitude is reduced to moderate, the scale is reduced to local and the probability is reduced to high.

### 5.2.5 Noise

Construction noise impacts are likely to be similar in nature and level to the operational phase, primarily from earthmoving to establish the pit and prepare the foundations of the plant. Also, noise generated during the erection of concrete and steel structures, which can be expected to generate impact noise, and noise from earthmoving equipment. The significance score for impacts related to noise at the nearest receptors during construction before mitigation is ***moderate.*** After mitigation the significance score reduces to ***low.***

Combined fugitive noise from the pit blasting ore and waste rock loading is expected to be well contained and attenuated by the barrier effect of the pit walls.

Noise from the haul trucks hauling waste rock and ore from the mine active bench to the WRD and ROM pad respectively is partially above ground level between the pit and the processing plant and therefore a more significant impact on remote sensitive receptors. However, this is an intermittent activity and the contribution to the continuous overall noise level is far than the operation of the plant itself, containing as it does, continuously operating particularly noisy machinery such as materials handling and milling equipment. The scope for mitigation of such machinery is also limited by the need for easy access for the haul trucks and to cranes for exchange, repair, or maintenance of the plant units.

Noise from the pit operations was assessed to be of ***moderate*** significance before mitigation, reduced to ***low*** after mitigation. Noise from the processing plant operations was assessed to be of ***moderate*** significance before mitigation, remaining ***moderate*** after mitigation.

### 5.2.6 Terrestrial Ecology

Impacts to the ecology of the area, specifically due to the mine construction activities can be summarised as follows:

- Clearing of vegetation;
- Spillage or release of harmful or toxic substances;
- Disturbance of biodiversity due to vibration and noise;
- Habitat degradation due to dust;
- Effects on local fauna migrations; and
- Increased access to previously inaccessible areas.

#### *5.2.6.1 Clearing of vegetation*

Vegetation clearing is likely to be the greatest impact on the vegetation communities affected by the proposed mine construction activities. All vegetation communities are likely to be affected by this impact.

Although the forest areas usually have the highest ecological integrity and conservation importance (as it contains the highest number of flora and fauna species), there has already been significant impacts in the project area due to logging, the bushmeat trade, exploration drilling activities in the area and other anthropogenic impacts.

A considerable amount of vegetation was cleared during the exploration process and rehabilitation has not yet commenced.

Vegetation communities are likely to be impacted on a very small spatial scale in comparison to the extent of the vegetation communities' total area in the region.

#### *5.2.6.2 Spillage of harmful or toxic substances*

##### Possible contaminants

Harmful or toxic substances that may affect the biota of the area if they were to enter the system include:

- Diesel or other fuel;
- Hypoid or engine oil;
- Sulphuric acid; and
- Other chemicals.

##### Effects of the contaminants

The spillage of harmful or toxic substances may impact on the fauna and flora of the area in a number of ways. Direct pathways include ingestion of the substances by fauna species resulting in toxicity in that individual, uptake of toxic chemicals by the roots plants which may lead to toxicity in the plants and the chemicals entering the plant or animals system due to contact (through the skin, leaves or stems). Indirect pathways include the ingestion of contaminated plants or animals by other herbivorous or predatory species. The predation of contaminated animals by both other animals and humans is a common occurrence during chemical contamination due to these animals being sluggish, and less likely to escape predation, due to chemical toxicity.

Sulphuric acid or other chemicals can have a negative effect on the flora and fauna in the area in which it is spilled, direct contact with plant and animal species can cause injury or death of the species. Larger spills may leach into the soil causing changes in the soil chemistry in the area which may be detrimental to the plant species in the area (Bråkenhielm and Qinghong, 1995). Small spills are likely to pose low risks to the fauna and flora of the area where the spills occur, these risks increase with an increase in the volume of the spill.

The relatively low probability, scale and magnitude of the effect of chemical spills, however, limit this to a **low** impact level. Furthermore, the project footprint already shows considerable signs of degradation, thereby, further lowering the likelihood of this impact having a considerable impact in the area.

#### *5.2.6.3 Disturbance of biodiversity due to vibration and noise*

Vibration and noise will have a significant effect mainly on fauna species in the immediate vicinity of the mine, haul roads, processing plants and waste dump areas, due to the heavy machinery utilised for the extraction and transport of the ore.

Vibration can affect a number of subterranean fauna taxa, such as burrowing mammals, reptiles and arthropods. Vibration affects these animals by causing the collapsing of burrows, and causing these animals to leave the area (Brodziewska, 2005).

Noise will also affect a wide range of taxa including avifauna, mammals, reptiles, amphibians and arthropods. Avifauna, especially songbirds, and amphibians may find it difficult to find mates in areas of increased noise. Mammals, reptiles and arthropods may find increased noise disturbing and therefore move away from the area (Brumm, 2004; Canaday and Rivadeneyra, 2001).

The impacts of vibration and noise may be substantial in ecosystems in tropical areas due to the, usually, high biodiversity in the area. The area in question in this study is, however, already substantially degraded due to the exploratory drilling, bushmeat trade and forest clearing in the area. The area which will potentially be affected by vibration and noise is also relatively small in comparison with the available habitat of these kinds in the region.

#### *5.2.6.4 Habitat degradation due to dust*

Increased dust may occur in the vicinity of the mining pit, processing plant, haul roads and waste sites. Dust will be caused by activities such as excavation of the pit, hauling ore or waste along dirt roads, dumping ore at the processing plants and dumping waste at the waste sites. Dust in the area will be greatly increased in the dry season due to the nature of the soil in the area, with very small particulates. Dust settling on plant material can reduce the amount of light reaching the chlorophyll in the leaves, thereby reducing photosynthesis, which in turn reduces plant productivity, growth and recruitment (Farmer, 1993).

This impact will most likely be **moderate** due to the existing impacts in the area and the fact that a number of roads in the area are already currently being utilised and the existing impact of dust is already quite high.

#### *5.2.6.5 Effects on local migrations*

Local migrations of fauna in the area may be affected by haul roads, open pit, TSF and WRD, due to these areas forming a barrier to migrating animals.

This impact can be mitigated by restricting the speed limit on the roads and education of drivers on these roads to avoid running over animals crossing the road.

#### *5.2.6.6 Increased access to previously inaccessible areas*

The bush meat trade was identified as one of the most severe impacts on faunal species in the region. This impact is largely limited to areas in the vicinity of the village and areas that are easily accessible from roads or from the open woodland areas. The clearing or constructions of any further roads which are easily accessible by the public are likely to increase this impact in the region.

### 5.2.7 Aquatic Ecology

#### *5.2.7.1 Increased sedimentation due to road building activities*

The habitat availability and the quality thereof, are major determinants of the aquatic community structure. When naturally vegetated landscapes are cleared, physical and biological relationships with adjacent streams are affected, usually resulting in stream bank erosion and increased sedimentation of the river channel. Changes in habitat structure due to sedimentation would result in changes in the species composition. Fish and aquatic macro-invertebrate species that prefer fast flowing riffle and rapid habitats would disappear due to the deposition of sediment in these habitats. Whereas species that are tolerant of modified habitat structure or that have wide range of habitat preferences would benefit. The significance of this impact was rated as ***moderate*** prior to implementation of mitigation measures.

#### 5.2.7.2 Increased sedimentation and water quality impairment due to run-off from waste dump

During the operational phase of the mine rainfall is likely to filter through into the waste dump. This water is likely to accumulate particles and pollutants that may pose a risk to the surrounding water courses. Sediment that washes off the waste dump during periods of rainfall may contribute to increased sedimentation in the aquatic environment. This will result in decreased ecosystem function and may have a limiting effect on aquatic biota. The significance of this impact prior to mitigation was rates as ***moderate***.

Implementation of mitigation measures reduced the significance of this impact to ***low***. This was due primarily to a reduction in the magnitude and probability of the impact.

#### 5.2.7.3 Decreased water quality due to accidental spills

Changes to the water quality could result in changes to the ecosystem structure and function as well as a potential loss of biodiversity. Water quality pollution often leads to modification of the species composition where sensitive species are lost and organisms tolerant to environmental changes dominate the community structure. The significance of this impact was rated as moderate prior to implementation of mitigation. Although the magnitude of this impact can be severe on a local scale, the probability of the impact is considered to be low and the duration of construction activities short

#### 5.2.7.4 Increased sediment runoff during site preparation

During site preparation indigenous vegetation will be cleared and graded. This increases the risk of erosion of the site and sediment deposition in the streams. This may result in changes in aquatic habitats and will result in changes to the biota communities including potentially the loss of certain species. The significance of this impact was rated as ***moderate*** prior to the implementation of mitigation measures.

Mitigation reduced the significance of this impact to ***low***. This was due to a reduction in the magnitude and probability of the impacts.

#### 5.2.7.5 Loss of biodiversity due to habitat loss associated with the diversion of the Marvoe Creek

Diversion of the Marvoe Creek will result in the loss of aquatic habitats which may in turn result in a change in ecosystem function and loss of certain taxa. However it should be noted that the baseline state of instream and riparian habitats in this section of the Marvoe Creek is critically modified due to artisanal mining activities. This has already resulted in substantial losses in ecosystem function and a large-scale reduction in the aquatic biodiversity. The significance of this impact was rated as ***moderate*** prior to mitigation.

#### 5.2.7.6 Water quality contamination due to run-off from the tailings storage facility

Changes to the water quality could result in changes to the ecosystem structure and function as well as a potential loss of biodiversity. Water quality pollution often leads to modification of the species composition where sensitive species are lost and organisms tolerant to environmental changes dominate the community structure. The significance of this impact was rated as ***moderate*** prior to mitigation.

Implementation of the recommended mitigation measures reduced the magnitude and probability of the impact and reduced the significance of the impact to ***low***.

#### 5.2.7.7 Alteration of natural flow regimes due to discharge of pit water

The alteration of flow regimes is often claimed to be the most serious and continuing threat to ecological sustainability of rivers and their associated floodplain wetlands (Bunn and Arthington, 2002). Flow modifications within a river may have several effects on the aquatic biota found within these systems. Firstly, flow is a major determinant of physical habitat, which in turn is a major determinant of biotic community structure. Secondly, aquatic species have evolved life history strategies primarily in direct response to the natural flow regimes. Thirdly, the invasion and success of exotic species in rivers is facilitated by the alteration of flow regimes (Poff and Ward, 1990; Bunn and Arthington, 2002). There are several impacts related to the change in the hydrological regime. These impacts include: reduced surface runoff and changes in groundwater recharge. Surface runoff is reduced as rainfall collects in depressions after heavy summer rains. The increased speed of runoff due to impermeable structures and drains could cause extensive erosion and scouring of the aquatic ecosystems if not designed adequately. Access roads to the mining area may also contribute to changes in the hydrological regime. The significance of this impact prior to mitigation was rated as ***moderate***.

Implementation of mitigation measures reduced the significance of this impact to ***low***.

#### 5.2.7.8 Increased pressure on aquatic resources due to the influx of people into the area

It is expected that development of the NLGM Project will result in an influx of people into the vicinity of the project area. Apart from those people who are working directly for the project during the construction and operational phases, a development of this nature attracts people that provide secondary services for the labour force. This influx of people into the area will result in increased pressure on the natural resources of the area. This is likely to result in increased pressure on fish communities in the Marvoe Creek and Mafa River. The significance of this impact was rated as ***moderate*** prior to mitigation.

The significance of this impact remaines ***moderate*** after mitigation.

## 5.3 Decommissioning and Closure Phase Impact Assessment

The decommissioning and closure phase will likely take place between the 1st quarter of 2022 and the 4th quarter of 2022 (i.e. over 12 months).

Table 43 summarises the potential impacts that are related to the closure and decommissioning phase of the proposed project.

**Table 43: Environmental Impact Assessment Matrix for the proposed NLGM Project – Decommissioning and Closure Phase**

| Potential Environmental Impact (Decommissioning and Closure Phase: Proposed NLGM Project) | ENVIRONMENTAL SIGNIFICANCE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before mitigation | | | | | | After mitigation | | | | | |
| | M | D | S | P | Total | SP | M | D | S | P | Total | SP |
| **1. Soils** | | | | | | | | | | | | |
| Soil status and erosion (Demolition and removal of structures) | 4 | 2 | 1 | 3 | 21 | L | 2 | 1 | 1 | 2 | 8 | L+ |
| Soil status and erosion (Surface re-shaping) | 6 | 2 | 1 | 4 | 36 | M | 2 | 1 | 1 | 2 | 8 | L+ |
| Drop in stream turbidity (Surface re-shaping) | 6 | 2 | 1 | 4 | 36 | M | 2 | 1 | 1 | 2 | 8 | L+ |
| Improved soil status in rehabilitated areas (Topsoil deposition) | 4 | 2 | 1 | 3 | 21 | L | 2 | 1 | 1 | 2 | 8 | L+ |
| Drop in stream turbidity (Re-vegetation) | 4 | 2 | 1 | 3 | 21 | L | 2 | 1 | 1 | 2 | 8 | L+ |
| **2. Surface water** | | | | | | | | | | | | |
| Impact of pit decanting on the Lake Piso RAMSAR wetland | 2 | 3 | 4 | 2 | **18** | L | 2 | 3 | 4 | 2 | **18** | L |
| Pit filling up and decanting and impacting on receiving streams | 8 | 5 | 3 | 5 | **80** | H | 6 | 5 | 2 | 3 | **39** | M |
| Impact of runoff from dirty areas on receiving water environment | 8 | 5 | 3 | 5 | **80** | H | 4 | 1 | 2 | 3 | **21** | L |

| Potential Environmental Impact (Decommissioning and Closure Phase: Proposed NLGM Project) | ENVIRONMENTAL SIGNIFICANCE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before mitigation | | | | | | After mitigation | | | | | |
| | M | D | S | P | Total | SP | M | D | S | P | Total | SP |
| Impact of flooding of the flood control dyke in the Marvoe Creek | 8 | 1 | 3 | 3 | **36** | **M** | 4 | 1 | 2 | 3 | **21** | **L** |
| **3. Groundwater** | | | | | | | | | | | | |
| Outflow of significant volumes of water from the defunct mine workings. | 8 | 5 | 2 | 5 | **75** | **M** | 8 | 5 | 2 | 5 | **75** | **M** |
| Impact on the groundwater table post closure. | 8 | 4 | 2 | 5 | **70** | **M** | 8 | 4 | 2 | 5 | **70** | **M** |
| Contamination of contact / mine water post closure | 8 | 5 | 2 | 5 | **75** | **M** | 6 | 5 | 2 | 5 | **65** | **M** |
| Contamination of surrounding aquifers post pit closure. | 8 | 5 | 2 | 5 | **75** | **M** | 6 | 5 | 2 | 4 | **52** | **M** |
| TSF Impact on the groundwater table post closure– reduced recharge. | 8 | 5 | 2 | 5 | **75** | **M** | 8 | 5 | 2 | 5 | **75** | **M** |
| TSF contamination of underlying aquifers post closure. | 5 | 5 | 2 | 4 | **48** | **M** | 4 | 5 | 2 | 4 | **44** | **M** |
| WRD Impact on the groundwater table post closure. | 5 | 5 | 2 | 4 | **48** | **M** | 4 | 5 | 2 | 4 | **44** | **M** |
| WRD contamination of underlying aquifers post closure. | 4 | 5 | 2 | 4 | **44** | **M** | 3 | 5 | 2 | 3 | **30** | **M** |
| **4. Air Quality** | | | | | | | | | | | | |
| Dust may be generated from barren areas at the top of the TSF before re-vegetation is successfully completed. | 8 | 2 | 2 | 3 | 36 | **M** | 4 | 2 | 2 | 2 | 16 | **L** |
| Potential dust release from stockpiled or stored materials. | 6 | 2 | 2 | 4 | 40 | **M** | 6 | 2 | 2 | 3 | 30 | **M** |
| Potential impacts of dust releases from haul road traffic | 6 | 2 | 2 | 4 | 40 | **M** | 6 | 2 | 2 | 3 | 30 | **M** |
| Potential for windblown smelter flue dust | 8 | 2 | 2 | 3 | 36 | **M** | 6 | 2 | 2 | 3 | 30 | **M** |
| Potential impacts from Site vehicle exhaust emissions | 4 | 2 | 2 | 3 | 24 | **L** | 4 | 2 | 2 | 3 | 24 | **L** |
| Potential combustion emissions from power generation | 8 | 2 | 2 | 4 | 48 | **M** | 6 | 2 | 2 | 3 | 30 | **M** |
| **5. Noise** | | | | | | | | | | | | |
| Noise at nearest Sensitive receptors | 6 | 2 | 2 | 5 | 50 | **M** | 4 | 2 | 2 | 5 | 40 | **L** |
| **6. Terrestrial Ecology** | | | | | | | | | | | | |
| Spillage, leakage or release of harmful or toxic substances during transport or at areas where they are stored or used such as filling stations and the processing plant. | 4 | 1 | 1 | 5 | 30 | **M** | 2 | 1 | 1 | 2 | 8 | **L** |
| Disturbance of biodiversity due to vibration and noise, in the vicinity of the pit, processing plant and along roads. | 2 | 1 | 1 | 5 | 20 | **L** | 1 | 1 | 1 | 5 | 15 | **L** |
| Habitat degradation due to dust at the pit sites, waste dump site and along roads | 2 | 4 | 1 | 5 | 35 | **M** | 2 | 2 | 2 | 4 | 24 | **L** |
| Effects on local migrations at pit sites, waste dump and along roads | 2 | 4 | 1 | 5 | 35 | **M** | 2 | 4 | 1 | 3 | 21 | **L** |
| Increased access to previously inaccessible areas. | 2 | 4 | 2 | 3 | 24 | **L** | 2 | 4 | 2 | 2 | 16 | **L** |
| **7. Aquatic Ecology** | | | | | | | | | | | | |
| Contamination of surface water by ARD associated with tailings storage facility | 8 | 5 | 3 | 2 | 32 | **M** | 6 | 5 | 3 | 2 | 28 | **L** |

The following sections describe the potential impacts associated with the decommissioning and closure phase, as summarised in the table above.

## 5.3.1 Soils

### *5.3.1.1 Improved Soil Status*

The Ferralsols in Soil Body “A” found on footslopes and lower mid-slopes have inherent favorable structure, drainage and depth. They are relatively stable to erosion but the high coarse fragment content increases soil erosion potential. Despite this, the material provides a suitable medium for the rehabilitation of disturbed areas via stockpiling and later used as topdressing on disturbed areas. After the placement of topsoil, soil conditions in disturbed areas will be markedly improved.

### *5.3.1.2 Reduced Stream Turbidity*

Once rehabilitation of the TSF, WRD, DC and processing plant is completed using stored topsoil and re-vegetating, potential for erosion will be greatly reduced, ensuring that sediment input into downstream rivers would be minimal.

## 5.3.2 Surface water

### *5.3.2.1 Impact of pit decanting on the Lake Piso RAMSAR wetland*

The pit will fill and decant after mine closure. The initial decant water is likely to be polluted and not meet the discharge standards (Golder, 2012). Water quality post closure monitoring on surface water should be undertaken. The water quality monitoring results of the water pumped from the pit during operations will provide a better understanding of the quality that is likely post closure. The location of the Lake Piso RAMSAR wetland site is shown in Figure 31 in the Protected Areas section. . The impact in terms of decant water from the pit on downstream users, including  Lake Piso, which is 40km downstream of the mine site, will be insignificant due to the dilution factor. The impact was ranked as **low**.

### *5.3.2.2 Pit filling and decanting*

The site is in a high rainfall low evaporation climatic area. The pit will fill and decant sometime in the future after closure of the mine. Relevant post closure monitoring on surface water should be undertaken. Groundwater modelling of the potential decant should be verified/calibrated in order to plan for management of decant onto surface to ensure water quality is within the relevant standards. All potentially contaminated water is to be treated as dirty water. Initially the impact is ranked as high as the water quality is likely to be poor (Golder, 2012c). However the water quality monitoring results of the water pumped from the pit during operations will provide a better understanding of the quality that is likely post closure. The mitigation is to do research closer to mine closure to see what treatment if required would be acceptable to ensure water quality that is going to decant will be within the standards. Mitigation is also to start with research prior to mine closure. With time the pit water is likely to be diluted and the water quality will improve over time.

### *5.3.2.3 Runoff from dirty area to receiving environment*

If the stormwater management system is not maintained, the runoff from dirty areas will impact of the water quality of the receiving streams and the downstream users. The impact was ranked as high. The mitigation measure is to maintain the stormwater management system. This mitigation measure will reduce the impact rank to ***low***.

### *5.3.2.4 Flooding of flood control dyke in the Marvoe Creek*

If the flood control dyke in the Marvoe Creek is not maintained, flooding of the flood control dyke will impact the water of the receiving streams due to the runoff from dirty areas. The impact was ranked as moderate. The mitigation measure is to inspect the flood control dyke in the Marvoe Creek and make required repairs and upgrades. This mitigation measure will reduce the impact rank to ***low***.

### 5.3.3 Groundwater

#### Mine post closure water balance – open pit mining

The potential mine water balance impacts relating to the outflow of significant volumes of water from the defunct mine workings post closure were assessed to be of ***moderate*** significance. With mitigation primarily aimed at the water quality, which include the removal of stormwater diversions to facilitate flooding, the construction of spill structures for the floodwater to spill to the DC of the Marvoe Creek as well as regular assessment of the water quality to provide water treatment if required (e.g. pit lake treatment, constructed wetland, water treatment plant, etc.), the rating remains the same, in other words decant is inevitable:

- The water balance of the mine workings consists primarily of rainfall recharge, groundwater inflow and groundwater outflow;
- In addition to the eventual decant at the opencast pit perimeter (lowest points), sub-surface decant will occur as contaminated base-flow to low-lying areas (i.e. immediately downstream of the pit perimeter);
- Sub-surface “decant” can be expected in the form of a contamination plume developing in the direction of groundwater flow (i.e. this groundwater does not decant at the pit perimeter or immediately downstream of the pit perimeter);
- In certain areas, groundwater flow will continue to be toward the mined-out opencasts, even after steady-state/post-mining groundwater levels had been reached. This may result due to:
  - Natural groundwater flow directions; and
  - The post-mining groundwater level in the pit being lower than the surrounding aquifers;
- It is expected that the decant volumes will not exceed the estimated total inflows from both groundwater and rainfall runoff estimated for the operational phase;
- Decant will vary on a seasonal basis; and
- Unaided decant can probably be expected between 8-16 years after closure. This assumption however needs to be tested.

#### Impact on groundwater levels

With cognisance of the post closure return to steady state conditions the impact was assessed to be ***moderately positive***. With mitigation which entails the removal of stormwater diversions to facilitate flooding, due to the duration for the establishment of steady state conditions, the significance rating remains the same:

- The dewatering cone will slowly retract from the maximum impact during mining (i.e. when the in-pit groundwater levels were at the lowest) as the pit continues to fill with water;
- In certain areas, groundwater flow will continue to be towards the mined-out opencasts, even after steady-state/post-mining groundwater levels had been reached. This may result due to:
  - Natural groundwater flow directions; and
  - The post-mining groundwater level in the pit being lower than the surrounding aquifers;

#### Impact on the groundwater quality of the surrounding aquifer(s)

The potential post closure impact statement on the groundwater quality of the surrounding aquifer(s) summarised blow, resulted in a rating of ***moderate*** significance. With mitigation, which include the removal of stormwater diversions to facilitate flooding of the opencast pit, as well as continuously assessment of the water quality to provide water treatment if required (e.g. pit lake treatment, constructed wetland, water treatment plant, etc.), the rating although reduced remains ***moderate***:

- Contaminated groundwater decanting to surface as base-flow can manifest as contaminated surface water run-off or salts precipitating on surface (which may in turn be transported further by rainfall run-off);
- The time to decant should have significant bearing on the long-term water quality trends;
- Although speculative, flooding of the pit by directing surface runoff towards the pit, temporarily or permanently might be advantageous;
- Again speculative and regardless of the flooding option, although possibly greatly aided by flooding the pit, seasonality could bring about stratification resulting in better quality direct and sub-surface “decant”; and
- Apart from the possible increase in the contaminant load, the capacity of dilution from the receiving environment (diverted Marvoe Creek) should be taken into account.

#### *5.3.3.1 Assessment of potential impacts associated with the TSF*

The risk of impacting downstream users of surface and groundwater resources during the closure phase is expected to be minimal due to permanent spillway that will be established to permit the drainage of the surface of the closed facility and the capping of the TSF (0.5 m of granular material to serve as a capillary break and 0.5 m of topsoil), see Section 6.5.2.

##### Impact on groundwater levels

Post closure the reduced recharge affected by both the clay liner as well as the mitigation measures stated above results in an impact statement assessed to be ***moderately positive***.

##### Impact on groundwater quality:

The potential impact on the groundwater quality post closure was assessed to be of a ***moderate*** significance. With mitigation, this significance rating was deemed to remain ***moderate***:

- Reduced recharge will result in a much slower moving contamination plume; and
- If the recharge reduction measures prove to be ineffective, the groundwater quality impact zones will continue to expand due to the continued infiltration from the TSF.

#### *5.3.3.2 Assessment of potential impacts associated with the WRD*

The WRD will be reshaped to 18 degrees to allow drainage channels on the side slope for the run-off to flow to the Open Pit, also for ease of cover placement and to provide 10m wide benches on the side slope for water management. Placement of an engineered cover on the waste rock dump is likely to reduce the likelihood and rate of generating ARD and or metal-rich leachate during the closure phase, thereby minimising the risk of impacting on downstream receptors. The reshape angle should encourage self-vegetation from the area.

##### Impact on groundwater levels:

The potential impact on the water table post closure was assessed to be of a ***moderate*** significance. With mitigation, this significance rating was deemed to remain ***moderate*:**

- Artificial recharge to the underlying aquifer(s) can still be expected; and
- Enhanced water levels can be expected within the zones of influence and to add to the pit water balance.

##### Impact on groundwater quality:

The potential impact on the groundwater quality post closure was assessed to be of a ***moderate*** significance. With mitigation, this significance rating although reduced was deemed to remain ***moderate***.

Within the zones of influence some contamination can be expected from base flow to rivers and streams as well as from groundwater flow towards the mine workings. The placement of an engineered cover and sound water management measures should retard the contaminant migration.

### 5.3.4 Air Quality

During site decommissioning and closure there will be a period where areas are not yet re- vegetated, especially on h TSF. This can lead to erosion and associated dust release, especially under dry conditions. The significance score for impacts during this period before mitigation is ***moderate***. This is because the magnitude is expected to be high, it is during the decommissioning phase and the duration is expected to be short term, potential effects will be in the local area and potential emission from this activity has a medium probability. After mitigation the significance score during decommissioning and closure is reduced to ***low*** as the probability of the release reduced to low and the probability is also reduced to low.

Stockpiled materials in particular are often subject to wind erosion if not managed appropriately which may have the potential to cause dust releases. The significance score for impacts during decommissioning from dust releases from stockpiled and stored materials before mitigation is ***moderate***. This is because the magnitude is expected to be moderate, it is during construction and the duration is expected to be short term, potential effects will be in the local area and potential emission from this activity are highly probable. After mitigation the significance score is reduced to ***low*** as the probability of the release reduced to medium. Once decommissioning is complete and the Site enters closure the significance is likely to reduce to low as the magnitude and probability will reduce further.

Haul road traffic is often a major dust source during decommissioning through the re-suspension of any dust on the haul roads and dispersion of materials from vehicle tyres. The significance score for impacts from dust releases from haul roads during decommissioning before mitigation is ***moderate***. This is because the magnitude is expected to be moderate, it is during decommissioning and the duration is expected to be short term, potential effects will be in the local area and potential emission from this activity are highly probable. After mitigation the significance score is reduced to ***low***, as the probability of the release reduced to medium. Once decommissioning is complete and the Site enters closure the significance is likely to reduce to low as the magnitude and probability will reduce further.

The decommissioning of the smelter has the potential to create windblown dust if it is dismantled as some dust will still be present in the system and any associated stacks. The significance score for impacts from dust releases from the decommissioning of the smelter before mitigation is ***moderate***. This is because the magnitude is expected to be high, it is during the decommissioning period and the duration is expected to be short term, potential effects will be in the local area and potential emission from this activity are of medium probability. After mitigation the significance score is reduced, but remains ***moderate***, as the probability of the release reduced to moderate and the probability to medium. Once decommissioning is complete and the Site enters closure the significance is likely to reduce to low as the magnitude and probability will reduce further.

The impact of the above activities will vary depending on their location. Dust impacts from the NLGM decommissioning will be most significant during south westerly winds, which tend to occur during the summer months. However, during these months precipitation is likely to dampen dust and naturally suppress it. Impacts from construction are likely to be most significant when easterly winds prevail i.e. in the winter. At this time, no precipitation is likely to occur that may dampen dusty activities therefore it may be beneficial to undertake these tasks outside of the winter months.

Vehicle exhaust emissions are predominantly NOx and $PM_{10}$ and studies have shown that the concentrations of these decrease rapidly from the kerbside and that from beyond 200 m the contribution of vehicle emissions to local pollution levels is not significant. The potential impact on local air quality from traffic therefore needs to assessed where there will be a significant change in vehicle movements and there are sensitive receptors located within 200 m of the road network. The significance score for impacts on air quality during decommissioning from vehicle emissions before mitigation is **low**. This is because the magnitude is expected to be low, it is during construction and the duration is expected to be short term, potential effects will be in the local area and potential emission from this activity are medium probability. After mitigation the significance score remains the same as there is no way of reducing the magnitude, duration, scale or probability of the emissions, only monitoring them to ensure they become no worse. Once decommissioning is complete and the Site enters closure the significance is likely to reduce to low as the magnitude and probability will reduce further.

The power plant consideration is based on the assumption that there are 8 Caterpillar engines, with specifications as per the process sheets (temperature of 410 degrees). Stack heights of at least 25 m (e.g. above the height of the building which may be between 15-25 m) and diameter of 254 mm. Likely emissions include $NO_x$, $SO_2$, $PM_{10}$, HC, CO and power generation will be required throughout the construction process. The significance score for impacts on air quality from power generation before mitigation is ***moderate***. This is because the magnitude is expected to be high, it is during decommissioning and the duration is expected to be short term, potential effects will be in the local area and potential emission from this activity are highly probable. After mitigation the significance score reduces, but remains ***moderate*** as the magnitude is reduced to moderate and the probability reduced to medium. Once decommissioning is complete and the Site enters closure the significance is likely to reduce to low as the magnitude and probability will reduce further.

### 5.3.5 Noise

Noise impacts associated with the decommissioning and closure of the pit, processing plant and TSF are likely to be very similar to the construction phase as it is likely that the same earthmoving equipment and procedures will be used. There will be no noise generating items/infrastructure left after decommissioning which could lead to irreversible degradation of the noise climate. Thus, the significance score for impacts related to noise at the nearest receptors during decommissioning and closure before mitigation is ***moderate.*** After mitigation the significance score reduces to ***low.***

### 5.3.6 Terrestrial Ecology

Impacts to the ecology of the area, specifically due to closure phase can be summarised as the following:

- Spillage or release of harmful or toxic substances;
- Disturbance of biodiversity due to vibration and noise;
- Habitat degradation due to dust;
- Effects on local migrations; and
- Increased access to previously inaccessible areas.

These impacts will affect each of the vegetation communities identified in the area, although the impact in each of these vegetation communities will differ according to the sensitivity of the community and the extent of the community affected. Furthermore, although the driving forces behind the impacts are the same in each of the communities, and the mitigation of these impacts will be similar in each of the communities, rehabilitation of these communities may differ once operation has ceased.

### 5.3.7 Aquatic Ecology

#### *5.3.7.1 Contamination of surface water due to ARD generated by the tailings storage facility*

Mine excavation usually results in an influx of water, either due to rainfall, interception of ground water or alteration of surface landforms. Typically this excess water needs to be pumped out and either treated or stored. This water can be contaminated by particulate matters, oil and grease, unburnt explosives and other chemicals. If the coal seems contain high amount of pyrites the mine water may be acidic and thus pollute the groundwater and the nearby aquatic ecosystem after being discharged. This phenomenon is commonly known as ARD and can have a detrimental effect on associated aquatic ecosystems. These effects can be categorised as chemical, physical, biological and ecological, although the overall impact on the community structure is the loss of biodiversity, simplifying the food chain and so significantly reducing ecological stability.

The impacts of ARD are difficult to predict due to the variability of discharge from the source, variation in the strength and composition of the source which varies seasonally, the effect of surface runoff from exposed areas of the mines during heavy rainfall, and the effect of the catchment discharge characteristics affecting dilution and the concentration of organic matter in the water chelating soluble metals present. Assessment is also difficult due to the complexity of the impacts, although diversity and abundance are key variables for biotic evaluation. The nature (strength) and volume of ARD can be altered by controlling generation and dilution on site. ARD and its impacts can be managed by exclusion of oxygenated water from reactive minerals or neutralisation of the acid produced. All reduction and remediation measures can become expensive, but need to be implemented to ensure the protection of the aquatic environments.

Implementation of the recommended mitigation measures reduced the significance of this impact from ***moderate*** to ***low.***

## 5.4 Geochemistry Risk Assessment

The preliminary geochemistry risk assessment carried out by Golder from March to May 2012 aimed to characterise the ARD and ML potential of the waste rock; tailings; geological mine waste materials that would be exposed, disturbed and/or deposited during the proposed mining operations, as an indication of the pollution potential of each of the above mentioned mining facilities. Should materials have a material ARD and or ML risk, recommendations were made to reduce these risks to acceptable levels through source control reduction and pathway intervention measures. Due to the aims and nature of the geochemistry discipline and the risk assessment methodology the completion of the impact assessment matrix was not included. This section of the impact prediction and evaluation thus provides a summary of the key findings of the preliminary geochemistry risk assessment. (Refer to **Volume II of the EIS, Section D**, for the final Preliminary Geochemistry Risk Characterisation Report).

The stratigraphy of the Project geology is established around three main units consisting of footwall and hanging wall banded migmatites and gneisses, with the zones hosted in predominantly greenschist-amphibolite facies metamorphosed ultrabasic rocks, referred to as Silicified Metamorphosed Ultrabasic Suite or SMUS. The gold mineralisation itself occurs with stronger arsenopyrite mineralization. Pyrrhotite, pyrite and minor-to trace amounts of chalcopyrite (CuFeS2), niccolite (NiAs, containing 43.9% nickel and 56.1% arsenic) and gersdoffite (NiAsS) occurs.

The risks of ARD and ML are unique to each of the following proposed mine facilities:

- WRD;
- Open pit and placement of waste rock into open pit;
- TSF; and
- Ore Stockpiles (ROM).

Based on the geochemical characterisation test results the ARD risk associated with these mine facilities has been assessed. Due to the high uncertainly level, the precautionary principle is applied in the recommendation of mitigation measures and for the on-going assessment and management of the ARD risks associated with each of mine facility.

The objectives of the preliminary geochemical characterisation study were to answer three key questions related to the risk of ARD and ML associated with the proposed mining activities of the Project. These key questions and the answers are provided the four mining facilities with a potential to impact on local surface and groundwater resources:

1) Will any of the geological and mine waste material generated by the proposed mining activities have a potential to generate ARD and ML?

### Waste Rock Dump and Open Pit

The same geological materials that will be deposited on the Waste Rock Dump will be exposed in the Open Pit. Oxide waste rock material was found to be non-acid producing with a potential to leach metals such as Al, Fe, P, As, Cr, Mn and Ni. Transitional ore/sulphide materials were found to have a likely and possibly acid generating potential with a potential to leach metals such as: Al, Fe, P, As, Cr, Cd, Mo, Cu, Sb, Mn and Ni. Initial drainage from the waste rock materials will most likely have alkaline (>pH9) drainage.

### Tailings Storage Facility

The tailings material (assuming representivity) is classified as possibly generating acidic drainage. However, due to the relative low Sulphide content (0.18%) and excess alkalinity associated with process water used in the transport of the tailings material, it is unlikely that the tailings will generate an acidic drainage even upon full oxidation. The tailings material has a potential to leach the following metals: As, B, Ca, Co, Cr, Cs, Cu, Fe, Mn, Ni and Zn. The tailings supernatant or process water has elevated concentrations of the following constituents: $SO_4$, free CN, $NO_3$, $NH_4$, Cu, Co, Cr, Ba, Sr, F, As, Mn, Na, Ni and Pb.

### ROM Ore Stockpiles

ROM material was not specifically analysed for this preliminary geochemical characterisation study. However, based on the characterisation of low grade ore and metallurgical test work, it can confidently be said that the ROM materials will be likely acid generating with the potential to leach elements such as: Al, Fe, P, As, Cr, Cd, Mo, Cu, Sb, Mn and Ni,

2) What are the ARD and ML risks associated with the handling and disposal of these materials?

### Waste Rock Dump

ARD and ML leaching processes associated with the waste rock materials that will be deposited on the proposed Waste Rock Dump will contaminate the seepage and run-off water generated from this facility. The level of contamination is not quantified at this point in time, however, based on the geochemical characterisation it is conservatively assumed to exceed the Liberian drinking water quality guidelines.

### Tailings Storage Facility

ARD and ML processes associated with the tailings material, combined with the quality of the process water used for transportation to the TSF, will contaminate seepage and run-off generated from the TSF. Seepage qualities during the operational phase will be strongly influenced by process water quality whereas ARD and ML processes will be more dominant in the post closure phase. The seepage from the TSF will exceed Liberian drinking water quality standards. The quality of stormwater from the TSF is not known, however, it is conservatively assumed to exceed Liberian drinking water quality standards.

### Open Pit

ARD and ML processes associated with exposed waste rock material and ore, as well as backfilled waste rock materials, in the Open Pit will contaminate the run-off water quality in the pit during the operational phase. Historical oxidation products associated with these materials will also contaminate the post closure pit lake that will form after groundwater rebound. The level of contamination is not quantified at this point in time, however, based on the geochemical characterisation it is conservatively assumed to exceed the Liberian drinking water quality guidelines.

### ROM Ore Stockpiles

ARD and ML leaching processes associated with the ore stockpile materials that will be deposited on the proposed ROM Pad will contaminate the seepage and run-off water generated form this facility. The level of contamination is not quantified at this point in time, however, based on the metallurgical test work it is conservatively assumed to exceed the Liberian drinking water quality guidelines.

# 6.0 SOCIO-ECONOMIC ANALYSIS OF PROJECT IMPACTS

This section highlights and describes the assessment of potential socio-economic related impacts associated with the proposed Project. Included in this section are the cultural heritage assessment and the VIA, because these both form part of the Human Environment.

## 6.1 Construction Phase and Operational Phase Impact Assessment

Table 44 summarises the potential socio-economic, cultural heritage and visual impacts that are related to the proposed Project for the construction and operational phases, and provides a significance rating for each impact before and after mitigation.

**Table 44: Environmental Impact Assessment Matrix for the proposed NLGM Project**

| Potential Environmental Impact (Proposed NLGM Project) | ENVIRONMENTAL SIGNIFICANCE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before mitigation | | | | | | After mitigation | | | | | |
| | M | D | S | P | Total | SP | M | D | S | P | Total | SP |
| **1. Socio-economic** | | | | | | | | | | | | |
| Physical displacement impacting built structures and sites of religious significance. | 10 | 5 | 1 | 5 | 80 | H | 2 | 5 | 1 | 5 | 40 | M |
| Economic displacement impacting agricultural land and natural resources, and artisanal mining opportunities | 10 | 5 | 2 | 5 | 85 | H | 2 | 5 | 1 | 5 | 40 | M |
| Creation of employment opportunities | 4 | 4 | 2 | 4 | 40 | M | 6 | 4 | 2 | 5 | 60 | M |
| Impacts to water levels and water quality | 6 | 5 | 2 | 5 | 65 | M | 2 | 4 | 2 | 3 | 24 | L |
| Noise and dust pollution related to construction excavations | 6 | 4 | 2 | 5 | 60 | M | 2 | 4 | 2 | 3 | 24 | L |
| Access restrictions to services and developments | 8 | 5 | 2 | 4 | 60 | M | 2 | 5 | 2 | 2 | 18 | L |
| Population influx resulting in social tensions and an increase in sexually transmitted diseases, notably HIV/AIDS | 6 | 4 | 2 | 4 | 48 | M | 2 | 2 | 2 | 2 | 12 | L |
| Potential for conflict | 6 | 2 | 2 | 3 | 30 | M | 2 | 2 | 2 | 2 | 12 | L |
| Increase in traffic and safety hazards | 6 | 4 | 2 | 4 | 48 | M | 2 | 4 | 2 | 3 | 24 | L |
| Increase in business opportunities in local services | 6 | 4 | 2 | 3 | 36 | M | 6 | 5 | 2 | 5 | 65 | M |
| Loss of sense of place | 6 | 5 | 2 | 5 | 65 | M | 2 | 4 | 2 | 3 | 24 | L |
| Creation of employment opportunities (Construction Phase) | 4 | 2 | 2 | 4 | 32 | L | 6 | 4 | 2 | 5 | 60 | M |
| Creation of employment opportunities (Operational Phase) | 6 | 4 | 2 | 4 | 48 | M | 8 | 4 | 2 | 5 | 70 | H |
| Noise and dust pollution | 6 | 4 | 2 | 5 | 60 | M | 2 | 4 | 2 | 3 | 24 | L |
| Improved services and community development potential | 6 | 4 | 2 | 3 | 36 | M | 8 | 5 | 2 | 5 | 75 | H |
| **2. Cultural Heritage** | | | | | | | | | | | | |
| Potential accidental destruction of identified prayer site that lies immediately adjacent to the Project footprint (Site 1: Sekpendeh-Woni guyoh) associated with Jawajei village. | 10 | 5 | 3 | 2 | 36 | M | 6 | 5 | 3 | 2 | 28 | L |
| Loss of modern burial sites within the villages of Larjor and Kinjor (Sites 2 and 3). | 8 | 5 | 2 | 5 | 75 | H | 8 | 4 | 2 | 2 | 28 | L |
| Loss of religious buildings (church, mosque) and public meeting place in Kinjor (Sites 4, 5 and 6). | 6 | 5 | 2 | 5 | 65 | M | 4 | 3 | 2 | 2 | 18 | L |
| Loss of access routes to ceremonial sites in Jawajei (indirect impact). | 4 | 4 | 2 | 3 | 30 | M | 4 | 2 | 2 | 2 | 16 | L |
| Contamination of cultural heritage remains through pollution and leakages (e.g. of oil), for example, from vehicles. | 10 | 5 | 1 | 2 | 32 | M | 6 | 2 | 1 | 2 | 18 | L |

| Potential Environmental Impact (Proposed NLGM Project) | ENVIRONMENTAL SIGNIFICANCE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before mitigation | | | | | | After mitigation | | | | | |
| | M | D | S | P | Total | SP | M | D | S | P | Total | SP |
| **3. Visual Aesthetics** | | | | | | | | | | | | |
| Earthworks and construction of plant infrastructure | 1 | 2 | 2 | 5 | 25 | L | 1 | 2 | 2 | 5 | 25 | L |
| Airborne dust as a result of construction activity | 4 | 2 | 2 | 4 | 32 | M | 2 | 2 | 2 | 3 | 18 | L |
| Lighting at night | 4 | 2 | 2 | 5 | 40 | M | 2 | 2 | 2 | 5 | 32 | M |
| Tailings storage facility (TSF) | 4 | 4 | 2 | 5 | 50 | M | 3 | 5 | 2 | 5 | 50 | M |
| Waste rock dump | 4 | 4 | 2 | 5 | 50 | M | 4 | 4 | 2 | 5 | 50 | M |
| Open pit | 2 | 4 | 2 | 5 | 40 | M | 2 | 4 | 2 | 5 | 40 | M |
| Main plant | 2 | 4 | 2 | 5 | 40 | M | 2 | 4 | 2 | 5 | 40 | M |
| Ancillary infrastructure including roads, fences and services | 1 | 4 | 2 | 5 | 35 | M | 1 | 4 | 2 | 5 | 35 | M |
| Airborne dust as a result of ongoing mining activities | 4 | 4 | 2 | 4 | 40 | M | 2 | 4 | 2 | 3 | 24 | L |
| Emission plumes | 4 | 4 | 2 | 5 | 50 | M | 4 | 4 | 2 | 4 | 40 | M |

The following sections describe the potential socio-economic, cultural heritage and visual impacts associated with the NLGM Project for the construction and operational phases, as summarised in the table above.

### 6.1.1 Socio-economic

Direct impacts anticipated during these phases include the following:

- Physical displacement impacting structures and sites of religious significance;
- Economic displacement impacting agricultural land and natural resources, and artisanal mining opportunities;
- Creation of employment opportunities;
- Impacts to water levels and water quality;
- Noise and dust pollution related to construction excavations;
- Employment opportunities;
- Loss of sense of place;
- Environmentally intrinsic impacts including noise and air quality;
- Health and safety impacts, including an increase in sexually transmitted diseases, notably HIV/AIDS; and
- Improved services and community development potential.

Indirect impacts during construction include the following:

- Access restrictions to services and developments;
- Population influx resulting in social tensions and an increase in sexually transmitted diseases, notably HIV/AIDS;
- Potential for conflict;
- Increase in traffic and safety hazards;
- Increase in business opportunities in local services; and
- Loss of income and livelihood strategies.

#### 6.1.1.1 Physical and Economic Displacement

Baseline data collected by Golder in March 2011 indicated that a total of 201 households will be physically displaced in Kinjor and Larjor. Additional affected community infrastructure includes the primary school, religious buildings (three in total), the cemetery, the community meeting place and two water pumps. This number is expected to increase as a number of unfinished structures were noted in Kinjor and construction activities are continuous. Digby Wells Environmental from South Africa and Earthcons Inc. from Liberia have been retained by Aureus to develop a comprehensive RAP for the proposed Project. Their initial studies undertaken in late 2011 and subsequent progress report of April / May 2012 indicate that the Project will require the physical resettlement of approximately 300 households (and about 1,800 people). In addition, a third village, Jikandou, may be impacted by displacement, should the required project stream diversion significantly impact the village.

Physical displacement requires a separate resettlement plan (IFC PS5) that must take cognisance of the mining-based livelihoods, social networks and the wider community structures. Furthermore, many households may already have been displaced due to the civil war and are therefore vulnerable to impacts of further displacement. The development of alternative livelihood strategies should be the preferred mitigation measure, maximising all possibilities for involvement in employment. Although many of these positions will be skilled positions, the establishment of appropriate training and skills development at an early stage will allow local community members to benefit from such opportunities, for instance through an increase in the wage-earning population, indirectly increasing the demand for goods and services, potentially providing local business the opportunity to supply in this demand thus developing the local economy.

Customary land users engaged in crop cultivation within the Project area will experience economic displacement, affecting economic trees, food and cash crops. This may extend to displacement relating to changing natural resource availability, indirectly impacting subsistence livelihoods and traditional household structures. Reliance on natural resources has been noted throughout the baseline. Impacts on natural water resources, potentially affecting both the quality and quantity of water resources in some areas may affect fish that constitute a large proportion of households' daily diets. Disturbances to the area may impact the potential for hunting wild animals, providing both household sustenance and a source of income.

Additionally, the project will incur economic displacement through the loss of artisanal mining opportunities. This will have a significant impact on household income and livelihoods, especially for households in Kinjor and Larjor. The importance of artisanal mining in local communities has been highlighted in the baseline. Artisanal mining provides an essential income source for almost half of households in Kinjor and Larjor, supporting the cash economy in these villages and the associated services Kinjor has to offer to surrounding communities.

The impact assessment identified physical and economic displacement as a ***high*** impact prior to mitigation. With the implementation of mitigation measures, including the RAP, this can be reduced to ***moderate*** significance, indicating the continued monitoring is required.

#### 6.1.1.2 Creation of Employment Opportunities

It can be expected that opportunities will be available for unskilled and semi-skilled employment of the local population during the construction. Skilled workers will necessarily be brought in from elsewhere in Liberia or other countries. Early management and planning during the construction phase will mean that opportunities for skills development and training may also be available during construction activities. This impact is expected to have a ***moderate*** impact. With the implementation of recommended mitigation measures, this impact is expected to have a ***moderate (positive)*** significance.

#### 6.1.1.3 Impacts to Water Quantity and Quality

The diversion of the Marvoe Creek and water use requirements of project activities may affect water supply to downstream villages, specifically Jikandou, who rely entirely on natural water resources for domestic and agricultural purposes. The RAP has indicated that further studies need to be undertaken to determine the extent of impact on livelihoods of households in Jikandou and possible displacement of households. The quality of this water may also be affected by pollutants from both the TSF and waste dump, creating a health risk to the resident population. The diversion will require the construction of a dam nearby the process plant. This may increase upstream water levels in the villages of Jawajei and Kandama, contributing to flooding potential and access restrictions during the wet season.

This impact is expected to be of ***moderate*** significance. With the implementation of mitigation measures recommended in the specialist report, this impact can be reduced to ***low*** significance.

#### 6.1.1.4 Noise and Dust Pollution

Construction vehicles and excavations will increase ambient noise and decrease air quality through dust. Noise and dust will lead to increased irritation especially in the directly affected communities, which may cause social distress and reaction against the project. This impact is expected to be of ***moderate*** significance. With the implementation of mitigation measures recommended in the specialist reports, this impact can be reduced to ***low*** significance.

#### 6.1.1.5 Access Restrictions to Services and Developments

Kinjor currently acts as a hub for surrounding rural villages, providing a variety of services such as educational facilities and market opportunities to sell and purchase food and general supplies. Resettlement of this hub will increase the distance households from other villages need to travel to access such services.

Initial findings of the RAP indicate that four resettlement sites have been identified, with the preferred resettlement site of displaced households being in the vicinity of the Weagea River along the Daniels Town road (approximately 4km south, south-east of NLGM).However, final site selection and associated consultation still needs to be undertaken. Should the community's preferred site option of Weagea River be selected, the village of Jawajei (dependent on Kinjor) which would not require resettlement, would then be between 8 – 10km walk away from the village and services. Mining activities would be situated between the villages further restricting access.

This impact is expected to be of ***moderate*** significance. With the implementation of recommended mitigation measures, this impact can be reduced to ***low*** significance.

#### 6.1.1.6 Population Influx

An external workforce is likely to be brought into the area where employment positions cannot be filled locally. The creation of employment opportunities may also result in a population influx into the area in search of possible opportunities, contributing to existing ongoing population expansion in Kinjor. Construction teams that are constituted from people not from the project area have potential to create social tensions and cause disruption. Large labour contingents require appropriate security measures to protect neighbouring communities from social exploitation and petty crime. Construction teams equally face social integration challenges that need to be appropriately managed. An increase in exploitative sexual behaviour and the associated risk of sexually transmitted diseases are likely to occur, especially given the current lack of medical knowledge and facilities.

This impact is expected to be of ***moderate*** significance. With the implementation of recommended mitigation measures, this impact can be reduced to ***low*** significance.

#### 6.1.1.7 Conflict Potential

The displacement of artisanal mining and the livelihood base of a large proportion of the community has the potential to create conflict in the project area should alternative livelihood strategies not be in place. The International Labour Organisation (ILO) has noted that violent clashes may occur when artisanal miners are forced to relocate. Furthermore, armed conflict is not uncommon in mining disputes, especially in countries with a history of conflict. A report in 2002 contends that land-use conflicts between large mining companies and the local community have largely been due to poor communication, failure of companies to live up to commitments, and unexpected yet preventable environmental accidents. Early management of disputes, proactive community engagement and the development of a Livelihood Restoration Plan (LRP) to address the possibility of the project influencing the dynamics of conflict are essential to maintaining good relationships and avoiding disputes.

This impact is expected to be of ***moderate*** significance. With the implementation of recommended mitigation measures, this impact can be reduced to ***low*** significance.

#### 6.1.1.8 Increase in Traffic and Safety Hazards

Construction activities will lead to a significant increase in vehicular traffic. The recently constructed access route from Daniels Town to site is currently a secondary road, as are routes around the site. Increased traffic will lead to deterioration of these access routes and the creation of dust. Households have indicated that roads become impassable during the wet season, especially during the months of August and September. The new access route to site passes by a number of recently established villages, usually busy with pedestrians and small business operations. These areas are presently unprotected.

This impact is expected to be of ***moderate*** significance. With the implementation of recommended mitigation measures, this impact can be reduced to ***low*** significance.

#### 6.1.1.9 Increase in Business Opportunities

An influx of population into the project area, including contracted construction teams, will increase the demand for goods and services. Increases in income-earning opportunities will also increase spending potential, providing opportunities for supply of such services, indirectly increasing the overall wealth of the area. This impact is expected to have a ***moderate (positive)*** significance.

#### 6.1.1.10 Employment Opportunities

During operations it is estimated that approximately 300 personnel will be employed. With sufficient training during the construction phase, a proportion of these personnel can be sourced from local communities. Increased employment will improve household income levels and livelihoods and is likely to increase the number of small businesses in operation, creating new enterprise opportunities. This positive impact is expected to have a ***moderate*** significance. This can be increases slightly to a ***moderate (positive)*** significance when mitigation measures are implemented.

#### 6.1.1.11 Loss of Sense of Place

Although directly affected communities are dependent on artisanal mining and employment from BMMC, others in the surrounding area depend on subsistence agriculture for survival. The development of an opencast mine and associated infrastructure and consequent displacement will therefore pose change to the landscape, resulting in a loss of sense of place to local communities.

This impact is expected to have a ***moderate*** significance. With the implementation of recommended mitigation measures, this impact can be reduced to ***low*** significance.

#### 6.1.1.12 Environmentally Intrinsic Impacts

It is likely that the operations phase will result in an increase ambient noise and decrease air quality through dust, potentially impacting the health and quality of life of local communities. Impacts relating to noise and air quality will be included in specialist assessments submitted as part of the full ESIA report. This impact is expected to have a ***moderate*** significance. With the implementation of recommended mitigation measures, this impact can be reduced to ***low*** significance.

#### 6.1.1.13 Health and Safety Impacts

Health and safety issues will impact on local populations throughout the operational phase. Increases in traffic, potential dust and water pollution and emissions from the processing plant may negatively impact health levels. Furthermore, increases in levels of traffic close to pedestrian areas and blasting activities may cause physical injury. The lack of nearby health facilities may increase risks from such impacts. Lack of healthcare facilities will also increase the risks of an increase HIV/AIDS given likely population influx and movement. This impact is expected to have a ***moderate*** significance. With the implementation of recommended mitigation measures, this impact can be reduced to ***low*** significance.

#### *6.1.1.14 Improved Services and Community Development Potential*

To date, BMMC have constructed water pumps in local villages, provided financial assistance to the local school, and are in the process of constructing a clinic. The project may provide opportunities for continued improvements in basic infrastructure and community development, especially in the support or provision of education, health care and basic services, and in providing opportunities for skills development. Such development will need to take into consideration the project's impact on access to services from all villages, planning development to benefit the entire community with the traditional area of jurisdiction. This positive impact is expected to have a ***moderate*** significance. This can be increased to a ***high (positive)*** significance when mitigation measures are implemented.

### 6.1.2 Cultural Heritage

Potential impacts to cultural heritage during construction may include:

- The proposed extraction activities associated with the Project, will result in the disturbance of five identified cultural heritage resources;
- Access to ceremonial/sacred sites used by the local communities may be affected by the Project;
- Construction activities associated with the Project have the potential to cause accidental damage to cultural heritage resources located within or on the periphery of the development footprint; and
- Operational activities associated with the Project have the potential to cause accidental damage to cultural heritage resources located within or on the periphery of the development footprint.

Using the data gathered during the baseline data collection field work, an assessment of the value of importance of each cultural heritage site identified within the local study area has been made. The impact assessment has been carried out after employing GIS analysis.

The impact assessment is largely based on professional judgement and has utilised the depth of knowledge of the appointed consultant and cultural historian engaged in the field work, drawing on distinctions between any important remains and those of a lesser significance.

The baseline value or sensitivity is derived from a consideration of each feature or site in terms of their form, survival, condition, complexity, context and period. It also takes into account the scale at which they matter and their rarity.

The impact is defined as a change resulting from the Project activities that affects cultural heritage resources. Impacts can be either adverse (e.g. direct removal and loss of a resource, which would be irreversible and permanent) or beneficial (e.g. improvement in the setting). The most significant impacts on cultural heritage resources will be physical as a direct consequence of construction activities and will mainly be confined to the areas of new land take required during the Project.

However, impacts may also be indirect, such as those caused by changes in the land form restricting access.

On this basis it is judged that the footprints of the proposed mine areas have the potential to have a direct impact upon five cultural heritage sites identified from the baseline field work comprising:

- Site 2 - Larjor cemetery;
- Site 3 - Kinjor cemetery;
- Site 4 - Kinjor church;
- Site 5 - Kinjor mosque; and
- Site 6 - Kinjor townhouse.

It is considered that ground works associated with the Project will directly impact on these five sites. All sites are judged to be of local cultural heritage value and if impacts were to occur, these would be negative and irreversible.

In addition, there is also the potential that accidental damage could be caused to:

- Site 1 - Sekpendeh-Woni guyoh, associated with Jawajei village.

This site is located on the western edge of the Project footprint and without adequate demarcation and protection could be accidentally damaged during the construction phase.

There is the potential for uncontrolled and accidental spillages of fuel and other liquids into the ground and thus, if it were to occur, cause contamination to identified cultural heritage sites, with the significance of effect without mitigation being negative and irreversible.

Finally, the villages access the ceremonial and sacred sites listed in Table 4 above. The Project has the potential to affect the access routes to these sites, which, if it were to occur, is considered to be an indirect impact.

### 6.1.3 Visual Aesthetics

#### *6.1.3.1 Earthworks and construction of plant infrastructure*

The presence of construction equipment and related works in the construction of the plant and associated mining areas (e.g., storage areas, access roads) will introduce visually intrusive elements into the landscape and locally result in increased traffic. Although considered a temporary and intermittent impact the amount of large vehicles will increase as construction progresses.

The construction of the project plant and infrastructure will require removal of vegetation and alteration of the existing topography that will result in a change in the existing landscape character. However due to the relatively flat landscape it is anticipated that only limited topographical changes will be required.

The alterations to the topography will have a visual impact on the landscape that will be most visible during the early stages of construction. However, these alterations are not likely to be seen by the majority of receptors due to the presence of existing vegetation; therefore the impact from earthworks and construction of plant infrastructure is low.

The loss of vegetation and prominent trees during clearing for the purposes of constructing the project plant will also have an impact as these elements are considered to be a valuable visual resource within the study area. As a result of the limited information that was available at the time of writing, it is not known how many such trees are potentially threatened by the proposed project, but where this may occur, the significance is considered to be high on a site-specific and local scale.

#### *6.1.3.2 Fugitive Dust*

The construction phase could result in increased fugitive dust emissions, particularly during windy conditions. Airborne dust is often visible over great distances and can be particularly bothersome, as it reduces visibility and also alter visual amenities by settling on plants, crops and built structures in large quantities. However, dust emissions will be kept at a minimum through mitigation measures identified under the air quality assessment.

#### *6.1.3.3 Lighting at night*

Night-time lighting will be required during construction. Due to the level of screening provided by the existing vegetation cover the impact of light pollution is expected to be limited, but may increase as construction progresses and more cranes and large plant are housed on site.

#### *6.1.3.4 Physical Structures*

During operations all of the main project components namely the open pit, waste rock dump, TSF and main plant are expected to some extent have an impact on the visual amenities of the area as it impacts the sense of place and is visually intrusive to the surrounding landscape. The presence of the Project's physical structures will greatly alter the visual baseline and will also be visually intrusive, due to the size and geometric shapes of the elements being introduced.

The TSF and open pit are expected to have a large footprint area; whereas waste rock dump will be of considerable height. All of these elements will also greatly contrast with their surrounding in terms of colour and texture; and to some extent be characterised by angular or unnatural landforms and edges. The plant infrastructure, although far less expansive in extent than the other elements, will also greatly and contrast with the natural surroundings. It is therefore expected that the level of visual intrusion of all the main project components will be high during operations. However ancillary infrastructure such as roads, fences, small buildings and services will only be visually intrusive to a low degree as previously mentioned, as these elements are not uncommon even in rural or largely undeveloped areas, and are not expansive.

Visual mitigation potential in terms of the open pit, waste rock dump and TSF during operations is limited to best practice measures and ensuring that optimal progressive rehabilitation is implemented throughout the lifespan of the mine.

#### *6.1.3.5 Emissions Plume*

A source of operational impact is the emission plume from the plant stack, which under certain conditions may be visible over large distances. Further sources of emissions would be generated from the burning of the waste at the waste disposal dump.

Mitigation measure to reduce these high emission levels would be to equip the stacks with dust filters to reduce fugitive dust emissions from the plant. The plant stack could from time to time create a visual plume as a result of water vapour, depending on the moisture content of the gasses released and meteorological conditions. This is not expected to occur continuously but will be visible from far away when it does.

To reduce the emission plume from the burning of the waste at the waste disposal dump, waste should be burnt during the wet season and on days that have a low wind potential, so as to reduce the emission plume from the burning of the waste. Certain waste types that would in any way be particularly harmful i.e. synthetic and high smoke-yield materials should be taken to a suitable disposal site; or a suitable disposal site should be established on site. This should be addressed in the waste management plan.

#### *6.1.3.6 Fugitive Dust*

The possibility exists that the project may result in the generation of fugitive dust during operation from exposed surfaces, vehicular traffic and the waste rock dump. The severity of dust pollution will be determined by a number of different factors such as prevailing wind strength and the extent of the area/s cleared by quarrying operations. However, mitigation measures will be implemented by NLGM to minimize fugitive dust.

#### *6.1.3.7 Night-time Lighting*

Night-time lighting will be required at the plant as it will be operating 24 hrs a day, 365 days of the year. Because of the relatively flat topography, limited levels of development within the study area and surroundings and the extent of the proposed development it is anticipated that night-time lighting could impact the visual landscape significantly. Especially where these activities are situated in remote, low development areas, these lights can potentially be highly visible and intrusive. However due to the dense vegetation cover of the surrounding forest areas and due to the proximity of the mine site to surrounding villages being greater than 2 km, the impact of light on receptors will be relatively low.

A number of measures can be implemented to further reduce the impact of lighting at night. These include providing lights with cover fittings that limit lateral and upwards light “spill”, and positioning lights to shine towards the intended areas of illumination rather than using floodlights. Limiting the heights at which lights are positioned where possible will also reduce light pollution.

## 6.2 Socio-economic Rehabilitation and Closure Phase Impact Assessment

Table 45 summarises the potential socio-economic, cultural heritage and visual impacts that are related to the closure and rehabilitation phase of the proposed project, and provides a significance rating for each impact before and after mitigation.

**Table 45: Environmental Impact Assessment Matrix for the proposed NLGM Project – Rehabilitation and Closure Phase**

| Potential Environmental Impact (Rehabilitation & Closure Phase: Proposed NLGM Project) | ENVIRONMENTAL SIGNIFICANCE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before mitigation | | | | | | After mitigation | | | | | |
| | M | D | S | P | Total | SP | M | D | S | P | Total | SP |
| **1. Socio-economic** | | | | | | | | | | | | |
| Reduction in employment opportunities and associated decline in economic activities | 8 | 5 | 2 | 5 | 75 | H | 2 | 5 | 2 | 5 | 45 | M |
| Noise and dust impacts | 6 | 2 | 2 | 5 | 50 | M | 2 | 2 | 2 | 3 | 18 | L |
| Water quality and quantity impacts | 6 | 4 | 2 | 5 | 60 | M | 2 | 2 | 2 | 3 | 18 | L |
| Change in economic benefits from mining to subsistence agriculture | 8 | 5 | 2 | 5 | 75 | H | 2 | 5 | 2 | 5 | 45 | M |
| **2. Cultural Heritage** | | | | | | | | | | | | |
| Potential accidental destruction of identified prayer site that lies immediately adjacent to the Project footprint (Site 1: Sekpendeh-Woni guyoh) associated with Jawajei village. | 10 | 5 | 3 | 2 | 36 | M | 6 | 5 | 3 | 2 | 28 | L |
| Loss of access routes to ceremonial sites in Jawajei (indirect impact). | 4 | 4 | 2 | 3 | 30 | M | 4 | 2 | 2 | 2 | 16 | L |
| Contamination of cultural heritage remains through pollution and leakages (e.g. of oil), for example, from vehicles. | 10 | 5 | 1 | 2 | 32 | M | 6 | 2 | 1 | 2 | 18 | L |
| **3. Visual Aesthetics** | | | | | | | | | | | | |
| Dismantling and removal of all infrastructure from site | 4 | 2 | 2 | 3 | 24 | L | 2 | 2 | 2 | 3 | 18 | L |
| Implementation of standard rehabilitation measures including re-contouring of the landscape and re-installation of natural land cover | 4 | 2 | 2 | 3 | 24 | L | 2+ | 5 | 2 | 2 | 18 | L+ |

The following sections describe the potential socio-economic, cultural heritage and visual impacts associated with the closure and rehabilitation phase of the NLGM Project, as summarised in the table above.

### 6.2.1 Socio-economic

The decommissioning and closure phase of the mine will involve backfilling of a section of the first open pit zone (Larjor). The other pit zones will not be backfilled. The open pits will be made safe by introducing safety berms around them. The infrastructure will not be removed from the NLGM site, as per the MDA agreement. Only a portion of the WRD that is left from the backfilling of the Larjor pit zone will be rehabilitated. The main objective is to rehabilitate the area back to its pre-mining land use and restore its suitability for agriculture.

It is recommended that a detailed rehabilitation plan is developed prior to construction and a detailed closure plan developed prior to regulatory approval.

Potential socio-economic related impacts associated with the decommissioning and closure phase may include the following:

- A temporary increase in employment opportunities followed by a decrease/reduction in employment opportunities and associated decline in economic activities:

  Mine closure would result in the loss of an estimated 300 direct jobs, as well as associated indirect employment and business enterprises dependent on mining operations and the increased population. The reduction in economic activities will be particularly significant as current income-generation is largely dependent on artisanal mining which will no longer be a possibility following decommissioning and closure. This potential impact is of ***high*** significance before mitigation, and is reduced to ***moderate*** significance after mitigation;

- Noise and dust impacts associated with decommissioning activities. This potential impact is of ***moderate*** significance before mitigation, and is reduced to ***low*** significance after mitigation;

- Impacts to the quality and quantity of water resources surrounding the Project area:

  The diversion of the Marvoe Creek will be permanent. Mitigation measures to address changes in water quality and quantity, especially for residents of Jikandou village, therefore need to be sustainable, long-term solutions that take into account potentially water impacts following closure of operations. This potential impact is of ***moderate*** significance before mitigation, and is reduced to ***low*** significance after mitigation; and

- Change in economic benefits from mining to subsistence agriculture. This potential impact is of ***high*** significance before mitigation, and is reduced to ***moderate*** significance after mitigation.

It is assumed that impacts will be fully assessed and options explored to mitigate these impacts when the Mine Closure Plan is developed at a later date.

### 6.2.2 Cultural Heritage

The majority of the potential impacts upon cultural heritage resources will occur during the construction and the operational phases. However, there remains the potential that accidental damage could occur and access to sites impacted during the rehabilitation and closure phase.

Potential impacts to cultural heritage during decommissioning and closure may include:

- Access to ceremonial/sacred sites used by the local communities; and
- Decommissioning and site closure activities associated with the Project have the potential to cause accidental damage to cultural heritage resources located within or on the periphery of the development footprint.

There is the potential that accidental damage could be caused to:

- Site 1 - Sekpendeh-Woni guyoh, associated with Jawajei village.

This site is located on the western edge of the Project footprint and without adequate demarcation and protection could be accidentally damaged during the decommissioning and closure phases.

There is the potential for uncontrolled and accidental spillages of fuel and other liquids into the ground and thus, if it were to occur, cause contamination to identified cultural heritage sites, with the significance of effect without mitigation being negative and irreversible.

The Project has the potential to affect the access routes to the ceremonial and sacred sites, which, if it were to occur, it is considered to be an indirect impact.

### 6.2.3 Visual Aesthetics

#### *6.2.3.1 Decommissioning Activities*

The process of decommissioning the NLGM mine, which will include the dismantling and deconstruction of project-related infrastructure and removing the material from site, is expected to cause a visual impact of a similar nature to that of the construction process, with two differences. Firstly, the process is expected to be somewhat shorter in duration than the construction process, and secondly will result in an increasingly improved visual condition thus creating a positive impact, due to the progressive removal of the project infrastructure from the landscape. Thus although the nature of the impact itself may be negative, the end result will be an improvement in the visual character of the landscape from that of the operational phase condition.

#### *6.2.3.2 Site Rehabilitation*

The implementation of post-closure rehabilitation measures, such as the re-contouring of the landscape to more closely resembling the natural topography and the re-installation of natural land cover, is expected to result in a significant additional improvement of the visual condition. Once implemented it is expected that visual condition will be very similar to that of the pre-project baseline, and is therefore considered a positive visual impact associated with this phase of the project.

## 6.3 Resettlement Action Plan (RAP)

An impact of the proposed Project is the requirement for the involuntary resettlement and disruption of project affected people (PAPs). A key mitigation measure is the development and implementation of the RAP. The RAP will provide an action plan to address these potential impacts and includes details of the compensation for PAPs. Because the RAP is closely linked to the SIA, it is described briefly in this section of the EIS.

As noted previously, the Project will require the physical resettlement of approximately 300 households, and approximately 1,800 people, residing in the two villages, Kinjor and Larjor, located within the Project area.

BMMC/Aureus contracted Digby Wells Environmental and EarthCons to develop a comprehensive RAP for the proposed Project. BMMC has committed to following the applicable Liberian legislation/regulations and international best practice in the implementation of associated resettlement activities.

The primary international standard applicable to involuntary resettlement is IFC Performance Standard 5 (PS5). Land Acquisition and Involuntary Resettlement. According to IFC PS5 resettlement is considered involuntary when affected individuals or households do not have the right to refuse the land acquisition that would displace them. The overall objectives of IFC PS5 are to:

- Avoid or at least minimise involuntary resettlement wherever feasible by exploring alternative project design options;
- Mitigate adverse social and economic impacts from land acquisition or restrictions on all affected persons' use of land by: (i) providing compensation for loss of assets at replacement cost; and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected;
- Improve, or at a minimum restore, the livelihoods and standards of living of displaced persons; and
- Provide opportunities to displaced people to derive appropriate development benefits from the project.

IFC PS5 requires the development and implementation of a comprehensive RAP that will set out the principles, procedures and actions that will be taken to mitigate adverse project impacts; compensate for losses and provide development benefits to those who will be resettled or displaced as a result of a project.

The development of the NLGM RAP is the first step in the resettlement process. The RAP will identify the impacts, their likelihood and extent, and will determine the types and levels of compensation based on the value of all assets that will be lost as a result of the project. The RAP will include an action plan for allocating compensation, the handing over of replacement land, and the realisation of development benefits. The costs associated with resettlement implementation will be estimated and documented in the RAP.

### 6.3.1 Components of the RAP

The NLGM RAP incorporates the following components;

- Identification of project impacts and affected populations;
- Legal framework for land acquisition and compensation;
- Compensation and entitlement framework;
- Description of resettlement assistance and restoration of livelihood activities;
- Detailed implementation budget;
- Implementation schedule;

- Description of organisational responsibilities;
- Framework for public engagement, participation, and development planning;
- Description of grievance procedures; and
- Framework for monitoring, evaluation and reporting for remedial actions.

### 6.3.2 Scope of the RAP

The NLGM RAP deals with the physical and/or economic resettlement of households and assets (a) located within the 500 m blasting zone (safety zone) from the proposed mine pit and (b) assets located within the footprint of mine associated facilities and infrastructure.

The communities that will be directly affected by the proposed NLGM are the towns/villages of Kinjor and Larjor.

### 6.3.3 RAP progress to date

The development of the NLGM RAP commenced in November 2011. As a first step, Digby Wells undertook consultations with the relevant government departments, county authorities, as well as with the potentially affected clan and town structures. The objectives of these consultations were to (a) introduce the RAP project, and (b) seek advice on the relevant Liberian legislation, regulations and procedures, as well as customary rights applicable to involuntary resettlement.

In November and December 2011, meetings were held with the chiefdom, clan and town leadership structures. This was followed by an open community meeting in Kinjor on 13 December 2011 to introduce the RAP study to the broader community, to initiate the RAP process, and propose a moratorium on further development in the towns of Kinjor and Larjor. Digby Wells indicated that the asset survey is planned for February 2012.

The above meeting was well attended and included the Cape Mount County Superintendent, District Commissioner, the Department of Mines and the Department of Civil Affairs, the County Member of Parliament, the Paramount Chief, Clan Chief, town chiefs, community structures and representatives from civil society. The meeting concluded with closing statements by government and local authority representatives, who in general expressed their satisfaction with the meeting outcome and Aureus' approach to the NLGM RAP.

A Resettlement Committee was subsequently established, representing all leadership structures in Kinjor and Larjor, as well as representatives from the Paramount Chief and Darblo Clan offices respectively. Currently, the functions of the committee are to monitor and control population influx, assist with RAP surveys and act as communication channel for the lodging grievances and concerns. A grievance and suggestion box was placed at the residence of the Kinjor town chief. Grievances received are addressed via the RC, the town chief and the NLGM community liaison officer. A formal grievance procedure and associated mechanism will be developed for the implementation of the RAP

Several asset assessments and other RAP requirements will be undertaken during 2012, and this will be documented in a detailed RAP Report for submission to relevant authorities in Liberia.

# 7.0 CUMULATIVE AND RESIDUAL IMPACTS

## 7.1 Cumulative Impacts

Cumulative impacts/effects generally refer to impacts that are additive or interactive (synergistic) in nature and result from multiple activities over time, including the project being assessed. This, the cumulative impact assessment considers the Project within the context of other similar land uses, in the local study area and greater regional context.

Cumulative impacts result when the effects of an action are added to or interact with other effects in a particular place and within a particular time. It is the combination of these effects, and any resulting environmental degradation, that are the focus of cumulative impact analysis. While impacts can be differentiated by direct, indirect, and cumulative, the concept of cumulative impacts takes into account all disturbances since cumulative impacts result in the compounding of the effects of all actions over time. Thus the cumulative impacts of an action can be viewed as the total effects on a resource, ecosystem, or human community of that action and all other activities affecting that resource.

Cumulative impacts:

- Are caused by the aggregate of past, present, and future actions;
- Are the total effect, including both direct and indirect effects, on a given resource, ecosystem, and human community of all actions taken, no matter who has taken the actions;
- Rarely correspond to political or administrative boundaries;
- May result from the accumulation of similar effects or the synergistic interaction of different effects; and
- May last for many years beyond the life of the project that caused the effects.

The NLGM Project is located in a rural area with no other mining or industrial activities taking place in the greater area. Thus, cumulative impacts will for the most part be low or insignificant at the current time.

Table 46 below provides statements on the predicted cumulative impacts associated with the proposed NLGM Project.

**Table 46: Predicted Cumulative Impacts associated with the Project**

| Aspect | Predicted Cumulative Impact |
|---|---|
| **Soil** | Currently a limited area of arable soil will be impacted as a result of the Project, but as ongoing mining development takes place the area may become significantly larger, which will potentially impact on food supply in the area. The need for subsistence food supply of farmers in the area would then have to be considered. The significance of the cumulative impacts from a soil perspective is assessed to be low. |
| **Surface Water** | The proposed project will be the first mining development in the area as well as the first industry in the area. Thus, the significance of the cumulative impacts from a surface water perspective is assessed to be low.<br><br>Related to surface water is the diversion of the Marvoe Creek by means of the proposed DC. As the Marvoe Creek will be permanently diverted, the cumulative impact of this is assessed to be of moderate significance before mitigation, and of minor significance after mitigation. |
| **Groundwater** | The proposed project will be the first mining development in the area as well as the first industry in the area. Thus, the significance of the cumulative impacts from a groundwater and geochemistry perspective is assessed to be low to insignificant. (No cumulative impacts were identified). |
| **Air Quality** | The NGLM project will be the first mining development in the area and also the first industry in the area. Other air emissions do occur in the area but these are small-scale localised emissions including, but not limited to, biomass burning, artisanal mining and farming. Due to the scale of these releases it is unlikely that there will be any large cumulative impacts. Thus, the significance of the cumulative impacts from an air quality perspective is assessed to be insignificant. |
| **Noise** | The area has no other industrial or noise sources within 5 km of the legal |

| Aspect | Predicted Cumulative Impact |
|---|---|
| | boundary of the NLGM Project site, so there are no impacts which are cumulative with other noise sources external to the site. Thus, the significance of the cumulative impacts from a noise perspective is assessed to be insignificant. |
| **Terrestrial Ecology** | From a terrestrial ecology perspective, forest clearing and disturbances in the greater area arise from subsistence agriculture, commercial logging and artisanal mining. The significance of the cumulative impacts from a terrestrial ecology perspective is assessed to be moderate, due to the scale/size of the potential disturbance area. |
| **Aquatic Ecology** | The cumulative impact of the Project will depend on the degree to which the development leads to a development node that in turn leads to additional deforestation of the forests beyond the Project footprint by people drawn into the Project area by the NLGM mining development. It should also be considered that the artisanal miners already in the project area will be displaced by the development and may move their current activities into the sections of the Marvoe Creek upstream and downstream of the development, or to other rivers/streams in the greater area, which could result in the further degradation of the Marvoe Creek or other rivers. The significance of the cumulative impacts from an aquatic ecology perspective is assessed to be moderate. |
| **Socio-economic** | The NLGM Project will be the first mining development and industry in the area. As such, socio-economic related cumulative impacts of the Project are expected to be limited. However, it is important to note that additional prospecting areas exist within the BEA-MDA, to the north and east of the NLGM Project site. These areas, specifically Ndablama, approximately 40 km north east of the Project area, are home to artisanal mining communities. Developments should therefore take cognisance of potential displacement and reduced opportunities for artisanal mining, an economic activity supporting a large proportion of households, on a wider scale through the development and management of alternative livelihood strategies and skills development programmes. The significance of the cumulative impacts from a socio-economic perspective is assessed to be moderate to low.<br><br>Related to the socio-economic assessment is the RAP. The Kinjor and Larjor communities will be permanently relocated as a result of the Project, and from a social perspective the cumulative impact associated with this is assessed to be high to moderate, but can be managed if the appropriate mitigation measures are implemented effectively. |
| **Cultural heritage** | It is anticipated that the limited number of cultural heritage sites affected by the NLGM development is likely to have added to a slight overall adverse impact on this aspect of the local cultural heritage in the greater area. Thus, the significance of the cumulative impacts from a cultural heritage perspective is assessed to be low. |
| **Visual** | Currently there are no existing mining developments in the area and NLGM will also be the first industry in the area. Therefore from a visual assessment, the cumulative impact is assessed to be low. |

## 7.2 Residual Impacts

For the purposes of this impact assessment, residual impacts are those that remain significant following the application of mitigation measures. This is referred to in the Liberian EPA EIA Guidelines (2006) as an impact that has ‘irreversible damage’, and thus this section complies with the Guidelines in that it covers a “statement of the degree of irreversible damage and an explanation” for each discipline covered in the EIA.

Table 47 below provides statements on the predicted residual impacts associated with the proposed NLGM Project.

**Table 47: Predicted Residual Impacts associated with the Project**

| Aspect | Predicted Cumulative Impact |
|---|---|
| **Soil** | Permanent land/soil sterilisation in the mine infrastructure footprint area (due to the presence of the TSF, WRD and processing plant etc.) will occur. |
| **Surface Water** | The surface water related impacts resulting from the proposed Project were rated as moderate using the methodology prescribed, which makes use of a numerical system. There are no envisaged impacts that remain significant following the application of mitigation measures. |
| **Groundwater and Geochemistry** | Residual impacts related to ARD and associated impacts on groundwater will be assessed by means of a Phase 2 geochemistry assessment going forward. Thus, at this time, without qualitative groundwater modelling having been undertaken, not the Phase 2 geochemistry assessment, it is not possible to determine the potential residual impacts from a groundwater or geochemistry perspective. |
| **Air Quality** | The NGLM Project will be the first mining development in the area and also the first industry in the area. Other air emissions do occur in the area but these are small-scale localised emissions including, but not limited to, biomass burning, artisanal mining and farming. Due to the scale of these releases it is unlikely that there will be any large cumulative impacts. Thus, the significance of the cumulative impacts from an air quality perspective are assessed to be insignificant. |
| **Noise** | There are no predicted residual or latent impacts on the noise environment. |
| **Terrestrial Ecology** | It is impossible to develop the proposed Project within a relatively natural area without having a “net loss” of biodiversity. As the project stands there are no substantial losses in biodiversity predicted, provided the mitigation measures mentioned in the EMP (Section 9 are implemented properly). Due to the loss of forest areas where the mine infrastructure will be located, the significance of the residual impact is assessed to be of moderate significance. |
| **Aquatic Ecology** | From an aquatic ecology perspective, no significant residual impacts were identified following the application of mitigation measures. An impact which remained moderately significant after mitigation was the additional pressure exerted on the aquatic ecosystems of the project area by people moving into the area due to the proposed mining development. Although the section of the Marvoe Creek which is due to be diverted and mined is extensively impacted, the habitat in the river upstream and downstream of the Project area remains largely intact. If these habitats can be protected from artisanal mining and deforestation the significance of this residual impact will be reduced. |
| **Socio-economic** | The majority of socio-economic impacts identified during the impact assessment can be reduced to low significance following the implementation of mitigation measures. However, impacts of physical and economic displacement remain of moderate significance, even with mitigation, due to their permanent nature. As such, socio-economic monitoring and management measures should extend throughout the life of the project in order to ensure that the quality of life of displaced persons is equal to or better than prior to displacement. |
| **Cultural heritage** | On the basis that all cultural heritage impacts assessed by means of the EIA will take place during the construction and operational phase and are to be mitigated, it is anticipated that any residual impacts will be low on the basis that the mitigation measures set out in the EMP (Section 9) are implemented. |
| **Visual** | Due to the specific climate, existing levels of development and patters of land use, it is likely that the region's economy will continue to focus on subsistence agriculture for the foreseeable future. Furthermore the relative isolation of the NLGM sites from other significant industrial development means that it is unlikely |

| Aspect | Predicted Cumulative Impact |
|---|---|
| | that extensive use of the land will occur post-closure. As a result, the landscape could, and should, be returned to a state approximating the pre-development condition.<br>However, due to the height of the WRD and extent of the TSF footprint, the landscape topographical character would be altered. The remaining area can largely be restored and pre-existing vegetation re-instated to some extent. The residual impact once the site has been fully rehabilitated would therefore be low to moderate, depending on the success of the rehabilitation process. |

# 8.0 ECONOMIC INFORMATION REGARDING THE PROJECT

## 8.1 Mineral Resource Estimate

Resource estimation by BMMC has been based on interpretations using integrated geological and grade information recorded from diamond drill core logging and assaying. Procedures for classifying the reported resources were undertaken within the context of the mineral resource classification scheme used in Canada, the National Instrument 43-101 (NI 43-101).

Estimated tonnages and grades have been classified with consideration of the following criteria:

- Quality and reliability of raw data (sampling, assaying, surveying).
- Confidence in the geological interpretation.
- Number, spacing and orientation of intercepts through mineralised zones.
- Knowledge of grade continuities gained from observations and geostatistical analyses.
- The likelihood of defined material meeting economic mining constraints over a range of reasonable future scenarios, and expectations of relatively low selectivity of mining.

All material has been reported at a 1.0 g/t Au cut-off (Table 48), as this value corresponds to a likely open pit cut-off ranges (AMC, 2012).

**Table 48: NLGM Mineral Reserve Estimate**

| Reserve Category | | | |
|---|---|---|---|
| PROVEN | Tonnes | (Mt) | 0.7 |
| | Au Ounces In-situ | (kozs) | 102 |
| | Au Grade In-situ | (g/t) | 4.3 |
| PROBABLE | Tonnes | (Mt) | 8.0 |
| | Au Ounces In-situ | (kozs) | 771 |
| | Au Grade In-situ | (g/t) | 3.0 |
| TOTAL | Tonnes | (Mt) | 8.7 |
| | Au Ounces In-situ | (kozs) | 873 |
| | Au Grade In-situ | (g/t) | 3.1 |
| | Waste Tonnes | (Mt) | 130 |
| | Strip Ratio | (t/t) | 14.9 |

Notes: 1. CIM definitions were used for Mineral Reserves
2. A cut off of 0.65 g/t Au is applied for all zones
3. Due to rounding, some columns or rows may not add up exactly to the computed totals

## 8.2 Economic Analysis

### 8.2.1 Economic Model

Aureus/BMMC has developed a financial model in order to evaluate the economics of the project – this was used for the National Instruments 43-101 (NI 43-101) technical release in February 2012. AMC confirms that the inputs to the financial model used in the NI 43-101 have been appropriately derived from, and reflect the investigations of, the various studies, as commented on in the previous sections of this report (AMC, 2012). Aureus/BMMC will update the financial model for the Definitive Feasibility Study.

#### *8.2.1.1 General Assumptions*

The Reserve Model is pre-tax and pre-finance, allows for working capital and is based on a detailed analysis of gold processing throughput. The financial model is based on the following assumptions:

- Currency base is the US $;
- The financial model is in real Q1 2012 terms;
- Due to the unknown date of when the project will be brought in to production, the start of gold production has been assumed to be from ‘Year 1’ with a mining pre-production and a plant and infrastructure construction period of 1 year (Year 0);
- A base case discount rate of 8%;
- The financial model uses an average gold price of US $ 1,350/oz;
- Royalty is 3% of gross revenue but does not account for the Republic of Liberia’s retention of a free of charge equity interest in Bea’s operations equal to 10% of its authorised issued and outstanding share capital without dilution (i.e a 10% “carried interest”);
- The financial model includes an estimated US $ 51m of capital expenditure (sunk costs) prior to the start of project execution mine construction; and
- No additional contingency costs have been allowed for in the capital cost estimates.

Gold recovery has been assumed to be 93%.

#### *8.2.1.2 Project Economics*

A net present value has been calculated for the Project through the application of Discounted Cash Flow (DCF) techniques to the pre-tax, pre-financing cash flow derived from the inputs and assumptions presented in this and previous sections of the report. All figures are presented in Q1 2012 real terms.

For the base case analysis an average gold price of US $ 1,350 has been used.

A government royalty of 3% of revenue has been assumed. The financial model is reported on the basis of 100% of the Project, with no consideration of the free carried interest.

A summary of the base line results and cash flow modelling and valuation is presented below in Table 49 below. The average life of mine cash cost per ounce of gold is estimated at US $ 632 with an expected pre-tax Net Present Value (NPV) of US $ 260 using an 8% discount rate and pre-tax Internal Rate of Return (IRR) of 62%. The expected payback period for the Project is less than two years (AMC, 2012).

**Table 49: Cash Flow and Valuation Summary (AMC, 2012)**

| Description | Units | Project Totals/Averages |
|---|---|---|
| Recovered Gold | kozs | 812 |
| Mill Processing Life | Years | 8 |
| Net Smelter Revenue | US $ m | 1,065 |
| Operating Costs | US $ m | 514 |
| Net Operating Cash Flow | US $ m | 551 |
| Capital Costs | US $ m | 162 |
| Net Pre-Tax Cash Flow | US $ m | 390 |
| NPV (8%) | US $ m | 260 |
| IRR | % | 62 |
| Payback | years | < 2 years |
| Cash Cost per Ounce | US $/oz | 632 |

### *8.2.1.3 Project Sensitivities*

Table 50 below illustrates an analysis of the project NPV sensitivity to variations in gold price, operating cost and capital cost estimates used in the base case.

**Table 50: Project Sensitivities**

| Sensitivity | NPV 8% Discount Rate | Variance to Base Case |
|---|---|---|
| Gold Price | US $ M | % |
| +10% | 340 | +31 |
| -10% | 180 | -31 |
| Capital Costs | | |
| +10% | 248 | -5 |
| Operating Costs | | |
| +10% | 221 | -15 |
| Grade | | |
| -10% | 180 | -31 |
| **Sensitivity** | **NPV 8% Discount Rate** | **Variance to Base Case** |
| Gold Price | US $ M | % |

The financial model sensitivities indicate that the project is economically robust. The project NPV is least sensitive to capital cost variations.

AMC has verified that the financial model inputs reflect accurately the technical and financial costs reported in the study.

AMC has reviewed the basis of the technical assumptions applied to the economic assessment, together with the operating and capital cost estimates, and, while they are at a level of accuracy that requires further definition as part of a project feasibility study, they are considered appropriate support the continuing investigation of the Project (AMC, 2012).

# 9.0 ENVIRONMENTAL MANAGEMENT PLAN AND MITIGATION MEASURES

BMMC is committed to limiting the impact of operations at the proposed NLGM Mine on the environment in line with Liberian legislation and international best practice standards and principles. In order to achieve this aim, BMMC will implement an EMP. The EMP will be updated every four years, as per Liberian legislative requirements.

Based on the potential impacts identified in Section 5.0, the following section describes the associated mitigation measures that BMMC/Aureus is required to implement, aimed at reducing potential negative environmental and social impacts and enhancing potential positive environmental and social impacts.

The EMP translates the findings and recommendations of the impact assessment into measures for management and monitoring of impacts of the proposed Project activities.

## 9.1 Purpose and Methodology of the EMP

The purpose of the EMP is to describe the mitigation measures and commitments that will be adopted by BMMC to reduce negative impacts and enhance the positive impacts of the Project.

The objectives of this EMP are to establish environmental management commitments that will:

- Minimise adverse impacts on the environment;
- Maximise positive impacts that arise from the Project;
- Ensure that environmental mitigation measures are in place from the start of the Project; and
- Monitor any changes in the environment that may be associated with the Project; negative or positive.

## 9.2 EMP for the Bea-MDA Concession Area

An EMP for the on-going exploration activities on the Project site as well as in the greater Bea-MDA concession area is included in this EIS at the request of the EPA.

This exploration EMP will be used in conjunction with BMMC's/Aureus's various Procedures to implement appropriate mitigation measures aimed at reducing negative impacts associated with exploration activities.

### 9.2.1 Exploration Mitigation Measures

Table 51 presents the mitigation measures that have been identified for the exploration activities that are on-going in the NLGM Project area and within the greater Bea-MDA concession area. (It is important to note that no impact assessment was conducted for the exploration component of BMMC's activities, and thus this is not included in this EIS).

**Table 51: Environmental Management Programme – Exploration related activities (Bea-MDA Concession Area)**

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | Duration of mitigation measures | Responsible Person/Party |
|---|---|---|---|---|---|
| **Aureus Mining Procedure 1. Drilling Operations – Pre-drilling** | | | | | |
| 1. | Aureus Mining Procedure 1 | Drilling Operations – Pre-drilling | ▪ Select a drilling rig that is both suitable for the job required and will result in minimal impact;<br>▪ When selecting a drilling contractor, determine their previous record for conducting work in a responsible manner;<br>▪ Ensure that drilling contractors are aware of the environmental clauses and their liability under the drilling contract;<br>▪ Confirm that the areas selected for drilling are not sensitive in either an environmental or cultural context (eg susceptible to erosion or have heritage values);<br>▪ Determine whether the rig been thoroughly cleaned to remove any soil, plant or weed material that is foreign to the site;<br>▪ Determine if there is appropriate fire fighting equipment (contractor) available and have spark arresters been fitted to exhausts if the rig is to be used in regions of long grass;<br>▪ Determine whether preventative maintenance checks been undertaken to minimise the chance of fluid leaks from the vehicle (eg. hydraulic lines); and<br>▪ Determine that all access tracks to drill pad sites have been constructed in accordance with *Procedure 6 – Clearing of Roads, Tracks and Use of Borrow Pits*. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |
| 2. | Aureus Mining Procedure 1 | Drilling Operations – Siting of drilling pads | All designated drill pad sites need to be:<br>▪ Cleared according to Procedure 5 – Topsoil Management and Rehabilitation, kept to a minimal size, with the unnecessary clearing of vegetation avoided, while still allowing the drilling operation to be carried out in a safe and efficient manner; (refer to attached site specific site preparation guidelines).<br>▪ Sited to avoid direct and indirect impacts (i.e. runoff, dust etc) on sensitive areas; and<br>▪ Sited away from drainage lines and water courses and a suitable buffer zone established. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |
| 3 | Aureus Mining Procedure 1 | Drilling Operations – Operation of drill rigs | ▪ Encourage contract drilling companies to use biodegradable drilling additives;<br>▪ Ensure the drilling contractor is trained in the containment and clean up of spilled hydrocarbons;<br>▪ Ensure that no litter or waste should ever be placed down a drill hole;<br>▪ Ensure, for both occupational health and environmental reasons, that all drilling operations minimise the level of dust and noise that is generated; and<br>▪ Communicate to the drilling contractor their environmental responsibilities, in order that a high level of environmental performance is consistently achieved in the field. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | Duration of mitigation measures | Responsible Person/Party |
|---|---|---|---|---|---|
| 4 | Aureus Mining Procedure 1 | Drilling Operations – Use of water during drilling operations | ▪ Drainage down a slope, its entry into drainage channels or its collection around the rig must be strictly avoided.<br>▪ Prior to drilling a new area, identify the potential presence of any high pressure or saline aquifers.<br>All water used as a result of drilling operations:<br>▪ Must be contained by the construction of suitably sited sumps, which must be constructed before drilling commences;<br>▪ All sumps must be deep enough for the proposed activity;<br>▪ Under no circumstances is the sump to be used as refuse dump;<br>▪ Should be reused wherever possible in the drilling process; and<br>▪ If it is highly saline, must be restricted to contact with vegetation. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |
| 5 | Aureus Mining Procedure 1 | Drilling Operations – Containment and cleanup of spills | All spillages of lubricating oils, hydraulic oils and diesel spills must be:<br>▪ Contained immediately and not allowed to enter any drainage lines or watercourses; and<br>▪ Cleaned up, with all contaminated soil collected and removed from the site and disposed of in accordance with the *Procedure 3 – Waste Management*. | Throughout the Exploration Phase | Aureus Exploration Manager, Environmental Manager and Drilling Contractors |
| 6 | Aureus Mining Procedure 1 | Drilling Operations – Rehabilitation | At the completion of drilling operations at a drill site:<br>▪ All equipment must be removed from the drill pad and immediate area;<br>▪ All waste is to be removed and disposed of in accordance with the Procedure 3 – Waste Management;<br>▪ Rehabilitation to commence as soon as practical, as part of the rehabilitation of all disturbed areas resulting from the exploration program as per Procedure 5 – Topsoil Management and Rehabilitation; and<br>▪ All drill holes to be capped as per Procedure 8 - Drill Hole Sampling and Capping.<br>▪ Monitoring of the progress and success of rehabilitation efforts should be carried out in accordance with the *Procedure 4 - Environmental Monitoring Programs*. | Throughout the Exploration Phase | Aureus Exploration Manager, Environmental Manager and Drilling Contractors |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | Duration of mitigation measures | Responsible Person/Party |
|---|---|---|---|---|---|
| **Aureus Mining Procedure 2. Drilling Operations – Site access** | | | | | |
| 7 | Aureus Mining Procedure 2 | Drilling Operations – Site access | Approval to construct roads and tracks requires the company to:<br>▪ Carry out planning regarding road placements;<br>▪ Consider whether a road is actually required or can access be gained via alternative methods (i.e. helicopter);<br>▪ Determine if there are any existing roads/tracks that can be used to gain access to a designated area;<br>▪ Determine if the construction of all required roads is permitted under the exploration conditions and that the required approvals have been secured from the relevant authorities; and<br>▪ Consult with landowners to determine any additional requirements that may be important prior to constructing the road. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |
| 8 | Aureus Mining Procedure 2 | Drilling Operations – Locating Access Roads and Tracks | Determining the most favourable location of access roads and tracks requires consideration of the following:<br>▪ Use of aerial photographs to assist in the location of tracks and roads, especially in areas with considerable vegetation, sand dunes and/or salt lakes present;<br>▪ Determine the type and volume of traffic likely to use the track and how long access will be required;<br>▪ Plan all routes along suitable natural features and avoid areas of high erosion potential, the crossing of drainage channels and any areas of dense or sensitive vegetation; and<br>▪ Roads should ascend and descend along ridges wherever possible and traverse slopes along contour lines. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |
| 9 | Aureus Mining Procedure 2 | Drilling Operations – Constructing Roads and Tracks | If no existing access roads are available and BMMC/Aureus requires a track to be constructed then the following issues need to be considered:<br>▪ Before construction commences, it is crucial that all earth moving and road equipment is cleaned of all soil and plant/weed seeds before being moved to the new area; and<br>▪ Aim for construction of roads during favourable seasons (ie. avoid construction of roads and tracks during the wet season). | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | Duration of mitigation measures | Responsible Person/Party |
|---|---|---|---|---|---|
| 10 | Aureus Mining Procedure 2 | Drilling Operations – Actual track construction | Guidelines that need to be followed by contractors for the actual construction of roads includes:<br>▪ Only construct a road to a depth sufficient for the designated use of the track;<br>▪ Consider rolling or clearing tracks with the dozer blade set 300 mm above ground level for any lightly used tracks;<br>▪ Promote the use of the pre-existing wheel tracks for access to lightly used areas;<br>▪ Disguise the entry point onto tracks and roads wherever possible to discourage their use for recreational purposes;<br>▪ Control travelling speeds by constructing roads with gentle curves rather than long straight sections; and<br>▪ If available, build up heavily used roads with compacted gravel to reduce the occurrence of wheel rut formation. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |
| 11 | Aureus Mining Procedure 2 | Drilling Operations – Additional requirements | In addition to actual track construction, a number of other requirements need to be met, including:<br>▪ Ensure that all topsoil or vegetation that is removed is stockpiled for later use during road /track rehabilitation;<br>▪ Allow for surface run off from roads to be diverted away via spoon drains and avoid any erosion damage or sediment loads into water bodies ;<br>▪ Avoid any significant work or maintenance on tracks or roads during wet weather; and<br>▪ Instruct contractor drilling personnel about their responsibility in the correct use of tracks and roads. | Throughout the Exploration Phase | Aureus Exploration Manager, Aureus Environmental Manager and Drilling Contractors |
| **Aureus Mining Procedure 3. Drilling Operations – Exploration** | | | | | |
| 12 | Aureus Mining Procedure 3 | Drilling Operations – Planning of borrow pits | Key planning issues associated with the location, construction and use of borrow pits includes:<br>▪ The preparation of a suitable plan that identifies the proposed location of all pits in relation to drainage lines, roads and areas that are considered to be sensitive for cultural or environmental reasons;<br>▪ Establishing a surveyed (GPS) photo point at each borrow pit site;<br>▪ Locate borrow pits away from natural drainage lines and use, where practical, a natural vegetative screen to minimise the visual impact from roads; and<br>▪ On slopes that are prone to surface run off, position borrow pits along contours. | Throughout the Exploration Phase | Aureus Exploration Manager, Aureus Environmental Manager and Drilling Contractors |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | Duration of mitigation measures | Responsible Person/Party |
|---|---|---|---|---|---|
| 13 | Aureus Mining Procedure 3 | Drilling Operations – Construction of borrow pits | The environmental considerations relating to the construction of borrow pits include:<br>▪ Restrict individual pits to a maximum area of 50m x 200m and only clear vegetation within this zone;<br>▪ Allow and construct only one access road to and from the borrow pit;<br>▪ Buffer zones of at least 30m should be left between individual pits to provide a seed source to aid in rehabilitation efforts; and<br>▪ Excavation of pits must not exceed 2 metres in depth. | Throughout the Exploration Phase | Aureus Exploration Manager, Aureus Environmental Manager and Drilling Contractors |
| 14 | Aureus Mining Procedure 3 | Drilling Operations – Topsoil stockpiling and rehabilitation | To assist in the successful rehabilitation of borrow pits, they must be constructed to ensure that:<br>▪ All topsoil is to be removed and stockpiled for re-use during rehabilitation; and<br>▪ No waste from exploration camp or drilling operations is to be buried in borrow pits.<br>Guidelines for the rehabilitation of borrow pits is outlined in the *Procedure 5 – Topsoil Management and Rehabilitation*. | Throughout the Exploration Phase | Aureus Exploration Manager, Aureus Environmental Manager and Drilling Contractors |
| **Aureus Mining Procedure 4. Drilling Operations – Waste management** | | | | | |
| 15 | Aureus Mining Procedure 4 | Drilling Operations – Drill site waste | ▪ Drilling operations produce a range of waste products that include ripped sample bags, drill rods, general domestic waste, waste lubricants, waste sample material etc.<br>▪ Both drilling contractor and Aureus must check site to make sure it is clear of waste. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |
| 16 | Aureus Mining Procedure 4 | Drilling Operations – Solid waste | All solid waste generated at a drill site:<br>▪ must not be buried on site under any circumstances;<br>▪ must be returned to the exploration camp and if appropriate, properly segregated (eg. domestic waste, scrap steel etc);<br>▪ must be securely contained to prevent loss during transportation;<br>▪ must be stockpiled safely at the exploration camp in preparation for disposal or removal to a recycling plant if appropriate (eg. drill rods and recyclable material);<br>▪ must be completely removed from each drill pad (including cigarette butts) before drilling commences at a new site. There must be nothing left; and<br>▪ will be audited periodically to ensure that no waste materials remain at any drill site commissioned by the company. | Throughout the Exploration Phase | Aureus Exploration Manager, Environmental Manager, and Drilling Contractors |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | Duration of mitigation measures | Responsible Person/Party |
|---|---|---|---|---|---|
| 17 | Aureus Mining Procedure 4 | Drilling Operations – Hydrocarbon waste | All hydrocarbon-based waste generated at a drill site must be:<br>▪ treated according to the Procedure 9 - Hydrocarbon and Chemical Management if the waste product is a hydrocarbon or chemical waste; and<br>▪ removed to temporary storage, if it consists of contaminated soils (storage methods will be dependent on the level of contamination). All contaminated material must be removed from the lease for treatment or disposal off-site. | Throughout the Exploration Phase | Drilling Contractors |
| 18 | Aureus Mining Procedure 4 | Drilling Operations – Liquid waste | Liquid waste generated through the use of water during drilling operations:<br>▪ must be contained in a sump within the boundaries of the drill pad as per the *Procedure 1 - Drilling Operations;*<br>▪ should have suspended sediment settled out and removed prior to disposal or evaporation;<br>▪ must not be allowed to contaminate groundwater; and<br>▪ should be re-used at every available opportunity.<br>Liquid hydrocarbon waste generated from vehicles, heavy equipment and drill rigs must be:<br>▪ managed in accordance with the Procedure 9-Hydrocarbons and Chemical Management;<br>▪ remain within the boundaries of the drill pad;<br>▪ placed in appropriate sealed containers for transport to the exploration camp and then off the lease;<br>▪ held in a suitable location prior to removal off site; and<br>▪ cleaned up immediately if spilt, along with any contaminated soil for removal off site. | Throughout the Exploration Phase | Aureus Exploration Manager, Environmental Manager, and Drilling Contractors |
| 19 | Aureus Mining Procedure 4 | Drilling Operations – Exploration camp waste | It is important that waste materials generated from an exploration camp:<br>▪ **must not** be buried on site;<br>▪ will be suitably packaged and placed in a designated trailer for removal off the lease area;<br>▪ must be securely covered while being transported;<br>▪ that consists of human generated waste and contaminated waste water must be disposed of in accordance with State Health Regulations. Domestic wastewater must be disposed of in a manner that prevents the contamination of surface and groundwater;<br>▪ that can be recycled, be segregated and stockpiled safely in preparation for removal to appropriate recycling facilities; and<br>▪ consisting of oily rags, disused parts etc be stored in disused 200 L drums (with suitable lids) that cannot fill with rainwater. | Throughout the Exploration Phase | Aureus Exploration Manager, Environmental Manager, and Drilling Contractors |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | Duration of mitigation measures | Responsible Person/Party |
|---|---|---|---|---|---|
| **Aureus Mining Procedure 5. Drilling Operations –Environmental Monitoring** | | | | | |
| 20 | Aureus Mining Procedure 5 | Drilling Operations – Baseline environmental surveys | As a minimum, the following should be considered for inclusion whenever exploration activities are to occur:<br>▪ photographs should be taken of all areas likely to be disturbed, prior to any clearance of access roads and tracks or any exploration drilling work. All photo points must be logged using a GPS;<br>▪ flora and fauna surveys must be carried out in areas of high environmental significance or in areas of particular environmental sensitivity;<br>▪ photographic and archaeological surveys may be needed in areas that have high cultural values;<br>▪ baseline studies, that incorporate soil surveys, will assist in identifying areas that may have a high erosion potential; and<br>▪ completion of any required hydrogeological surveys in areas of high environmental significance, to ensure that high quality groundwater resources are not impacted and the extraction of groundwater does not affect local vegetation. | Throughout the Exploration Phase | Environmental Manager |
| 21 | Aureus Mining Procedure 5 | Drilling Operations – Monitoring during exploration programs | Periodic monitoring during an exploration program requires:<br>▪ planning of the monitoring program to ensure it is scientifically and statistically valid;<br>▪ that monitoring sites are well chosen;<br>▪ that the monitoring frequency and timing is carefully selected with consideration for seasonal variations;<br>▪ the program is able to quantify any significant impacts or changes; and<br>▪ a suitable reporting structure is developed. | Throughout the Exploration Phase | Environmental Manager |
| 22 | Aureus Mining Procedure 5 | Drilling Operations – Monitoring after exploration is completed | ▪ All areas that have been cleared as part of an exploration program will need to be monitored to determine the success of implemented rehabilitation works.<br>▪ It is important that flora and vegetation are monitored for their growth rates, but also the re-colonization of fauna to a rehabilitated area should be monitored periodically to determine the total success of rehabilitation programs.<br>▪ As a minimum, photo monitoring prior to and immediately after rehabilitation should be carried out and then on a periodic basis until the program identifies that the rehabilitation has been effective. | Throughout the Exploration Phase | Environmental Manager |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | Duration of mitigation measures | Responsible Person/Party |
|---|---|---|---|---|---|
| **Aureus Mining Procedure 6. Drilling Operations – Topsoil Management and Rehabilitation** | | | | | |
| 23 | Aureus Mining Procedure 6 | Drilling Operations – Storage and management of topsoil | In arid areas, shallow topsoil containing plant seeds and basic organic matter:<br>▪ should be carefully removed and stockpiled when an area is being cleared;<br>▪ must be stockpiled separately to subsoils and any cleared vegetation;<br>▪ when locating topsoil stockpiles, consider the need to re-access the stockpile for use at a later date;<br>▪ should be pushed into stockpiles that are low (generally less than 2m), have a reasonable surface area, be gently battered and located away from drainage lines;<br>▪ should not be stored for more than 12 months, as storage time diminishes seed viability and microbial activity ; and<br>▪ once stockpiled, should promote revegetation to protect the soil from erosion, discourage weeds and maintain soil microbe populations. | Throughout the Exploration Phase | Aureus Exploration Manager, Environmental Manager, and Drilling Contractors |
| 24 | Aureus Mining Procedure 6 | Drilling Operations – General rehabilitation principles | Successful rehabilitation of disturbed areas requires that all the following guidelines be implemented:<br>▪ the removal of all structures, waste material and contaminated soil;<br>▪ filling of all pits and sumps and the re-establishment of all natural drainage lines;<br>▪ ensuring that all drill holes are capped in accordance *with Procedure 8 – Drill Hole Sampling and Capping*;<br>▪ ensuring that all rehabilitation work carried out promotes the contouring and subsequent blending of the area back to the original land form;<br>▪ areas of compacted subsoils are loosened and stored topsoil is effectively redistributed over re-contoured areas; and<br>▪ the success of regenerated areas, including any areas prone to erosion, is monitored. | Throughout the Exploration Phase | Aureus Exploration Manager and Environmental Manager |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | | Duration of mitigation measures | Responsible Person/Party |
|---|---|---|---|---|---|---|
| 25 | Aureus Mining Procedure 5 | | Rehabilitation of camp Sites | All exploration campsites that are no longer needed by the company are to be rehabilitated and successfully re-vegetated in accordance with company policy. The closure and decommissioning of a camp site involves the following steps:<br>▪ Rehabilitation Planning<br>assemble all photographic and written records that detail the condition of the site prior to the construction of the camp; and<br>in consultation with landowners, develop a suitable rehabilitation plan or strategy for the site.<br>▪ Camp Closure and Rehabilitation<br>removal of all equipment from the site including all accommodation units, storage sheds etc.;<br>removal of any stockpiled waste or recyclable materials;<br>excavation and removal of any contaminated soil from the fuel storage facility or any other areas within the camp;<br>filling and levelling of all drains, sumps or other water diversions with the aim of reconstructing the contours of the original landform;<br>respreading of all available original topsoil and any stockpiled vegetation over the site;<br>deep ripping of heavily compacted land. If not required, harrowing of the surface may be used. Ensure that any ripping or harrowing is done along the contours of sloping sites; and<br>documenting of the rehabilitation work and periodic monitoring of the site to determine the success of the work. | Throughout the Exploration Phase | Aureus Exploration Manager, Environmental Manager, and Drilling Contractors |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | | Duration of mitigation measures | Responsible Person/Party |
|---|---|---|---|---|---|---|
| 26 | Aureus Mining Procedure 5 | | Tracks and roads | Lightly used roads and tracks:<br>▪ tracks originally cleared using "blade up" techniques and lightly compacted may be best left to regenerate naturally; and<br>▪ other tracks which are slightly more compacted should be harrowed after the redistribution of topsoil and any previously cleared vegetation.<br>Roads constructed in a more conventional manner will require:<br>▪ all drains and culverts to be removed and drainage patterns returned to pre-existing conditions;<br>▪ some local contour adjustment to return the altered landform to its original contours;<br>▪ deep ripping or harrowing depending on the level of compaction;<br>▪ all ripping to follow the contours on sloping areas (not down-slope);<br>▪ replacing and dispersing sub-soils over the road surface; and<br>▪ redistributing topsoil and stockpiled vegetation over the subsoils. | Throughout the Exploration Phase | Aureus Exploration Manager |
| 27 | Aureus Mining Procedure 5 | | Rehabilitation of borrow pits | As a guide, the most effective methods for the rehabilitation of these pits include:<br>▪ initial regrading and shaping, to create a well contoured level surface which is self-draining;<br>▪ the floor of the pit should be ripped to a 50cm depth at a 2 metre line spacing;<br>▪ ripping to be carried out along in-pit contours;<br>▪ in sloping areas, erosion controls may be needed to divert run on water from above the pit;<br>▪ any stockpiles of sub-soil to be returned and spread evenly over pit and its access road;<br>▪ stockpiled topsoil must then be spread evenly over the surface of the pit;<br>▪ any previously cleared vegetation or stockpiled timber to be spread over the topsoil; and<br>▪ if seeding of borrow pits is required, then local seed collected from shelter belts around the pit should be used. | Throughout the Exploration Phase | Aureus Exploration Manager |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | | Duration of mitigation measures | Responsible Person/Party |
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| **Aureus Mining Procedure 7. Drilling Operations – Clearing of Roads, Tracks and Use of Borrow Pits** | | | | | | |
| 28 | Aureus Mining Procedure 7 | Drilling Operations – Roads and tracks | Planning | Approval to construct roads and tracks requires the company to:<br>▪ firstly, consider whether a road is actually required or can access be gained via alternative methods (ie helicopter);<br>▪ determine if there are any existing roads/tracks that can be used to gain access to a designated area;<br>▪ determine if the construction of all required roads is permitted under the exploration conditions and that the required approvals have been secured from the relevant authorities; and<br>▪ consult with landowners to determine any additional requirements that may be important prior to constructing the road.<br>Determining the most favourable location of access roads and tracks requires consideration of the following:<br>▪ use of aerial photographs to assist in the location of tracks and roads, especially in areas with considerable vegetation, sand dunes and/or salt lakes present;<br>▪ determine the type and volume of traffic likely to use the track and how long access will be required;<br>▪ plan all routes along suitable natural features and avoid areas of high erosion potential, the crossing of drainage channels and any areas of dense or sensitive vegetation;<br>▪ in arid environments stands of mature trees must be avoided and not cleared; and<br>▪ roads should ascend and descend along ridges wherever possible and traverse slopes along contour lines. | Throughout the Exploration Phase | Aureus Exploration Manager |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | | Duration of mitigation measures | Responsible Person/Party |
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| 29 | Aureus Mining Procedure 7 | | Constructing roads and tracks | If no existing access roads are available and the company requires a track to be constructed then the following issues need to be considered:<br>▪ before construction commences, it is crucial that all earth moving and road equipment is cleaned of all soil and plant/weed seeds before being moved to the new area; and<br>▪ aim for construction of roads during favourable seasons (ie. avoid construction of roads and tracks during the wet season).<br>Guidelines that need to be followed by contractors for the actual construction of roads includes:<br>▪ only construct a road to a depth sufficient for the designated use of the track;<br>▪ consider rolling or clearing tracks with the dozer blade set 300 mm above ground level for any lightly used tracks;<br>▪ promote the use of the pre-existing wheel tracks for access to lightly used areas;<br>▪ disguise the entry point onto tracks and roads wherever possible to discourage their use for recreational purposes;<br>▪ control travelling speeds by constructing roads with gentle curves rather than long straight sections; and<br>▪ if available, build up heavily used roads with compacted gravel to reduce the occurrence of wheel rut formation.<br>▪ In addition to actual track construction, a number of other requirements need to be met, including:<br>▪ ensure that all topsoil or vegetation that is removed is stockpiled for later use during road /track rehabilitation;<br>▪ allow for surface run off from roads to be diverted away via spoon drains and avoid any erosion damage or sediment loads into water bodies ;<br>▪ avoid any significant work or maintenance on tracks or roads during wet weather; and<br>▪ instruct contractor drilling personnel about their responsibility in the correct use of tracks and roads.<br>Rehabilitation of all roads and track should be carried out in accordance with the requirements of *Procedure 5 – Topsoil Management and Rehabilitation.* | Throughout the Exploration Phase | Aureus Exploration Manager |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | | Duration of mitigation measures | Responsible Person/Party |
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| 30 | Aureus Mining Procedure 7 | Drilling Operations – Use and management of borrow pits | Planning | Key planning issues associated with the location, construction and use of borrow pits includes:<br>▪ the preparation of a suitable plan that identifies the proposed location of all pits in relation to drainage lines, roads and areas that are considered to be sensitive for cultural or environmental reasons;<br>▪ establishing a surveyed (GPS) photo point at each borrow pit site;<br>▪ locate borrow pits away from natural drainage lines and use, where practical, a natural vegetative screen to minimise the visual impact from roads; and<br>▪ on slopes that are prone to surface run off, position borrow pits along contours. | Throughout the Exploration Phase | Aureus Exploration Manager |
| 31 | Aureus Mining Procedure 7 | | Construction | The environmental consideration relating to the construction of borrow pits include:<br>▪ restrict individual pits to a maximum area of 50m x 200m and only clear vegetation within this zone;<br>▪ allow and construct only one access road to and from the borrow pit;<br>▪ buffer zones of at least 30m should be left between individual pits to provide a seed source to aid in rehabilitation efforts; and<br>▪ excavation of pits must not exceed 2 metres in depth. | Throughout the Exploration Phase | Environmental Manager, and Drilling Contractors |
| 32 | Aureus Mining Procedure 7 | | Topsoil stockpiling and rehabilitation | To assist in the successful rehabilitation of borrow pits they must be constructed to ensure that:<br>▪ all topsoil is to be removed and stockpiled for reuse during rehabilitation; and<br>▪ no waste from exploration camps or drilling operations is to be buried in borrow pits.<br>Guidelines for the rehabilitation of borrow pits is outlined in the *Procedure 5– Topsoil Management and Rehabilitation.* | Throughout the Exploration Phase | Environmental Manager and Drilling Contractors |

| No. | Reference | Exploration Activity | | Mitigation & Control Measure(s) | Duration of mitigation measures | Responsible Person/Party |
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| **Aureus Mining Procedure 8. Drilling Operations – Management of Exploration Camps** | | | | | | |
| 33 | Aureus Mining Procedure 8 | Drilling Operations – Planning and siting exploration camps | Planning | Key planning considerations that need to be incorporated at an early stage include:<br>▪ whether a camp site is actually needed or if it is possible to travel to exploration or drilling areas from an existing camp;<br>▪ the expected duration of the camp;<br>▪ if any pre-existing access roads or tracks exist to/from the proposed location of the camp;<br>▪ the proposed size of the camp and the area required to be cleared for all camp facilities – it is important to minimise the "footprint" of the camp as much as practical;<br>▪ the requirement to **avoid any clearing** of mature or semi-mature vegetation;<br>▪ the expected volume of waste likely to be generated and the proposed means of storage/removal of this material;<br>▪ how the costs of relating to the closure and rehabilitation of the camp can be reduced through effective early planning decisions; and<br>▪ the identification and recording of pre-existing environmental conditions of the site prior to disturbance, (baseline conditions) through the use of survey and photographic evidence. This will also assist in future closure and rehabilitation work. | Throughout the Exploration Phase | Aureus Exploration Manager |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | | Duration of mitigation measures | Responsible Person/Party |
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| 34 | Aureus Mining Procedure 8 | | Site selection | The selection of a suitable campsite must consider:<br>▪ the landowners preferred location for a camp site;<br>▪ any additional concerns from landowners with respect to the operation of the camp, such as access roads, sites for the storage of waste etc;<br>▪ the existence and potential use of any previously degraded sites (ie old camp site, etc) in the vicinity of the favoured location;<br>▪ types of potential impacts of locating a camp at the selected site;<br>▪ any sensitive environmental/cultural issues associated with the proposed site;<br>▪ the erosion potential of the area once it has been cleared;<br>▪ the possibility of nuisance dust problems;<br>▪ the likelihood of contamination of any local surface or groundwater;<br>▪ the impacts, if any, on existing drainage patterns;<br>▪ the location of waste storage facilities;<br>▪ ease of access during construction and operation of the camp;<br>▪ the requirement to minimise damage to vegetation; and<br>▪ the location of fuel and oil storage facilities. | Throughout the Exploration Phase | Aureus Exploration Manager |
| 35 | Aureus Mining Procedure 8 | Drilling Operations – Construction of the camp | During the actual construction of the camp the following must be considered:<br>▪ camps are to be constructed in accordance with company plans and procedures;<br>▪ disturbance to soils and vegetation is to be kept to a minimum; and<br>▪ disposal of wastewater is to be undertaken in accordance with company guidelines. | | Throughout the Exploration Phase | Aureus Exploration Manager |
| 36 | Aureus Mining Procedure 8 | Drilling Operations – Environmental Management of the camp during occupancy | To ensure that the day-to-day operation of the campsite has a minimal impact:<br>▪ a clear set of camp rules are produced and provided to all staff and contractors;<br>▪ camp rules are adhered to on a day-to-day basis;<br>▪ any environmental incidents are reported, as directed in the *Procedure 3 – Environmental Incident and Non-Compliance Reporting*;<br>▪ all waste generated at the site and waste returned from drilling operations must be managed in accordance with the *Procedure 3 – Waste Management*;<br>▪ hydrocarbons and chemical storage conforms to *Procedure 9 – Hydrocarbon and Chemical Management*; and<br>▪ sewage and wastewater is disposed of in safe and responsible manner. | | Throughout the Exploration Phase | Aureus Exploration Camp Manager |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | Duration of mitigation measures | Responsible Person/Party |
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| 37 | Aureus Mining Procedure 8 | Drilling Operations – Closure and rehabilitation of exploration camps | Factors that need to be considered when closing a camp include the:<br>▪ requirement to ensure that pre-camp conditions can eventually be achieved following rehabilitation;<br>▪ removal of **all** camp buildings, equipment and other temporary infrastructure from the site;<br>▪ removal of all wastes and recyclable material off the lease area;<br>▪ repair of any damaged drainage lines and refilling of any constructed sumps;<br>▪ removal of any contaminated soil (including material sourced from drill pads); and<br>▪ implementation of a monitoring program (photographic) to evaluate the on-going progress and success of rehabilitation efforts. | Throughout the Exploration Phase | Aureus Exploration Camp Manager |
| **Aureus Mining Procedure 9. Drilling Operations – Drill Hole Sampling and Capping** | | | | | |
| 38 | Aureus Mining Procedure 9 | Drilling Operations – Management of sample bags | Sample bags used for drilling should be managed as follows:<br>▪ whenever possible, use non-synthetic sample bags;<br>▪ ensure that the quantity of bags removed from temporary storage are only those needed for immediate drilling work;<br>▪ ensure that sample bags are secured at all times to prevent their loss to wind gusts;<br>▪ any bags that become wind borne must be retrieved immediately; and<br>▪ the quantity of bags removed should be noted, recorded and accounted for at the completion of each drilling day.<br>▪ To minimise damage to the surrounding vegetation full sample bags must not be stored outside the immediate boundary of the drill pad. | Throughout the Exploration Phase | Drilling Contractors |
| 39 | Aureus Mining Procedure 9 | Drilling Operations – Contamination of topsoil | In order to minimise the environmental impact of these activities, employees and contractors should ensure that samples taken from the drill hole are either:<br>▪ placed back down the drill hole;<br>▪ removed from the site;<br>▪ blended in with the topsoil in the vicinity of the drill hole; or<br>▪ buried before final rehabilitation activities. | Throughout the Exploration Phase | Drilling Contractors |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | | Duration of mitigation measures | Responsible Person/Party |
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| 40 | Aureus Mining Procedure 9 | Drilling Operations – Capping of drill holes | At the completion of drilling activities, the drilling contractor generally shall do the following:<br>▪ re-level the ground to the pre-drilling contour without leaving a hole or depression ;<br>▪ if applicable, cut the casing to 30cm below the surface;<br>▪ cap all drilled holes with **Aureus** supplied plugs;<br>▪ ensure that the plug is correctly seated into the casing<br>▪ Seal the hole with the plug by the concrete of 0.5m by 0.5m by 0.25m dimension, with polypipe sticking out of the plug to identify the hole. Top of concrete plug should be level with ground surface.<br>▪ This completes the contractor responsibility for the hole.<br>▪ GGM will then log and record the location of the hole with a GPS and mark its location with a relevant marker; | | Throughout the Exploration Phase | Drilling Contractors |
| 41 | Aureus Mining Procedure 9 | Drilling Operations – Drill holes encountering water | All drill holes that encounter groundwater must be sealed at relevant intervals to:<br>▪ eliminate the chance of cross contamination of aquifers of differing salinities; and<br>▪ prevent the discharge of ground waters to the surface. | | Throughout the Exploration Phase | Drilling Contractors |
| 42 | Aureus Mining Procedure 9 | Drilling Operations – Documentation of drilling activities | ▪ All drill sites are to be photographed prior to drill pad construction, prior to collaring, after completion of drilling and after completion of site rehabilitation. Photographs should also be taken at regular intervals after the completion of drilling to monitor vegetation regrowth progress.<br>▪ This checklist is to be signed by both the Exploration Manager and the Contractor representative after each hole is drilled and rehabbed. | | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |
| **Aureus Mining Procedure 10. Drilling Operations – Hydrocarbon and Chemical Management** | | | | | | |
| 43 | Aureus Mining Procedure 10 | Drilling Operations – Management of hydrocarbons | Transportation | ▪ all vehicles transporting fuels and oils must be roadworthy and suitable for the safe transport of the goods in question;<br>▪ all drums or containers should be properly secured to restrict movement and spillages;<br>▪ appropriate identification and safety signs must be displayed and fire equipment carried for the transportation of bulk quantities; and<br>▪ responsible driving practices must be adhered to at all times. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | | Duration of mitigation measures | Responsible Person/Party |
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| 44 | Aureus Mining Procedure 10 | | Storage of bulk fuels and oils | Storage of fuels and oils:<br>▪ should be earth bunded to a volume of 110% of the largest container of stored fuel;<br>▪ should be located away from camp accommodation areas;<br>▪ require adequate fire extinguishers to be available;<br>▪ should be cleared of all vegetation to a radius of 3 metres around the facility; and<br>▪ that require off site disposal or recycling, will have appropriate storage containers and be stored in a safe and secure manner. | Throughout the Exploration Phase | Aureus Exploration Manager and Environmental Manager |
| 45 | Aureus Mining Procedure 10 | | Use of hydrocarbon products | ▪ refuelling and servicing of most vehicles and equipment must be carried out in a designated area within the fuel storage area;<br>▪ all unloading, loading or handling of fuels must be conducted away from drainage lines;<br>▪ drilling rigs should ideally be serviced and refuelled at exploration camps. If drilling rigs require any refuelling or servicing whilst at drill pads then all relevant precautions should be taken to minimise the probability of spills;<br>▪ all soil contaminated by fuels or oil spills shall be removed to the exploration camp for temporary storage, prior to the removal off the tenement;<br>▪ in the event that hydrocarbon contaminated soil cannot be removed to the exploration camp, it should be spread thinly over disturbed ground, ripped and a small quantity of fertiliser added to facilitate remediation;<br>▪ empty fuel and oil drums must be properly stockpiled to eliminate the spillage of residual oils and fuels;<br>▪ all empty drums and containers must be periodically removed from the site and appropriately disposed or recycled;<br>▪ all spills over 20 litres must be reported via the *Accident/Incident Report Form and procedure* provided in this Manual. A GPS coordinate must be taken of the spill location and recorded on the incident form; and<br>▪ all AUREUS exploration staff and contractors are to be adequately trained in the proper handling of hydrocarbon products. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | | Duration of mitigation measures | Responsible Person/Party |
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| 46 | Aureus Mining Procedure 10 | Drilling Operations – Use and management of chemicals | | All information concerning the use, safety and storage of individual chemical products is documented on relevant Material Safety Data Sheets (MSDS). MSDS's must be available for all chemicals used on site.<br>It is essential that all staff and field personnel are aware of the potential hazards involved with the handling of chemicals and that clean up procedures in the event of a spill are clearly understood.<br>Chemicals must be:<br>▪ handled, used and stored in strict compliance with the relevant MSDS; and<br>▪ managed in accordance with regulations covering the transportation of chemicals on public roads. These regulations are to be applied to all exploration roads/tracks. | Throughout the Exploration Phase | Aureus Exploration Manager and Environmental manager |
| 47 | Aureus Mining Procedure 10 | | Storage of Chemical Products | Individual chemicals will require specific storage procedures. These will be outlined in the relevant MSDS. Overall, all chemicals must be:<br>▪ clearly labelled and held in appropriate storage containers;<br>▪ stored within the manufacturers recommended temperature range for safe storage;<br>▪ stored in a secure facility; and<br>▪ stored away from accommodation areas, regions of high vehicle use etc. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |
| 48 | Aureus Mining Procedure 10 | | Surplus Chemicals | Supplies of chemicals that are surplus to requirements should be securely stored until they can be removed from the exploration site and disposed of in the appropriate manner. Empty chemical containers must not be buried on site and must be removed and disposed of in the designated area or according to the appropriate AUREUS procedure for disposal of the chemical(s). Under no circumstances should excess chemicals be buried on site. | Throughout the Exploration Phase | Aureus Exploration Manager, Environmental Manager and Drilling Contractors |

| No. | Reference | Exploration Activity | | Mitigation & Control Measure(s) | Duration of mitigation measures | Responsible Person/Party |
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| **Aureus Mining Procedure 11. Drilling Operations – Reconnaissance Exploration Activities** | | | | | | |
| 49 | Aureus Mining Procedure 11 | Drilling Operations – Reconnaissance exploration activities | Authorisation and consultation | All exploration work conducted by the company must:<br>▪ if vegetation disturbance is unavoidable, exploration work must be undertaken in accordance with *Procedure 5 – Top soil Management and Rehabilitation*<br>▪ ensure that the required authorisation for access has been granted (*Procedure 2 - Approvals);*<br>▪ discuss suitable access to the area with landowner in relation to gates, existing access roads and tracks etc.;<br>▪ not be undertaken in unfavourable climatic conditions;<br>▪ if it is to be conducted on pastoral land, limit disturbance to any stock or crop; and<br>▪ be aware of any known areas of cultural significance. Unidentified sites that are found are to be reported to senior management for notification to any relevant Lands Council. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |
| 50 | Aureus Mining Procedure 11 | | Vehicle Preparation and Management | All vehicles used by exploration personnel must:<br>▪ prior to entering a new area, have been rigorously cleaned to reduce the spread of weeds and exotic plants;<br>▪ if the vehicle has previously been used in an area where livestock diseases existed, appropriate safeguard measures are required before the vehicle is used at a new site;<br>▪ comply with any quarantine restrictions (eg. noxious weeds or disease) within the designated exploration area or any special precautions need to be noted and observed before entering or leaving these areas; and<br>▪ if required to traverse regions of long dry grass, vehicles will need to be fitted with spark arrestors. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |

| No. | Reference | Exploration Activity | Mitigation & Control Measure(s) | | Duration of mitigation measures | Responsible Person/Party |
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| 51 | Aureus Mining Procedure 11 | Drilling Operations – Responsible vehicle use | General Driving | ▪ **always** use existing tracks wherever possible and avoid any unnecessary off road driving over vegetation;<br>▪ limit and adjust driving speed in accordance with the terrain and road conditions;<br>▪ avoid generating large amounts of dust when driving on unsealed dusty roads;<br>▪ restrict off-road travel during periods of wet weather in order to reduce wheel rut formation and the potential bogging of vehicles;<br>▪ refuel all vehicles in a manner that minimises spills; and<br>▪ wherever possible follow the contours of hills rather than traversing hills at steep angles 'when off-road'. | Throughout the Exploration Phase | Aureus Exploration Manager and Drilling Contractors |
| 52 | Aureus Mining Procedure 11 | | Traversing watercourses and drainage lines | ▪ when crossing watercourses or drainage lines use existing culverts and fords and if unavailable, cross in manner that does not increase the potential for erosion of stream or drainage line banks;<br>▪ avoid driving over vegetation on the banks of streams and drainage lines; and<br>▪ note existing drainage lines in order that wheel tracks do not modify them and cause erosion. | Throughout the Exploration Phase | Environmental Manager and Drilling Contractors |
| 53 | Aureus Mining Procedure 11 | Drilling Operations – Camping and camp sites | Guidelines to assist in reducing the impacts of a small temporary camp include:<br>▪ all rubbish must be removed - **do not bury;**<br>▪ bury all faecal waste at least 50 m away from all water courses;<br>▪ secure all waste at night to reduce the chance of access by wildlife;<br>▪ select the site carefully with respect to damage of any existing vegetation;<br>▪ select a site away from stock water supplies;<br>▪ if fires are permitted, ensure that the area is cleared of all vegetation and that only fallen timber is used;<br>▪ if the duration of the stay needs to be lengthened then correct authorisation must be obtained from relevant landowners. For long duration's, the relevant guidelines contained in *Procedure 7 - Management of Exploration Camps* must be implemented as required. | | Throughout the Exploration Phase | Environmental Manager and Drilling Contractors |

## 9.3 EMP for the NLGM Project

Table 52 presents the EMP, and notably the mitigation measures, that have been identified for the construction, operational and decommissioning and closure phases of the Project, based on the potential impacts identified and assessed in Sections 5 and 6.

**Table 52: Environmental Management Programme – NLGM Project**

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
|---|---|---|---|---|---|---|---|---|---|
| **Soils – Construction & Operational Phases** | | | | | | | | | |
| 1. | Section 5.2<br><br>Liberia Integrated Water Resources Management (IWRM) Policy, 2006 | Disturbance of soil and erosion | Soil structure (fabric) will be altered due to compaction, reduced infiltration and increased erosion potential | Moderate | Low | ▪ Scalping (removal) of the upper 50cm of soil material prior to site disturbance The scalped soil will be stockpiled and demarcated.<br>▪ Where feasible, disturbed, exposed areas will be top dressed and re-vegetated on an ongoing basis during construction and operation. At closure, cleared areas will be restored where feasible.<br>▪ Areas that may be prone to erosion or where signs of erosion are evident will be stabilised. Methods of stabilisation include: brush-cut packing, mulch or chip cover, straw stabilising, sodding, hydro-seeding, the application of soil binders and physical stabilisation methods such as gabions, reno-mattresses, armour flex or retaining walls.<br>▪ Traffic and movement over stabilised areas will be restricted and controlled, and damage to stabilised areas shall be repaired and maintained to the satisfaction of the Environmental Manager.<br>▪ The total footprint area to be disturbed / developed will be kept to a minimum by demarcating the construction areas and restricting construction to these areas only | Life of mine as impacts occur | NLGM Operations Manager, with assistance from the Environmental Manager | Evidence of demarcated construction areas and enforcement thereof, scalping and erosion control measures. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
|---|---|---|---|---|---|---|---|---|---|
| 2. | | Sterilisation of soil/land | Sterilisation of land for other and future potential uses, mainly via compaction. Loss of Soil Body "A" where some soils have a favourable agricultural production potential | Moderate | Moderate | ▪ Mitigation is possible by means of the scalping and stockpiling of soils from affected areas (waste rock dump, processing plant and tailings dam) prior to mining. Soil amelioration via deep ripping will reduce compaction. | Life of mine | NLGM Operations Manager, with assistance from the Environmental Manager | Evidence of stockpiling and demarcation. Survey reports. |
| 3. | | Loss of Potential Arable Crop Land | The tailings dam, waste rock dump and processing plant will bury 218 ha of Soil Body "A". | Moderate | Moderate | ▪ There appears to be abundant land beyond the mine footprint which will support agriculture to the same extent and mitigates the potential loss of the 89 ha. | Life of mine | NLGM Operations Manager, with assistance from the Environmental Manager | Evidence of demarcation limiting impact. |
| 4. | | Loss of Actual Arable Crop Land | Mining operations will impact on 4 ha (approximate extent) of subsistence cassava, pineapple and maize cultivated within the mine extent (615 ha). | Moderate | Low | ▪ Compensate affected families for loss of crop production and assist in securing other suitable land for their relocation. | Life of mine | Rehabilitation manger / construction manager | Evidence of demarcation limiting impact. |
| 5 | Section 5.2<br><br>Liberia | Soil Erosion and Pollution of the Marvoe | Exposure of soils in the mine lease area, | Moderate | Low | ▪ Diversion drains around the mine pit, tailings dam and waste rock dump will carry 'clean' storm water around/away | Life of mine | NLGM Operations Manager, with | Evidence of construction and stream |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
|---|---|---|---|---|---|---|---|---|---|
| | Integrated Water Resources Management (IWRM) Policy, 2006 | Creek and Attribute Streams Due to Increased Turbidity | notably on haul roads, around the mine pit, tailings dam, diversion creek and processing plant will increase soil erosion via storm water runoff.<br>Fine tailings discharging into water courses will result in increased suspended sediment loads.<br>Increased turbidity in the Marvoe Creek will impact on downstream users via poor quality drinking water and biodiversity impact (siltation of wetlands). | | | from the affected areas and discharge it downstream of the mine, that is, 'clean' and 'dirty' runoff are separated.<br>▪ If limited dirty runoff discharges from the mine directly into free-flowing streams, seepage (toe) dams are to be constructed below the tailings wall and other sites where necessary.<br>▪ With design of the TSF fine tailings should not be discharged into natural watercourses. Tailings will be confined behind the tailings dam wall. Even when large storm flows may cause the wall to be overtopped, any escaped tailings should collect in the seepage/toe dam to settle. Should the toe dam spill, flows will be so high under such conditions that effective dilution of any pollution will occur.<br>▪ During construction and operations, the DC will divert clean river flow around the mine pit and other mining structures.<br>▪ Sediment-laden water from the construction area is to be put through settling tanks for later release. | | assistance from the Environmental Manager | monitoring data and reports |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
|---|---|---|---|---|---|---|---|---|---|
| 6. | Section 5.2<br><br>Liberia Integrated Water Resources Management (IWRM) Policy, 2006<br><br>WHO limits used for purposes of EIS | Soil Contamination Due to Leaching of Soluble Chemical Pollutants | Contamination of soils by petrol, diesel, other soluble mine contaminants and cement is likely to occur, especially along haulage roads and within the vicinity of the pit and workshops. Contamination of soils around the tailings facility and waste rock dump are also areas of concern due to acid rock drainage. | Moderate | Low | ▪ Excessive soil contamination by fuel or oil spills, for example, from mining vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ using bioremediation, in accordance with BMMC's procedures to be developed. Vehicles will be maintained regularly and kept in a good working order. Vehicle maintenance will not be carried out in random areas of the site, but in the designated workshops. Vehicles and mine machinery will be operational mostly along haulage roads and within specific areas, thus confining any pollutants to specific areas.<br>▪ Fuel and oil tanks and dispensing areas will be isolated to capture any spills. Vehicle servicing, repairs and washing will be in isolated, controlled areas. Workshops will have hard floors and sumps to capture any fugitive oils and greases.<br>▪ Cement mixing and truck washing areas will be isolated, with a sump leading to settling tanks from which the purified water will be discharged.<br>▪ Soils of the area are inherently stable and fairly erosion resistant, implying that if any contamination occurs, lateral movement across the landscape will be minimal. The soils have a natural chemical buffering capacity and will thus minimize movement of pollutants to a great extent. | Life of Mine | NLGM Operations Manager, with assistance from the Environmental Manager | Ongoing monitoring and audit reports |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ▪ It is proposed that tailings facilities be designed with a clay liner and cover with a breaker layer which should significantly limit contamination once proven. | | | |
| **Soils – Decommissioning & Closure Phase** | | | | | | | | | |
| 1. | | Soil erosion and impacts due to rehabilitation activities | Continued erosion and compaction of soil | Medium | Low | Same measures as for construction phase | Life of mine | NLGM Operations Manager, with assistance from the Environmental Manager | Evidence of erosion control measures |
| **Surface Water – Construction Phase** | | | | | | | | | |
| 1. | Liberia Integrated Water Resources Management (IWRM) Policy, 2006<br><br>WHO limits | Surface water contamination | Erosion and sedimentation | Moderate | Low | Construction of stormwater collection channels conveying the runoff to sediment control dams. The sediment control dams will settle out the sediment | Throughout the construction phase | NLGM Construction Manager | Water quality and sediment monitoring |
| 2. | Liberia Integrated Water Resources Management (IWRM) Policy, 2006<br><br>WHO limits | Surface water sedimentation | River flow changes, change in river bank and riparian vegetation areas, increase of erosion | Moderate | Low+ | Properly designed culvert crossing to pass the design flood with minimum backwater, physical stabilisation methods such as gabions, reno-mattresses, armour flex or retaining walls | Throughout the construction phase | NLGM Construction Manager | Water quality and sediment monitoring |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 3. | Liberia Integrated Water Resources Management (IWRM) Policy, 2006<br><br>WHO limits | Surface water sedimentation | Increase potential for erosion and sedimentation | Moderate | Low | The mitigation is to construct the channel during the dry season and to provide a sediment control dam at the diversion channel exit to settle out and reduce the sediment loads leaving the site | Throughout the construction phase | NLGM Construction Manager | Water quality and sediment monitoring |
| 4. | Liberia Integrated Water Resources Management (IWRM) Policy, 2006 | Surface water hydrology | Flooding of the diversion channel during construction | Moderate | Low+ | The mitigation measure proposed is to construct the diversion in the dry season and to schedule the construction to start at the downstream end to the upstream end with the flood control dyke constructed last. In this way the channel can drain and flood water will not interrupt construction | Throughout the construction phase | NLGM Construction Manager | Construction diversion in the dry season |
| **Surface Water – Operational Phase** | | | | | | | | | |
| 1. | Liberia Environmental Protection and Management Law (2006)<br><br>WHO limits | Pollution of surface water | Sub-standard water quality | Moderate | Low | Collect and treat the water in a sedimentation pond to meet the WHO drinking water standards | Throughout the operational phase. | NLGM Environmental Manager | Water treatment |
| 2. | Liberia Environmental Protection and Management Law (2006)<br><br>WHO limits | Pollution of surface water | Sub-standard water quality | Moderate | Low | Implementation of stormware management system | Throughout the operational phase. | NLGM Environmental Manager | Stormwater management |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
|---|---|---|---|---|---|---|---|---|---|
| 3. | Liberia Environmental Protection and Management Law (2006)<br><br>WHO limits | Pollution of surface water | Flooding of pit | Moderate | Low | Collect and treat the water in a sedimentation pond to meet the WHO drinking water standards | Throughout the operational phase. | NLGM Environmental Manager | Water treatment |
| 4. | Liberia Environmental Protection and Management Law (2006) | Flow reduction | Stream flow reduction | Low | Low | The catchment reduction is very small therefore the impact will be insignificant. No mitigation measures are required | N/A | N/A | N/A |
| **Surface Water – Decommissioning & Closure Phase** | | | | | | | | | |
| 1. | Liberia Environmental Protection and Management Law (2006) WHO | Dirty surface water | Decanting of pit after closure impacting on the Lake Piso RAMSAR wetland | Low | Low | N/A | N/A | N/A | N/A |
| 2. | Liberia Environmental Protection and Management Law (2006)<br><br>WHO Limits | Dirty surface water | Decanting sub standards water quality | High | Moderate | Research treatment options during LOM | Throughout the closure phase | NLGM Environmental Manager | Decant water treatment |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 3. | Liberia Environmental Protection and Management Law (2006)<br><br>WHO Limits | Pollution surface water | Poor water quality (sub standard) | High | Low | Maintain the stormwater management system | Throughout the closure phase | NLGM Environmental Manager | Maintenance stormwater management system |
| 4. | Liberia Environmental Protection and Management Law (2006) WHO | Pollution surface water | Flooding of dyke | High | Low | Inspect the flood control dyke in the Marvoe Creek and make repairs and upgrades. | Throughout the closure phase | NLGM Environmental Manager | Inspection the flood control dyke |
| **Groundwater – Construction Phase** | | | | | | | | | |
| 1. | Section 5 | All Aspects of the Construction Phase: Servicing and/or refuelling of construction equipment and vehicles. | Hydrocarbon contamination of soil (surface water and groundwater) from construction equipment and/or vehicle spillages. | | | ▪ Excessive soil contaminated by fuel or oil spills, for example, from mining vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ using bioremediation, in accordance with BMMC's procedures to be developed.<br>▪ Vehicles will be maintained regularly and kept in a good working order.<br>▪ Vehicle maintenance will not be carried out in random areas of the site, but in the designated workshops. | Throughout the construction phase, as the need arises. | NLGM Construction Manager | Vehicle maintenance records, records of hazardous waste management controls and practices etc. |
| 2. | Section 5 | Construction Phase:<br>In-pit water management<br>-<br>Pre- | Inflows of significant volumes of water into the pre-production mine workings. | | | ▪ Localised higher inflows could be effectively managed by advanced dewatering prior to mining. Alternatively drains could be constructed to drain these more significant flows to in-pit sumps. | Rainfall runoff and as soon as the water table is breached. | NLGM Mine Engineer & Environmental Manager. | Records of water quality monitoring, volumes pumped and where to. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| | | production mine workings. | | | | | | | Records of equipment. Rainfall gauging. |
| 3. | Section 5 | Construction Phase: In-pit water management - Pre-production mine workings. | Contamination of contact / mine water during. | | | ▪ Contact water quality monitoring for treatment if necessary and release into the environment or application elsewhere.<br>▪ Sediment settlement/removal would require the construction of sediment basins.<br>▪ Ensure that a hydrocarbon spills management plan is in place.<br>▪ Use emulsion explosives, which do not contain ANFO. | Throughout the construction phase. | NLGM Mine Engineer & Environmental Manager. | Records of mine water quality monitoring, volumes pumped and where to. Records of equipment. Rainfall gauging. |
| 4. | Section 5 | Construction Phase: Pre-production mine workings. | Lowering of the groundwater table. | | | ▪ Conduct a quantitative groundwater modelling study for the mining operations (by latest, the start of the construction phase),<br>▪ Commission groundwater monitoring system.<br>▪ Continuous monitoring of the water table in de-watering and monitoring boreholes. | Throughout the construction phase. | NLGM Mine Engineer & Environmental Manager. | Records of monthly water level monitoring. |
| 5. | Section 5 | Construction Phase: Pre-production mine workings. | Contamination of surrounding aquifers. | | | ▪ Due to groundwater flowing toward the dewatered mining areas, the surrounding aquifers are not expected to be impacted in terms of groundwater quality during the pre-production construction phase.<br>▪ Commission groundwater monitoring system.<br>▪ Implement quarterly groundwater quality monitoring. | Throughout the construction phase. | Environmental Manager. | Records of quarterly groundwater quality Monitoring. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 6. | Section 5 | Construction Phase: TSF. | Lowering of the groundwater table. | | | ▪ Water collected by the underdrain system will be conveyed to a manhole equipped with a pump, which will be located downstream of the TSF main dam. The quality of the water collected in the manhole will be continuously monitored. If the quality is acceptable for discharge it will be pumped to the Diversion Channel (DC) of the Marvoe Creek, if not, it will be pumped back to the TSF.<br>▪ Commission groundwater monitoring system.<br>▪ Implement monthly groundwater level monitoring. | Throughout the construction phase. | NLGM Construction Manager & Environmental Manager. | Records of sump water quality monitoring, volumes pumped and where to. Records of equipment. Rainfall gauging. Records of monthly water level monitoring records. |
| 7. | Section 5 | Construction Phase: TSF. | Contamination of underlying aquifers. | | | ▪ Separated rainfall runoff into clean and dirty water.<br>▪ All dirty water will be captured, to be re-used where possible.<br>▪ Implement quarterly groundwater quality monitoring. | Throughout the construction phase. | NLGM Construction Manager & Environmental Manager. | Records of quarterly groundwater quality monitoring. |
| 8. | Section 5 | Construction Phase: WRD. | Impact on the groundwater table. | | | ▪ Continuous sump pump volume metering and water distribution record keeping.<br>▪ Commission groundwater monitoring system.<br>▪ Implement monthly groundwater level monitoring. | Throughout the construction phase. | NLGM Construction Manager & Environmental Manager. | Records of sump water volumes pumped and where to. Records of equipment. Rainfall gauging. Records of monthly water level monitoring records. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 9. | Section 5 | Construction Phase: WRD. | Contamination of underlying aquifers. | | | ▪ Separated rainfall runoff into clean and dirty water.<br>▪ All dirty water should be captured, to be re-used where possible.<br>▪ Continuous sump water quality monitoring.<br>▪ Implement quarterly groundwater quality monitoring. | Throughout the construction phase. | NLGM Construction Manager & Environmental Manager. | Records of sump water quality monitoring Records of quarterly groundwater quality monitoring. |
| **Groundwater – Operational Phase** | | | | | | | | | |
| 1. | Section 6.3.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006 Liberian Drinking Water Quality Guidelines WHO Drinking Water Standards 1993 SANS 241 Drinking Water | All Aspects of the Operational Phase: Servicing and/or refuelling of construction equipment and vehicles. | Hydrocarbon contamination of soils (surface water and groundwater) from construction equipment and/or vehicle spillages. | Moderate | Low | ▪ Excessive soil contaminated by fuel or oil spills, for example, from mining vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ using bioremediation, in accordance with BMMC's procedures to be developed.<br>▪ Vehicles will be maintained regularly and kept in a good working order.<br>▪ Vehicle maintenance will not be carried out in random areas of the site, but in the designated workshops. | Throughout the operational phase, as the need arises. | NLGM Operational Manager. | Vehicle maintenance records, records of hazardous waste management controls and practices etc. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 2. | Section 6.3.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006 Liberian Drinking Water Quality Guidelines WHO Drinking Water Standards 1993 SANS 241 Drinking Water | Operational Phase: In-pit water management. | Inflows of significant volumes of water into the mine workings. | Moderate | Moderate | ▪ On-going dewatering from boreholes and in-pit sumps. | Throughout the operational phase. | NLGM Mine Engineer & Environmental Manager. | Records of biweekly mine water and monthly abstraction borehole quality monitoring, volumes pumped and where to. Records of equipment. Rainfall gauging. |
| 3. | Section 6.3.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006 Liberian Drinking Water Quality Guidelines WHO Drinking Water Standards 1993 SANS 241 Drinking Water | Operational Phase: In-pit water management. | Contamination of contact / mine water during. | High | Moderate | ▪ Biweekly or more often mine water quality monitoring for treatment if necessary and release into the environment or application elsewhere.<br>▪ Continued sediment removal implementation.<br>▪ Placement of in-pit sumps and sediment removal structures on material with the least ARD potential.<br>▪ Use emulsion explosives, which do not contain ANFO. | Throughout the operational phase. | NLGM Mine Engineer & Environmental Manager. | Biweekly records of mine water quality monitoring, volumes pumped and where to. Records of equipment. Rainfall gauging. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 4. | Section 6.3.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006 | Operational Phase: Mining. | Impact on the groundwater table. | Moderate | Moderate | ▪ Continued monitoring of the water table in de-watering and monitoring boreholes. | Throughout the operational phase. | NLGM Mine Engineer & Environmental Manager. | Records of monthly water level monitoring. |
| 5. | Section 6.3.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006<br>Liberian Drinking Water Quality Guidelines<br>WHO Drinking Water Standards 1993<br>SANS 241 Drinking Water | Operational Phase: Mining. | Contamination of surrounding aquifers. | Low | Low | ▪ Due to groundwater flowing toward the dewatered mining areas, the surrounding aquifers are not expected to be impacted in terms of groundwater quality during the operational phase.<br>▪ Continued quarterly groundwater quality monitoring. | Throughout the operational phase. | Environmental Manager. | Records of quarterly groundwater quality Monitoring. |
| 6. | Section 6.3.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006 | Operational Phase: TSF. | Impact on the groundwater table. | Moderate | Moderate | ▪ Continuous sump pump volume metering and water distribution record keeping.<br>▪ Continued monthly groundwater level monitoring.<br>▪ Rises in the water table that cannot be attributed to seasonality **should** serve as an early warning system to the effectiveness of the clay liner and its | Throughout the operational phase | NLGM Waste Manager & Environmental Manager. | Biweekly records of sump water volumes pumped and where to.<br>Records of equipment.<br>Rainfall |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| | | | | | | underlying drainage system.<br>▪ Evaluate newly-identified impacts. | | | gauging. Records of monthly water level monitoring records. |
| 7. | Section 6.3.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006 Liberian Drinking Water Quality Guidelines WHO Drinking Water Standards 1993 SANS 241 Drinking Water | Operational Phase: TSF | Contamination of underlying aquifers. | High | Moderate | ▪ Biweekly sump water quality monitoring.<br>▪ Continued quarterly groundwater quality monitoring.<br>▪ Evaluate newly-identified impacts | Throughout the operational phase. | NLGM Waste Manager & Environmental Manager. | Biweekly records of sump water quality monitoring. Records of quarterly groundwater quality monitoring. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 8. | Section 6.3.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006 | Operational Phase: WRD | Impact on the groundwater table. | Moderate | Moderate | ▪ Biweekly sump pump volume metering and water distribution record keeping.<br>▪ Continued monthly groundwater level monitoring will help quantifying the interaction between the WRD and the mine workings as well as the other zones of influence.<br>▪ Evaluate newly-identified impacts. | Throughout the operational phase. | NLGM Waste Manager & Environmental Manager Environmental Manager. | Records of biweekly sump water volumes pumped and where to. Records of equipment. Rainfall gauging. Records of monthly water level monitoring records. |
| 9. | Section 6.3.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006 Liberian Drinking Water Quality Guidelines WHO Drinking Water Standards 1993 SANS 241 Drinking Water | Operational Phase: WRD | Contamination of underlying aquifers. | High | Moderate | ▪ Biweekly sump water quality monitoring.<br>▪ Continued quarterly groundwater quality monitoring.<br>▪ Evaluate newly-identified impacts. | Throughout the operational phase | NLGM Waste Manager & Environmental Manager. | Records of biweekly sump water quality monitoring Records of quarterly groundwater quality monitoring. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| **Groundwater – Decommissioning & Closure Phase** | | | | | | | | | |
| 1. | Section 6.4.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006 Liberian Drinking Water Quality Guidelines WHO Drinking Water Standards 1993 SANS 241 Drinking Water | All Aspects of the Decommissioning & Closure Phase: Servicing and/or refuelling of construction equipment and vehicles | Hydrocarbon contamination of soils (surface water & groundwater) from construction equipment and/or vehicle spillages. | Moderate | Low | ▪ Excessive soil contaminated by fuel or oil spills, for example, from mining vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ using bioremediation, in accordance with BMMC's procedures to be developed.<br>▪ Vehicles will be maintained regularly and kept in a good working order.<br>▪ Vehicle maintenance will not be carried out in random areas of the site, but in the designated workshops. | Throughout the decommissioning and closure phase, as the need arises. | General Manager | Vehicle maintenance records, records of hazardous waste management controls and practices etc. |
| 2. | Section 6.4.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006 Liberian Drinking Water Quality Guidelines WHO Drinking Water Standards 1993 SANS 241 Drinking Water | Decommissioning, Closure and post Closure: In-pit water management | Inflow / Outflow of significant volumes of water from the defunct mine workings. | Moderate | Moderate | ▪ Stop open pit dewatering.<br>▪ Remove water diversion ditches to facilitate filling of the open Pit.<br>▪ Construct spill structures and ditch for the floodwater to spill to the DC.<br>▪ Monthly assessment of the water quality in the Open Pit and if required, provide water treatment system (e.g. pit lake treatment, constructed wetland, water treatment plant, etc.). | Throughout the decommissioning, closure and post closure phases. | NLGM Mine Engineer & Environmental Manager. | Records of monthly water quality monitoring, Rainfall gauging and in-pit water level rise as well as eventual decant volumes. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 3. | Section 6.4.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006 | Decommissioning, Closure and post Closure: Mining | Impact on the groundwater table. | Moderate + | Moderate + | ▪ Continued groundwater level monitoring.<br>▪ Evaluate newly-identified impacts. | Throughout the decommissioning, closure and post closure phases. | Environmental Manager. | Records of monthly water level monitoring. |
| 4. | Section 6.4.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006<br>Liberian Drinking Water Quality Guidelines<br>WHO Drinking Water Standards 1993<br>SANS 241 Drinking Water | Decommissioning, Closure and post Closure: Mining | Contamination of surrounding aquifers. | Moderate | Moderate | ▪ Continued groundwater quality monitoring.<br>▪ Evaluate newly-identified impacts | Throughout the decommissioning, closure and post closure phases. | Environmental Manager. | Records of six monthly groundwater quality Monitoring. |
| 5. | Section 6.4.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006 | Decommissioning, Closure and post Closure: TSF | Impact on the groundwater table. | Moderate + | Moderate + | ▪ Construct a permanent spillway to ensure physical stability of the facility during storm events.<br>▪ Cap the TSF (0.5 m of granular material to serve as a capillary break and 0.5 m of topsoil) in order to minimize rainfall infiltration and effect chemical stability to extent practically possible<br>▪ Continued groundwater level monitoring.<br>▪ Evaluate newly-identified impacts. | Throughout the decommissioning, closure and post closure phases. | NLGM Waste Manager & Environmental Manager. | Rainfall gauging. Records of monthly water level monitoring records. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 6. | Section 6.4.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006<br>Liberian Drinking Water Quality Guidelines<br>WHO Drinking Water Standards 1993<br>SANS 241 Drinking Water | Decommissioning, Closure and post Closure: TSF | Contamination of underlying aquifers. | Moderate | Moderate | ▪ Continued six monthly groundwater quality monitoring.<br>▪ Evaluate newly-identified impacts | Throughout the decommissioning, closure and post closure phases. | Environmental Manager. | Records of six monthly groundwater quality monitoring. |
| 7. | Section 6.4.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006 | Decommissioning, Closure and post Closure: WRD | Impact on the groundwater table. | Moderate | Moderate | ▪ Reshape, engineered capping & runoff water management to minimize rainfall infiltration and effect chemical stability to extent practically possible<br>▪ Continued monthly groundwater level monitoring will help quantifying the interaction between the WRD and the mine workings as well as the other zones of influence.<br>▪ Evaluate newly-identified impacts. | Throughout the decommissioning, closure and post closure phases. | NLGM Waste Manager & Environmental Manager. | Rainfall gauging. Records of monthly water level monitoring records. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 8. | Section 6.4.3 Liberia Integrated Water Resources Management (IWRM) Policy, 2006<br>Liberian Drinking Water Quality Guidelines<br>WHO Drinking Water Standards 1993<br>SANS 241 Drinking Water | Decommissioning, Closure and post Closure: WRD | Contamination of underlying aquifers. | Moderate | Moderate | ▪ Continued six monthly groundwater quality monitoring.<br>▪ Evaluate newly-identified impacts. | Throughout the decommissioning, closure and post closure phases. | Environmental Manager. | Records of six monthly groundwater quality monitoring. |
| **Air Quality – Construction Phase** | | | | | | | | | |
| 1. | Section 5<br><br>South African Action Levels for Residential Areas and International Guidelines | Air Quality | Stripping of vegetation and earth excavations may increase erosion and consequently dust releases. | Moderate | Moderate | ▪ Areas that may be prone to erosion or where signs of erosion are evident will be stabilised. Methods of stabilisation include: brush-cut packing, mulch or chip cover, straw stabilising, sodding, hydro-seeding, the application of soil binders and physical stabilisation methods such as gabions, reno-mattresses, armour flex or retaining walls.<br>▪ Traffic and movement over stabilised areas will be restricted and controlled, and damage to stabilised areas shall be repaired and maintained to the satisfaction of the Environmental Manager. | Throughout the construction phase, as the need arises | NLGM Construction Manager. | Evidence of demarcated construction areas and enforcement thereof, and erosion control measures. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| | | | | | | ▪ The total footprint area to be disturbed / developed will be kept to a minimum by demarcating the construction areas and restricting construction to these areas only. | | | |
| 2. | Section 5<br><br>South African Action Levels for Residential Areas and International Guidelines | Air Quality | Potential dust release during the construction period from construction activities including general plant usage, cutting, grinding, sawing and scabbling, usage of skips and chutes. | Moderate | Moderate | ▪ Conduct a quantitative air quality modelling study (before or during the construction phase).<br>▪ Locate machinery, fuel and chemical storage and dust generating activities away from site boundaries and sensitive receptors where possible.<br>▪ Utilise pre-fabricated materials to reduce cutting, grinding and sawing.<br>▪ Use water suppressant systems or dampening down whenever possible.<br>▪ Use of dust extraction techniques if available.<br>▪ Pre-washing of work surfaces when scabbling.<br>▪ Screen off work areas.<br>▪ Secure cover for all skips, where possible.<br>▪ Minimising drop heights to control the fall of materials.<br>▪ Sweeping and dampening down working areas regularly to prevent the build up of fine waste dust material.<br>▪ Implement a vehicle speed limit monitoring system on site, to help prevent/control dust from vehicles and for health and safety purposes. | Throughout the construction phase, as the need arises. | NLGM Construction Manager. | Monitoring and encouraging the use of covered skips on site, educating sub-contractors regarding mitigation methods and the need to minimise dust releases. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 3. | Section 5<br><br>South African Action Levels for Residential Areas and International Guidelines | Air Quality | Potential dust release from stockpiled or stored materials. | Moderate | Moderate | ▪ Conduct a quantitative air quality modelling study (before or during the construction phase).<br>▪ The quantitative air quality modelling study is required to include an assessment of the emissions from the power plant and the incinerator.<br>▪ Ensure that stockpiles exist for the shortest possible time.<br>▪ Minimise surface areas of stockpiled material to reduce the surface area exposed to wind erosion.<br>▪ Do not build steep sided stockpiles or those that have sharp changes in shape.<br>▪ Whenever possible, keep stockpiles away from the site boundaries, sensitive receptors and surface drains.<br>▪ If possible, keep stockpiles securely sheeted and only remove when necessary.<br>▪ Covering and protecting of stored materials from wind and dampening stored materials where appropriate. | Throughout the construction phase, as the need arises. | NLGM Construction Manager. | Maintain suitable records of equipment and materials on site. |
| 4. | Section 5<br><br>South African Action Levels for Residential Areas and International Guidelines | Air Quality | Stripping of vegetation and earth excavations may increase erosion and consequently dust releases. | Moderate | Moderate | ▪ Areas that may be prone to erosion or where signs of erosion are evident will be stabilised. Methods of stabilisation include: brush-cut packing, mulch or chip cover, straw stabilising, sodding, hydro-seeding, the application of soil binders and physical stabilisation methods such as gabions, reno-mattresses, armour flex or retaining walls.<br>▪ Traffic and movement over stabilised | Throughout the construction phase, as the need arises. | NLGM Construction Manager. | Evidence of demarcated construction areas and enforcement thereof, and erosion control measures. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | areas will be restricted and controlled, and damage to stabilised areas shall be repaired and maintained to the satisfaction of the Environmental Manager.<br>▪ The total footprint area to be disturbed / developed will be kept to a minimum by demarcating the construction areas and restricting construction to these areas only.<br>▪ Dampening down of all dusty activities, especially during dry weather.<br>▪ Temporary covering of earthworks where possible.<br>▪ Minimising drop heights.<br>▪ Loading and unloading of materials in areas protected from wind, where practicable. | | | |
| 5. | Section 5<br><br>South African Action Levels for Residential Areas and International Guidelines | Air Quality | Potential dust release from traffic on haul roads. | Moderate | Moderate | ▪ Conduct a quantitative air quality modelling study (before or during the construction phase).<br>▪ Use of hard surfaced roads where practicable.<br>▪ Regular inspection of haul roads for integrity and repair if required.<br>▪ Wheel and vehicle wash at exit of NLGM accommodation camp construction site.<br>▪ On-site speed limits.<br>▪ Regularly cleaning and dampening down of haul roads.<br>▪ Limit vehicles idling motors.<br>▪ Covering of loads transported to and from site. | Throughout the construction phase, as the need arises. | NLGM Construction Manager. | Auditing of road conditions, evidence of monitoring and enforcement of compliance with site speed limit, recording percentage of covered loads etc. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 6. | Section 5<br><br>WHO Air Quality Standards | Air Quality | Vehicle combustion emissions (NO2, PM10, CO2) | Low | Low | ▪ Conduct a quantitative air quality modelling study (before or during the construction phase).<br>▪ Regular inspection of site vehicles engines and repairs if required.<br>▪ Regular inspections of site vehicles tyres pressures and adjust if required.<br>▪ Annual official inspection of site vehicles emission in relation to Euro standard limits or other appropriate standards. | Throughout the construction phase, as the need arises. | NLGM Construction Manager. | Auditing of records of inspection and emission testing reports. Evidence of appropriate action if non-compliance occurs. |
| 7. | Section 5<br><br>WHO Air Quality Standards | Air Quality | Power plant combustion emissions (NO2, SO2, PM10, HC, CO) | Moderate | Moderate | ▪ Conduct a quantitative air quality modelling study (before or during the construction phase).<br>▪ Regular inspection of site power generators and repair if required.<br>▪ Annual official inspection of site power plant emission in relation to appropriate emission limits/standards.<br>▪ Site design with appropriate stack configurations to minimise ground level impacts from combustion emissions.<br>▪ Site design with appropriate emissions abatement technology (as appropriate) to minimise emissions to atmosphere and to minimise ground level impacts from combustion emissions. | Throughout the construction phase, as the need arises. | NLGM Construction Manager. | Auditing of records of inspection and emission testing reports. Evidence of appropriate action if non-compliance occurs. |
| **Air Quality – Operational Phase** | | | | | | | | | |
| 1. | Section 5.0 & 14.0<br><br>South African | Air Quality | Potential dust release from open cast mining and ore | High | Moderate | ▪ Water suppressant systems will be used whenever possible.<br>▪ Implement speed control systems and management systems, for example, | Throughout operational phase, at regular, | NLGM Site Manager. | Records of compliant dust monitoring data and |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| | Action Levels for Residential Areas and International Guidelines | | crushing. | | | speed humps where necessary.<br>▪ Storage of dusty materials should be enclosed if possible with sufficient dust suppressing measures.<br>▪ Implement a vehicle speed limit monitoring system on site, to help prevent/control dust from vehicles and for health and safety purposes. | scheduled intervals and also as the need arises. | | evidence of appropriate actions for non compliance in Site log. Vehicle speed monitoring data and reports, as well as evidence of dealing with speed limit offenders |
| 2. | Section 5.0 & 14.0<br><br>South African Action Levels for Residential Areas and International Guidelines | Air Quality | Flue dust is created during the smelting process and has the potential to become airborne if not managed correctly. | Moderate | Low | ▪ Increase plant efficiency through site layout.<br>▪ Optimise plant operation to allow for consistent operation.<br>▪ Enclose or contain emissions from vessels and discharge points.<br>▪ Cover all transport vehicles and enclose storage and process equipment, where possible.<br>▪ Provide wash facilities to prevent the migration of particulate matter.<br>▪ Implement a vehicle speed limit monitoring system on site, to help prevent/control dust from vehicles and for health and safety purposes. | Throughout operational phase, at regular, scheduled intervals and also as the need arises. | NLGM Site Manager. | Records of compliant dust monitoring data and evidence of appropriate actions for non compliance in Site log. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 3. | Section 5.0 & 14.0<br><br>South African Action Levels for Residential Areas and International Guidelines | Air Quality | Soil stripping, earth excavations and areas with little vegetation are associated with the movement of large amounts of materials and there is the potential for dust releases to accompany these activities. | Moderate | Low | ▪ Water suppressant systems will be used whenever possible.<br>▪ Minimise drop heights.<br>▪ Implement a vehicle speed limit monitoring system on site, to help prevent/control dust from vehicles and for health and safety purposes. | Throughout operational phase, at regular, scheduled intervals and also as the need arises. | NLGM Site Manager | Evidence of demarcated mining areas and enforcement thereof, and erosion control measures. |
| 4. | Section 5.0 & 14.0<br><br>South African Action Levels for Residential Areas and International Guidelines | Air Quality | Potential dust release from traffic on haul roads. | Moderate | Moderate | ▪ Use of hard surfaced roads where practicable.<br>▪ Regular inspection of haul roads for integrity and repair if required.<br>▪ Wheel and vehicle wash at exit of NLGM accommodation camp construction site.<br>▪ Implement a vehicle speed limit monitoring system on site, to help prevent/control dust from vehicles and for health and safety purposes..<br>▪ Regularly cleaning and dampening down of haul roads.<br>▪ Limit vehicles idling motors.<br>▪ Covering of loads transported to and from site. | Throughout operational phase, at regular, scheduled intervals and also as the need arises. | NLGM Site Manager | Environmental auditing of road conditions, monitoring compliance with site speed limit, recording percentage of covered loads etc. |

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| 5. | Section 5.0 & 14.0<br><br>WHO Air Quality Standards | Air Quality | Vehicle combustion emissions ($NO_2$, $PM_{10}$, $CO_2$) | Low | Low | ▪ Regular inspections of site vehicles engines and repair if required.<br>▪ Regular inspections of site vehicles tyres pressures and adjust if required.<br>▪ Annual official inspection of site vehicles emission in relation to Euro standard limits or other appropriate standards. | Throughout the operational phase, as the need arises. | NLGM Site Manager. | Auditing of records of inspection and emission testing reports. Evidence of appropriate action if non-compliance occurs. |
| 6. | Section 5.0 & 14.0<br><br>WHO Air Quality Standards | Air Quality | Power plant combustion emissions ($NO_2$, $SO_2$, $PM_{10}$, HC, CO) | Moderate | Moderate | ▪ Regular inspection of site power generators and repair if required.<br>▪ Annual official inspection and monitoring of site power plant emissions in relation to appropriate emission limits/standards.<br>▪ Annual official inspection and monitoring of the site incinerator emissions in relation to appropriate emission limits/standards.<br>▪ Site design with appropriate stack configurations to minimise ground level impacts from combustion emissions.<br>▪ Site design with appropriate emissions abatement technology (as appropriate) to minimise emissions to atmosphere and to minimise ground level impacts from combustion emissions. | Throughout the operational phase, as the need arises. | NLGM Site Manager. | Auditing of records of inspection and emission testing reports. Evidence of appropriate action if non-compliance occurs. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 7. | Section 5.0 & 14.0<br><br>WHO Air Quality Standards | Air Quality | Gold processing plant emissions (NO2, SO2, PM10, HCN, NH3, Metals) | High | Moderate | ▪ Regular inspection of site processing and repair if required.<br>▪ Annual official inspection and monitoring of gold processing plant emissions in relation to appropriate emission limits/standards.<br>▪ Site design with appropriate stack configurations to minimise ground level impacts from combustion emissions.<br>▪ Site design with appropriate emissions abatement technology (as appropriate) to minimise emissions to atmosphere and to minimise ground level impacts from processing emissions. | Throughout the operational phase, as the need arises. | NLGM Site Manager | Auditing of records of inspection and emission testing reports. Evidence of appropriate action if non-compliance occurs. |
| **Air Quality – Decommissioning & Closure Phase** | | | | | | | | | |
| 1. | Section 5.0 & 14.0<br><br>South African Action Levels for Residential Areas and International Guidelines | Air Quality | Flue dust is created during the smelting process and has the potential to become airborne if not managed correctly. | Moderate | Moderate | ▪ Follow appropriate decommissioning plan for the Smelter<br>▪ Follow appropriate site remediation. | Throughout decommissioning phase, at regular, scheduled intervals. | NLGM Site Manager | Records of compliant dust monitoring data and evidence of appropriate actions in non compliant in Site log. |
| 2. | Section 5.0 & 14.0<br><br>South African Action Levels for Residential Areas and International Guidelines | Air Quality | Potential dust release from stockpiled or stored materials. | Moderate | Moderate | ▪ Ensure that stockpiles exist for the shortest possible time.<br>▪ Minimise surface areas of stockpiled material to reduce the surface area exposed to wind erosion.<br>▪ Do not build steep sided stockpiles or those that have sharp changes in shape.<br>▪ Whenever possible, keep stockpiles | Throughout decommissioning phase, at regular, scheduled intervals and also as the need arises. | NLGM Site Manager | Records of compliant dust monitoring data and evidence of appropriate actions in non compliant in Site log. |

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| | | | | | | away from the site boundaries, sensitive receptors and surface drains.<br>▪ If possible, keep stockpiles securely sheeted and only remove.<br>▪ Covering and protecting of stored materials from wind and dampening stored materials where appropriate. | | | |
| 3. | Section 5.0 & 14.0<br><br>South African Action Levels for Residential Areas and International Guidelines | Air Quality | Soil stripping, earth excavations and areas with little vegetation are associated with the movement of large amounts of materials and there is the potential for dust releases to accompany these activities. | Moderate | Low | ▪ Dampening down of all dusty activities, especially during dry weather.<br>▪ Temporary covering of earthworks where possible.<br>▪ Minimising drop heights.<br>▪ Loading and unloading of materials in areas protected from wind, where practicable. | Throughout decommissioning phase, at regular, scheduled intervals and also as the need arises. | NLGM Site Manager | Records of compliant dust monitoring data and evidence of appropriate actions for non compliance in Site log. |
| 4. | Section 5.0 & 14.0<br><br>South African Action Levels for Residential Areas and International Guidelines | Air Quality | Potential dust release from traffic on haul roads. | Moderate | Moderate | ▪ Use of hard surfaced roads where practicable.<br>▪ Regular inspection of haul roads for integrity and repair if required.<br>▪ Wheel and vehicle wash at exit of NLGM accommodation camp construction site.<br>▪ On-site speed limits.<br>▪ Regularly cleaning and dampening down of haul roads.<br>▪ Limit vehicles idling motors.<br>▪ Covering of loads transported to and from site. | Throughout decommissioning phase, at regular, scheduled intervals and also as the need arises. | NLGM Site Manager | Environmental auditing of road conditions, monitoring compliance with site speed limit, recording percentage of covered loads etc. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 5. | Section 5.0 & 14.0<br><br>WHO Air Quality Standards | Air Quality | Vehicle combustion emissions (NO2, PM10, CO2) | Low | Low | ▪ Regular inspections of site vehicles engines and repair if required.<br>▪ Regular inspections of site vehicles tyres pressures and adjust if required.<br>▪ Annual official inspection of site vehicles emission in relation to Euro standard limits or other appropriate standards. | Throughout the decommissionin g phase, as the need arises. | NLGM Site Manager | Auditing of records of inspection and emission testing reports. Evidence of appropriate action if non-compliance occurs. |
| 6. | Section 5.0 & 14.0<br><br>WHO Air Quality Standards | Air Quality | Power plant combustion emissions (NO2, SO2, PM10, HC, CO) | Moderate | Moderate | ▪ Regular inspection of site power generators and repair if required.<br>▪ Annual official inspection of site power plant emission in relation to appropriate emission limits/standards.<br>▪ Site design with appropriate stack configurations to minimise ground level impacts from combustion emissions.<br>▪ Site design with appropriate emissions abatement technology (as appropriate) to minimise emissions to atmosphere and to minimise ground level impacts from combustion emissions. | Throughout the decommissionin g phase, as the need arises. | NLGM Site Manager | Auditing of records of inspection and emission testing reports. Evidence of appropriate action if non-compliance occurs. |
| **Noise – Construction Phase** | | | | | | | | | |
| 1. | WHO/WB limits used for purposes of EIS | Noise from construction activities | Noise level elevation at SRs. | Moderate | Low | ▪ Choose low noise plant alternatives<br>▪ Systematic maintenance of all forms of equipment,<br>▪ Training of personnel to adhere to operational procedures that reduce the occurrence and magnitude of individual noisy events. | Throughout the construction phase, as the need arises. | NLGM Construction Manager | Vehicle maintenance records, records of noise control measurement<br><br>Noise |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| | | | | | | ▪ Earthworks/material stockpiles will be placed as barriers to protect boundaries from noise from operations and especially from haul roads<br>▪ Internalise all haul roads<br>▪ Fit efficient silencers and enclose engine compartments<br>▪ Damp mechanical vibrations of panels<br>▪ Minimise fall heights and other impacts of material | | | measurement at specified positions near and around Construction site |
| **Noise – Operational Phase** | | | | | | | | | |
| 1. | WHO/WB limits used for purposes of EIS | Pit Operation Noise generation | Generation of nuisance noise from vehicle movement and operational activities, notably the opencast mining operations. (This may lead to exceedances of noise standards). | Moderate | Low | ▪ Establishment of an ambient noise monitoring programme.<br>▪ The noise monitoring programme implemented on site will be aimed at detecting deviations from predicted noise levels<br>▪ Corrective measures will be implemented where warranted if changes in noise level are detected.<br>▪ Choice of low noise plant alternatives<br>▪ Proper design and maintenance of silencers on diesel-powered equipment<br>▪ Systematic maintenance of all forms of equipment,<br>▪ Training of personnel to adhere to operational procedures that reduce the occurrence and magnitude of individual noisy events.<br>▪ Earthworks/material stockpiles should be | On a three monthly basis during the operational phase | NLGM Operations Manager, with assistance from the Environmental Manager | Site vehicle enforcement regulations<br><br>Noise measurement at specified positions near and around pit |

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| | | | | | | placed as barriers to protect boundaries from noise from operations and especially from haul roads<br>▪ Internalise all haul roads<br>▪ Fit efficient silencers and enclose engine compartments<br>▪ Damp mechanical vibrations of panels<br>▪ Erect berm, screen or barrier at permanent sites and haul roads | | | |
| 2. | WHO/WB limits used for purposes of EIS | Noise from crushing and Process Plant | Noise level elevation at SRs. | Moderate | Moderate | ▪ Choice of low noise plant alternatives<br>▪ systematic maintenance of all forms of equipment<br>▪ training of personnel to adhere to operational procedures that reduce the occurrence and magnitude of individual noisy events.<br>▪ Select permanent plant site far from dwellings<br>▪ Reduce noise at source by acoustic Process, etc.<br>▪ Isolate source by acoustic enclosure, etc. | Throughout the operation phase, as the needed | NLGM Plant Manager with assistance from the Environmental Manager | Noise measurement at relevant pre-specified positions near and around the plant |
| **Noise – Decommissioning & Closure Phase** | | | | | | | | | |
| 1. | WHO/WB limits used for purposes of EIS | Noise from decommissioning/closure activities | Noise level elevation at SRs. | Moderate | Low | ▪ Choose low noise plant<br>▪ Systematic maintenance of all forms of equipment,<br>▪ Training of personnel to adhere to operational procedures that reduce the occurrence and magnitude of individual noisy events. | Throughout the decommissioning phase, as the need arises. | NLGM Plant or Decommissioning Manager | Vehicle maintenance records, records of noise control measurement<br><br>Noise |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| | | | | | | ▪ Fit efficient silencers and enclose engine compartments<br>▪ Damp mechanical vibrations of panels<br>▪ Minimise fall heights and other impacts of material | | | measurement at specified positions near/around the plant site |
| **Terrestrial Ecology – Construction & Operational Phase** | | | | | | | | | |
| 1. | Section 5<br><br>National Environmental Policy of Liberia (2002).<br><br>National Biosafety Framework (2004).<br><br>National Forestry Reform Law (2006)<br><br>Convention on Biological Diversity<br><br>UN Convention on International Trade and Endangered Species | Loss of plant communities or biodiversity | Loss of or alteration to plant communities and reduction in biodiversity on-site – this refers mainly to vegetation within pit footprints, along new roads that may be cleared, the plant site and the waste dump. | Moderate | Moderate | ▪ Conduct Red Data species search and rescue efforts before ground clearing begins in order to reduce negative impacts on species of concern<br>▪ Keep footprint to its minimum so as not to unnecessarily strip vegetation. | Throughout construction & operations phases, as the need arises | NLGM General Manager | Have a running nursery housing all species of concern from cleared areas, with a minimum loss of important biota. |

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| 2. | As above | Contaminatio n by pollutants | Hydrocarbon contamination of surface water from construction equipment and/or vehicle spillages. | Moderate | Low | ▪ Excessive soil contamination by fuel or oil spills, for example, from mining vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ using bioremediation, in accordance with BMMC's procedures to be developed.<br>▪ Vehicles will be maintained regularly and kept in a good working order.<br>▪ Vehicle maintenance will not be carried out in random areas of the site, but in the designated workshops. | Throughout construction & operations phases, as the need arises | NLGM General Manager | Vehicle maintenance records, records of hazardous waste management controls and practices etc |
| 3. | As above | Reduction in surface water quality | Stripping of vegetation may increase erosion, which will in turn increase the amount of suspended solids in downstream watercourses. | Moderate | Low | ▪ Areas that may be prone to erosion or where signs of erosion are evident will be stabilised. Methods of stabilisation include: brush-cut packing, mulch or chip cover, straw stabilising, sodding, hydro-seeding, the application of soil binders and physical stabilisation methods such as gabions, reno-mattresses, armour flex or retaining walls.<br>▪ Traffic and movement over stabilised areas will be restricted and controlled, and damage to stabilised areas shall be repaired and maintained to the satisfaction of the Environmental Manager.<br>▪ The total footprint area to be disturbed / developed will be kept to a minimum by demarcating the construction areas and restricting construction to these areas only. | Throughout construction & operations phases, as the need arises | NLGM General Manager | Evidence of demarcated construction areas and enforcement thereof, and erosion control measures. |

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| 4. | As above | Increased population pressure on fauna and flora species | Increased access to previously inaccessible areas. | Moderate | Low | ▪ Control access to roads<br>▪ Control firearms, traps and other methods of hunting on site | Throughout operational phase, as the need arises. | NLGM General Manager | Evidence of demarcated construction areas and enforcement thereof, and erosion control measures. |
| 5. | As above. | Impacts on fauna | Impacts on local migration routes of fauna | Moderate | Low | ▪ Areas can be isolated by means of a chain link fence in order to prevent animals on local migrations entering these area and being destroyed;<br>▪ The effect of haul roads on local migrations can be mitigated by the installation of culverts at regular intervals along the roads and the installation of drift fences towards the culverts;<br>▪ Although these methods may not eliminate the mortalities among migrating animals, they should greatly reduce the number of animals killed on haul roads; and<br>▪ A low speed limit can be strictly enforced in order to reduce collisions with animals on the roads. | Throughout the operational phase, as the need arises. | NLGM Construction Manager | Maintain a very low fauna road mortality rate and allow access for local migrations |
| **Terrestrial Ecology – Decommissioning & Closure Phase** | | | | | | | | | |
| 1. | Section 5<br><br>National Environmental Policy of Liberia (2002). | Habitat destruction | Removal/disturbance of indigenous vegetation during decommissionin | Moderate | Low | ▪ The total footprint where dismantling of mining infrastructure is taking place will be kept to a minimum by demarcating the work area and restricting decommissioning and closure activities to these areas. | From the start to the end of the decommissioning and closure phase. | NLGM General Manager | Decommissioning and closure plan, maps and evidence of demarcation of |

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| | National Biosafety Framework (2004).<br><br>National Forestry Reform Law (2006)<br><br>Convention on Biological Diversity<br><br>UN Convention on International Trade and Endangered Species | | g and closure leading to habitat degradation, loss of indigenous keystone flora species, disturbance of sensitive floral areas, loss and changes in ecosystem functions and loss or alteration of plant communities. | | | | | | work areas. |
| 2. | As above. | Contaminatio n of fauna flora or habitats buy pollutants | Spillage, leakage or release of harmful or toxic substances during transport or at areas where they are stored or used such as filling stations and the processing plant. | Moderate | Low | ▪ Excessive soil contamination by fuel or oil spills, for example, from mining vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ using bioremediation, in accordance with existing procedures;<br>▪ Vehicles will be maintained regularly and kept in a good working order; and<br>▪ No oils or fuels from vehicles, machinery or generators should be allowed to enter ecosystems, in the case of accidental spills, immediate clean-up action must be initiated to prevent further spread.<br>▪ Standard operating procedures for the transport of potentially dangerous | Throughout the decommissionin g and closure phase. | NLGM General Manager | All vehicles have up to date service logs, no contamination spills on site. |

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| | | | | | | substances need to be put in place and followed;<br>▪ Toxic materials must be handled, and disposed of according to internationally accepted guidelines | | | |
| 3. | As above. | Habitat degaradation | Habitat degradation due to dust | Moderate | Low | ▪ Dust suppression on roads by applying water using bowsers;<br>▪ Adjacent paved areas and roads used for construction traffic can be maintained free of tracked soil or fill materials. At minimum, paved traffic areas, can be cleaned on a daily basis by wet sweeping and/or washing. More frequent cleaning can be provided as necessary. Adjacent paved areas and roads can be left clean at the end of each day;<br>▪ Exposed excavations, disturbed ground surfaces, and unpaved traffic areas can be maintained in a moist condition;<br>▪ During non-working hours, the site can be left in a condition that will prevent dust from being generated. At the end of each work day, disturbed areas can be wetted down and security fencing can be installed and or inspected to prevent access and additional disturbance;<br>▪ Provide temporary cover and daily maintenance for soil or fill stockpiles and keep active surfaces moist;<br>▪ A temporary decontamination pad and/or a stabilized construction entrance can be provided at active site entrance/egress locations to keep adjacent paved areas clean; and<br>▪ Construction activities should be conducted using methods that minimize | Throughout decommissionin g/closure phase | NLGM General Manager | Have minimum dust fallout according to dust monitoring program. |

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| | | | | | | dust generation.<br>▪ All onsite traffic can be restricted to specific designated roads. Off-road travel can only be authorized on a case-by-case basis (e.g. access to a remote monitoring well, etc.). Traffic speed can also be restricted to an appropriate level on all designated roads. All designated roads can be considered as high potential dust source areas, and as such, can be a priority for dust controls utilizing water and/or gravel. | | | |
| 4. | As above. | Impacts on migrating fauna | Effects on local migrations | Moderate | Low | ▪ Areas can be isolated by means of a chain link fence in order to prevent animals on local migrations entering these area and being destroyed;<br>▪ The effect of haul roads on local migrations can be mitigated by the installation of culverts at regular intervals along the roads and the installation of drift fences towards the culverts;<br>▪ Although these methods may not eliminate the mortalities among migrating animals, they should greatly reduce the number of animals killed on haul roads; and<br>▪ A low speed limit can be strictly enforced in order to reduce collisions with animals on the roads. | Throughout closure phase | NLGM General Manager | Maintain a very low (negligible) fauna road mortality rate. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| **Aquatic Ecology – Construction Phase** | | | | | | | | | |
| 1. | Section 5 | Protection of aquatic ecosystems including Red Data fish species | Increased sedimentation associated with vegetation clearing | Moderate | Low | ▪ Sediment traps should be installed and maintained where appropriate;<br>▪ Riparian vegetation bordering on drainage lines and rivers should be considered environmentally sensitive and impacts on these habitats should be avoided;<br>▪ If erosion has taken place, rehabilitation should commence as soon as possible;<br>▪ All roads need to be maintained and any erosion ditches forming along the road filled;<br>▪ Storm water must be managed so as to reduce the silt loads in the aquatic system;<br>▪ Berms/ earthen walls should be vegetated in order to avoid erosion and sedimentation. | Mitigation requires an ongoing sediment management program for the duration of the construction phase | NLGM Environmental Manager | Continued presence of *Amphilius atesuensis* cf., and *Doumea chappuisi* in suitable habitat downstream of the development |
| 2. | Section 5 | Protection of aquatic ecosystems including Red Data fish species | Decreased water quality due to accidental spills | Low | Low | ▪ All vehicles and equipment should be regularly maintained to avoid any oil leaks or spills. Furthermore, if any spill or leak does occur ensure that it is properly cleaned up as soon as possible to avoid significant effects;<br>▪ Spill kits should be available on site and in the case of a spill cleanup operations should commence as soon as possible in order to contain spills and limit the contamination of the receiving environment; | An emergency spill response plan should be put in place for the duration of construction phase. Water quality monitoring program should be implemented and maintained throughout the | NLGM Environmental Manager | Maintenance of all water quality parameters within existing baseline |

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| | | | | | | ▪ Staff members, especially drivers, should be educated as to the importance of avoiding hydrocarbon contamination in the receiving environment and should not be allowed to wash vehicles in streams and creeks. | construction phase | | |
| 3. | Section 5 | Maintenance of aquatic biodiversity | Loss of habitat associated with construction of the diversion | Moderate | Low | ▪ Creation of diverse habitats within the river diversion. Specific attention should be paid to creating habitat for the 2 Red Data species: *Doumea chappuisi* and *Malapterurus stiassnyae cf.* This will avoid the situation whereby the river diversion becomes simply a conduit for the river and may in time result in the establishment of aquatic biota within the diversion itself.<br>▪ Furthermore artisanal mining activities should not be permitted within the river diversion. | | NLGM Environmental & Construction Managers | Establishment of aquatic biota within river diversion |
| **Aquatic Ecology – Operational Phase** | | | | | | | | | |
| 1. | | Maintenance of aquatic biodiversity | Increased sedimentation and water quality impairment in the aquatic environment due to sediment runoff from the Waste Rock dump | Moderate | Low | ▪ Runoff water from the waste dumps and stockpiles should be channelled into pollution control dams to avoid impacts on the receiving environment. The water in these pollution control dams should be reused during the mining operations if possible;<br>▪ These stockpiles and waste dumps should also be placed in areas where groundwater and surface water pollution can be avoided;<br>▪ Sediment traps should be installed and | Mitigation measures need to be maintained throughout the operational phase of the project. Adequate stormwater management needs to be | NLGM Environmental & Operational Managers | Maintenance of water quality parameters within baseline ranges |

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| | | | | | | maintained where appropriate;<br>▪ The runoff should be routinely monitored for acidity and salinity as an early warning for potential increases in salinity or acidic drainage water; and<br>▪ Adequate stormwater management structures need to be constructed and maintained. | maintained during the operational phase | | |
| 2. | | Maintenance of aquatic biodiversity downstream of tailings impoundment | Water quality contamination due to run-off from the tailings storage facility | Moderate | Low | ▪ Best Industry Standards needs to be implemented in terms of tailings storage design. Built-in engineering designs such as drainage systems and decanting pools are recognised as mitigation measures;<br>▪ Water quality should be routinely monitored at aquatic ecosystems associated with the mining activities. This includes sites upstream and downstream of the tailings storage facility so that further mitigation measures can be implemented; | Mitigation measures need to be maintained throughout the operational phase of the project. | NLGM Environmental & Operational Managers | Maintenance of water quality downstream of tailings storage within baseline ranges. |
| 3. | | Maintenance of aquatic biodiversity & habitats downstream of discharge point | Alteration of natural flow regimes due to discharge of pit water | Moderate | Low | ▪ Discharge pit water into the Mafa River rather than into the Marvoe Creek. The Mafa River is much larger with a greater volume. Therefore the impact of the release of pit water into the Mafa River will have less of an impact than it would have on the Marvoe Creek;<br>▪ Discharge pit water in a manner that mimics the natural flow regimes in these rivers and maintains natural seasonal variations in flow. | Mitigation measures need to be maintained throughout the operational phase | NLGM Environmental & Operational Managers | Maintenance of biodiversity and avoidance of erosion of instream habitats downstream of discharge point |

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| 4. | | Maintenance of biodiversity in associated aquatic ecosystems | Increased pressure on aquatic resources due to influx of people into the project area | Moderate | Moderate | ▪ Education of staff and local villagers in terms of sustainable utilization of natural resources | Commence at start of Operational Phase and maintain throughout | NLGM Environmental and Social Managers | Increased awareness amongst local staff and villagers about sustainability issues. |
| **Aquatic Ecology – Decommissioning & Closure Phase** | | | | | | | | | |
| 1. | | Maintenance of water quality and biodiversity in the receiving environment | Contamination of surface water due to ARD generated by the tailings storage facility | Moderate | Low | ▪ The runoff should be routinely monitored for acidity and salinity as an early warning for potential increases in salinity or acidic drainage water;<br>▪ Water quality should be routinely monitored at aquatic ecosystems associated with the mining activities. This includes sites upstream and downstream of the tailings facility;<br>▪ The nature (strength) and volume of ARD can be altered by controlling generation and dilution on site. ARD and its impacts can be managed by exclusion of oxygenated water from reactive minerals or neutralisation of the acid produced | Monitoring of ARD downstream of the project area should be maintained as agreed upon in the Closure Plan | NLGM Closure Manager | Avoidance of ARD generated impacts during the Closure and post-Closure phases |
| **Socio-economic – Construction Phase** | | | | | | | | | |
| 1. | Section 6<br><br>Env. Protection and Mgt Law 2003 Section 14, 1j | To ensure that the quality of life of displaced households is equal to or | Physical displacement impacting structures and sites of religious significance. | High | Moderate | ▪ The significant physical and economic displacement of households will require a Resettlement Action Plan. This plan should include compensation for structures and loss of assets and support with moving to a new location and | Prior to construction activities with management and monitoring of | NLGM, Community Liaison Office, Community Development Officer | Resettlement Action Plan in place. Community consultation undertaken |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| | Land Acquisition Act 1929 | better than prior to displacement | | | | establishing a homestead.<br>▪ Displacement of the private landowners will be a negotiated displacement, a Type I impact in terms of PS5; mitigation should include the option of a lease agreement between BMMC and MDA to provide BMMC access to the land.<br>▪ The development of alternative livelihood strategies should be the preferred mitigation measure, maximising all possibilities for involvement in employment opportunities available. Although many of these positions will be skilled positions, the establishment of appropriate training and skills development at an early stage will allow local community members to benefit from such opportunities.<br>▪ A Livelihood Restoration Plan and Community Development Plan should be developed to ensure households are not left worse off following displacement.<br>▪ Establishment of grievance mechanism prior to project implementation to facilitate the resolution of affected community concerns and grievances, ensuring ongoing interaction with the community in order to build trust and maintain relationships throughout the life of the project. | implementation ongoing throughout the life of the project. | | and Community Liaison Officer appointed<br>Grievance mechanism established<br>Monitoring system established to monitor implementation activities and quality of life. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 2. | Section 6<br><br>Env. Protection and Mgt Law 2003 Part II, Section4, 2a | To ensure that the quality of life of displaced households is equal to or better than prior to displacement. | Economic displacement impacting agricultural land and natural resources, and artisanal mining opportunities. | High | Moderate | ▪ The significant physical and economic displacement of households will require a Resettlement Action Plan. This plan should include compensation for structures and loss of assets and support with moving to a new location and establishing a homestead.<br>▪ Displacement of the private landowners will be a negotiated displacement, a Type I impact in terms of PS5; mitigation should include the option of a lease agreement between BMMC and MDA to provide BMMC access to the land.<br>▪ The development of alternative livelihood strategies should be the preferred mitigation measure, maximising all possibilities for involvement in employment opportunities available. Although many of these positions will be skilled positions, the establishment of appropriate training and skills development at an early stage will allow local community members to benefit from such opportunities.<br>▪ A Livelihood Restoration Plan and Community Development Plan should be developed to ensure households are not left worse off following displacement.<br>▪ Establishment of grievance mechanism prior to project implementation to facilitate the resolution of affected community concerns and grievances, ensuring ongoing interaction with the | Prior to construction activities with management and monitoring of implementation ongoing throughout the life of the project. | NLGM, Community Liaison Office, Community Development Officer | Resettlement Action Plan in place. Community consultation undertaken and Community Liaison Officer appointed Grievance mechanism established Monitoring system established to monitor implementatio n activities and quality of life. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| | | | | | | community in order to build trust and maintain relationships throughout the life of the project. | | | |
| 3. | Section 6<br><br>Regs. on Mining Exploration Liberia 2008 Section 9, 9.1 | Local population offered employment opportunities where possible. | Creation of employment opportunities. | Moderate | Low | ▪ Establishment of a "local labour desk" at the mine or contractor offices to identify a local labour pool.<br>▪ Implementation of skills development programmes to ensure support local population in obtaining employment opportunities. | Prior to and during construction. | NLGM Mine Manager | Agreed percentage of local population employed by project.<br>Skills development programmes in place and monitoring systems established. |
| 4. | Section 6 | Surface Water related impacts on communities | Impacts to water levels and water quality | See Surface Water Impact Assessment recommendations/mitigation measures | | | | | |
| 5. | Section 6 | Noise impacts on communities | Noise and dust pollution related to construction excavations | See Noise and Air Quality Impact Assessment recommendations/mitigation measures | | | | | |
| 6 | Section 6<br><br>Regs. on Mining Exploration Liberia 2008 Section 9, 9.3 | Access restrictions to services and developments | To ensure development is spread equally amongst surrounding communities and villages are not indirectly affected by displacement of others. | Moderate | Low | ▪ Develop Community Development Plan taking into account all villages within traditional area of jurisdiction and their dependency on services and resources. | Prior to and during construction. | NLGM, Community Development Officer. | Community Development Plan established.<br>Community Development/ Social Monitoring system in place. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 7. | Section 6 | Reduce population and negative social connotations | Population influx resulting in social tensions and an increase in sexually transmitted diseases, notably HIV/AIDS. | Moderate | Low | ▪ Clear communication of all available employment positions to minimise population influx.<br>▪ Implementation of health development plans including upgrading facilities and awareness campaigns surrounding HIV/AIDS. | Prior to construction, construction and operation. | NLGM, Community Development Officer. | Inclusion of health targets in Community Development Plan. Monitoring of health data. |
| 8. | Section 6 | Avoidance of conflict in implementing resettlement and project. | Potential conflict | Moderate | Low | ▪ A dispute prevention and management plan should be developed with an aim to manage conflict and bring about positive change through conflict resolution processes. This will be assisted by ongoing community engagement and stakeholder involvement throughout the process.<br>▪ All grievances will be recorded, and a grievance mechanism developed by BMMC for the NLGM mine site. | Prior to construction, construction and operation. | NLGM Mine Manager, H&S Officer, Community Liaison Office. | Dispute prevention and management plan established. Monitoring of stakeholder engagement and resettlement process. |
| 9. | Section 6<br><br>Nat. Env. Policy 2002<br>Section 4.1 | Maintain the health and safety of local populations | Increase in traffic and safety hazards | Moderate | Low | ▪ A detailed health and safety plan must be developed to mitigate the construction and operation risks of the proposed project on the surrounding communities. This plan must take cognisance of the following:<br>– Increased risk of traffic through built-up areas;<br>– Use of streams and rivers at the point of crossing of waterways and the risk that increased traffic volumes will pose to people;<br>– Risks associated with blasting | Construction and operation phase. | NLGM Mine Manager, H&S Officer. | Health and safety plan developed. Monthly health and safety monitoring and reporting. |

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| | | | | | | activities during operation;<br>– Risks associated with operating the plant – a emergency plan must be developed that takes major emergency events and their impact on the community into consideration, including community evacuation plans; and<br>– Safety measures in relation to the storage, transportation and use of cyanide. | | | |
| 10. | Section 6<br><br>Regs. on Mining Exploration Liberia 2008 Section 9, 9.2 | Maximise opportunities to benefit from business development | Increase in business opportunities in local services. | Moderate | Moderate | ▪ Explore possibilities to include training opportunities for developing business opportunities in Community Development Plan.<br>▪ Consider funding small business development. | Construction and Operation. | Community Development Officer. | Small business development included in Community Development Plan. |
| **Socio-economic – Operational Phase** | | | | | | | | | |
| 1. | Section 9.4.1<br><br>Regs. on Mining Exploration Liberia 2008 Section 9, 9.1 | Local population offered employment opportunities where possible. | Employment creation | Moderate (Positive) | High (Positive) | ▪ Establishment of a “local labour desk” at the mine or contractor offices to identify a local labour pool.<br>▪ Implementation of skills development programmes to ensure support local population in obtaining employment opportunities. | Construction and Operation | NLGM Mine Manager | Agreed percentage of local population employed by project.<br>Skills development programmes in place ad monitoring systems established. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 2. | Section 6<br><br>Nat. Env. Policy 2002<br>Section 4.1 | Noise and dust pollution effects on communities | Noise and dust pollution | See Noise and Air Quality Impact Assessment recommendations/mitigation measures | | | | | |
| 3. | Section 6<br><br>Nat. Env. Policy 2002<br>Section 4.1 | Reduce or avoid health and safety risks | Health and safety impacts | Moderate | Low | As above | As above | As above | As above |
| 4. | Section 6<br><br>Regs. on Mining Exploration Liberia 2008<br>Section 9, 9.3 | Implement Community Development Plan and social monitoring programme | Improved services and community development potential | Moderate (Positive) | High (Positive) | ▪ Develop a Community Development Plan taking into account all villages within traditional area of jurisdiction, with an aim to long-term sustainable development.<br>▪ Implement a social monitoring programme, whereby variables such a population figures in the local villages, health status of local people, income levels etc. are recorded on a bi-annual basis. | Construction and Operation | NLGM Community Development Officer. | Community Development Plan in place. Monitoring systems established. |
| **Socio-economic – Closure & Decommissioning Phase** | | | | | | | | | |
| 1. | Section 6<br><br>Regs. on Mining Exploration Liberia 2008<br>Section 9, 9.1 | Minimise the impact in change of economic conditions and livelihood strategies. | Change in economic benefits from mining to subsistence agriculture | High | Moderate | ▪ Community Development Plan to include skills training and development to ensure transferrable skills and options for alternative livelihood strategies. | Operations | NLGM Community Development Officer. | Skills development programmes and alternative livelihood strategies included in Community Development Plan. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| | | | | | | | | | Monitoring of progress. |
| | Section 6 | Minimise the impact in change of economic conditions and livelihood strategies. | Change in economic benefits from mining to subsistence agriculture. | High | Moderate | ▪ Community Development Plan to include skills training and development to ensure transferrable skills and options for alternative livelihood strategies. | Operations | NLGM Community Development Officer. | Skills development programmes and alternative livelihood strategies included in Community Development Plan. Monitoring of progress. |
| **Cultural Heritage – Construction Phase** | | | | | | | | | |
| 1. | | Cultural heritage - protection of cultural heritage site | Potential accidental damage caused by construction activities to a sacred site on the western edge of the Project area (Site 1: Sekpendeh-Woni guyoh) | Moderate | Low | ▪ The potential threat is likely to be caused through inadvertent damage by staff not knowing the site is there. Therefore, to prevent vehicle or other accidental damage the area between the edge of the Project boundary and the cultural site will be demarcated by means of an earthen bund, fencing and signage. | Prior to commencement of the construction phase, and maintenance throughout. | NLGM Construction Manager | Installation of adequate protection measures, including bunding, fencing, and signage. |
| 2. | | Cultural heritage - cemeteries | Direct loss of modern burials from the cemeteries located in the villages of Kinjor | High | Low | ▪ Consultation to take place between the village chief/elders and relatives of the deceased to determine the locations of the known burial sites and to agree on the most appropriate means and timing for exhumation of the remains. | Prior to commencement of the construction phase. | NLGM Construction Manager | Records of discussions/agreements between NLGM and village chiefs |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| | | | and Larjor | | | ▪ Development of a Chance Find Procedure, in the event that cultural heritage remains are identified by workers during the course of the development phases.<br>▪ Treatment of the remains during and following exhumation to be undertaken with the greatest care to limit any damage to the remains.<br>▪ The provision of new burial locations for the remains and any grave marker to be agreed between NLGM and village chief/elders and the relatives of the deceased.<br>▪ Should other human remains be encountered from graves not identified, then all work to cease and NLGM to notify the village chief, to then formulate an action plan to deal with the discovery with the community's agreement. | During construction if other discoveries are made, as the need arises. | | |
| 3. | | Cultural heritage - religious buildings and meeting place | Direct loss of the village church, mosque and townhouse in Kinjor | Moderate | Low | ▪ Consultation to take place between the village chief/elders, religious leaders and the community to determine the design and locations for the new church, mosque and townhouse. NLGM to facilitate the new constructions.<br>▪ Photographic recording of the existing sites (internal and external) prior to their demolition and copies made available to the local community. | Prior to commencement of the construction phase. | NLGM Construction Manager | Records of discussions/agreements between NLGM and the community. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 4. | | Cultural heritage - loss of access to sacred sites | Indirect impact caused by the Project's construction activities that may inhibit members of the local community being able to access the cultural sites associated with Jawajei. | Moderate | Low | ▪ BMMC to provide alternative routes of access or transportation, where and when required (e.g. for the villagers of Jakindor to visit Jawajei for ceremonies).<br>▪ Villages to be notified that alternative access routes will be provided or transportation provided by Aureus, and consultation will be undertaken with the chiefs/village elders on routes/transport needs. | During construction, as the need arises. | NLGM Construction Manager | Records of discussions/agreements between NLGM and the community. |
| 5. | Section 9.3<br><br>Liberia Integrated Water Resources Management (IWRM) Policy, 2006<br><br>WHO limits used for purposes of EIS | Cultural heritage pollution | Hydrocarbon contamination of cultural heritage assets from construction equipment and/or vehicle spillages. | Moderate | Low | ▪ Excessive soil contamination by fuel or oil spills, for example, from mining vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ using bioremediation, in accordance with BMMC's procedures to be developed.<br>▪ Vehicles will be maintained regularly and kept in a good working order.<br>▪ Vehicle maintenance will not be carried out in random areas of the site, but in the designated workshops. | Throughout the construction phase, as the need arises. | NLGM Construction Manager | Vehicle maintenance records, records of hazardous waste management controls and practices etc |
| **Cultural Heritage – Operational Phase** | | | | | | | | | |
| 1. | | Cultural heritage - protection of cultural heritage site | Potential accidental damage caused by operational activities to a sacred site on | Moderate | Low | ▪ The potential threat is likely to be caused through inadvertent damage by staff not knowing the site is there. Therefore, to prevent vehicle or other accidental damage the area between the edge of the Project boundary and the cultural site | Continuation of the mitigation from operational phase and maintenance throughout. | NLGM General Manager & Community Affairs Manager | Installation of adequate protection measures, including bunding, |

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| | | | the western edge of the Project area (Site 1: Sekpendeh-Woni guyoh) | | | will be demarcated by means of an earth bund, fencing and signage. | | | fencing, and signage. |
| 2. | | Cultural heritage - loss of access to sacred sites | Indirect impact caused by the Project's operational activities that may inhibit members of the local community being able to access the cultural sites associated with Jawajei. | Moderate | Low | ▪ NLGM to provide alternative routes of access or transportation, where and when required (e.g. for the villagers of Jakindor to visit Jawajei for ceremonies).<br>▪ Villages to be notified that alternative access routes will be provided or transportation laid on by NLGM, and consultation will be undertaken with the chiefs/village elders on routes/transport needs.<br>▪ Updating and use of the Chance Find Procedure, in the event that cultural heritage remains are identified by workers during the course of the mine operations. | Throughout operation phase, as the need arises. | NLGM General Manager & Community Affairs Manager | Records of discussions/agreements between NLGM and the community. |
| 3. | | Cultural heritage - protection of cultural heritage site | Potential accidental damage caused by operational activities to a sacred site on the western edge of the Project area (Site 1: Sekpendeh-Woni guyoh) | Moderate | Low | ▪ The potential threat is likely to be caused through inadvertent damage by staff not knowing the site is there. Therefore, to prevent vehicle or other accidental damage the area between the edge of the Project boundary and the cultural site will be demarcated by means of an earth bund, fencing and signage. | Continuation of the mitigation from operational phase and maintenance throughout. | NLGM General Manager & Community Affairs Manager | Installation of adequate protection measures, including bunding, fencing, and signage. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| 4. | | Cultural heritage - loss of access to sacred sites | Indirect impact caused by the Project's operational activities that may inhibit members of the local community being able to access the cultural sites associated with Jawajei. | Moderate | Low | ▪ NLGM to provide alternative routes of access or transportation, where and when required (e.g. for the villagers of Jakindor to visit Jawajei for ceremonies).<br>▪ Villages to be notified that alternative access routes will be provided or transportation laid on by NLGM, and consultation will be undertaken with the chiefs/village elders on routes/transport needs | Throughout operation phase, as the need arises. | NLGM General Manager & Community Affairs Manager | Records of discussions/agreements between NLGM and the community. |
| 5. | Section 6<br><br>Liberia Integrated Water Resources Management (IWRM) Policy, 2006<br><br>WHO limits used for purposes of EIS | Cultural heritage pollution | Hydrocarbon contamination of cultural heritage assets from operation equipment and/or vehicle spillages. | Moderate | Low | ▪ Excessive soil contamination by fuel or oil spills, for example, from mining vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ using bioremediation, in accordance with BMMC's procedures to be developed.<br>▪ Vehicles will be maintained regularly and kept in a good working order.<br>▪ Vehicle maintenance will not be carried out in random areas of the site, but in the designated workshops. | Throughout the operation phase, as the need arises. | NLGM General Manager & Community Affairs Manager | Vehicle maintenance records, records of hazardous waste management controls and practices etc |
| **Cultural Heritage – Decommissioning & Closure Phase** | | | | | | | | | |
| 1. | | Cultural heritage - protection of cultural heritage site | Potential accidental damage caused by construction activities to a sacred site on | Moderate | Low | ▪ The potential threat is likely to be caused through inadvertent damage by staff not knowing the site is there. Therefore, to prevent vehicle or other accidental damage the area between the edge of the Project boundary and the cultural site | Continuation of the mitigation from operational phase and maintenance throughout | NLGM General Manager & Community Affairs Manager | Installation of adequate protection measures, including bunding, |

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| | | | the western edge of the Project area (Site 1: Sekpendeh-Woni guyoh) | | | will be demarcated by means of an earthern bund, fencing and signage. | | | fencing, and signage. |
| 2. | | Cultural heritage - loss of access to sacred sites | Indirect impact caused by the Project's closure and rehabilitation activities that may inhibit members of the local community being able to access the cultural sites associated with Jawajei. | Moderate | Low | ▪ NLGM to provide alternative routes of access or transportation, where and when required (e.g. for the villagers of Jakindor to visit Jawajei for ceremonies).<br>▪ Villages to be notified that alternative access routes will be provided or transportation laid on by NLGM, and consultation will be undertaken with the chiefs/village elders on routes/transport needs.<br>▪ Updating and use of the Chance Find Procedure, in the event that cultural heritage remains are identified by workers during the course of decommissioning and closure. | Throughout decommissioning and closure phases, as the need arises. | NLGM General Manager & Community Affairs Manager | Records of discussions/agreements between NLGM and the community. |
| 3. | Section 9.3<br><br>Liberia Integrated Water Resources Management (IWRM) Policy, 2006<br><br>WHO limits used for purposes of EIS | Cultural heritage pollution | Hydrocarbon contamination of cultural heritage assets from construction equipment and/or vehicle spillages. | Moderate | Low | ▪ Excessive soil contamination by fuel or oil spills, for example, from mining vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ using bioremediation, in accordance with BMMC's procedures to be developed.<br>▪ Vehicles will be maintained regularly and kept in a good working order.<br>▪ Vehicle maintenance will not be carried out in random areas of the site, but in the designated workshops. | Throughout decommissioning and closure phases, as the need arises. | NLGM General Manager & Community Affairs Manager | Vehicle maintenance records, records of hazardous waste management controls and practices etc |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| **Visual Aesthetics – Construction Phase** | | | | | | | | | |
| 1. | Section 15 Liberia Environmental Protection and Management Law (2006) | Earthworks and construction of plant infrastructure | Removal of the vegetation and the alteration of the existing topography will result in a change in the existing landscape character and therefore impacting on the visual resource value and becoming a visually intrusive element of the landscape. | Low | Low | ▪ Efforts will be employed to maintain the construction site in a neat and orderly condition during the construction phase;<br>▪ Designated areas for material storage, waste sorting and temporary storage, batching and other potentially intrusive activities will be created and screened off to the extent is feasible; and<br>▪ Where feasible, specimen trees must be transplanted to locations adjacent to the mine where they will not be affected by mining activities. | Throughout the construction phase, as the need arises. | NLGM Construction Manager | Monitoring of the construction site so that general housekeeping is complied with. |
| 2. | Section 9.4<br><br>Liberia Air Quality Standards<br><br>Liberia Environmental Protection and Management Law (2006)<br><br>WHO limits used for | Air quality – fugitive dust | Generation of fugitive dust emissions from vehicle movement and construction activities, notably the stripping of vegetation. Therefore reducing visibility and altering visual | Moderate | Low | ▪ When necessary, and particularly during the dry season, efficient watering of areas where construction activities result in dust creation and vehicular movements occur will be employed;<br>▪ All stockpiles of material that may be blown away during windy spells (such as sand, soil and excavated material etc.) will be suitably covered or other measures taken to prevent such occurrence. Suitable measures will be determined by the environmental control officer or site engineer based on the nature of the material, its use, etc; | Throughout the construction phase. Dust fallout monitoring as prescribed in the air quality assessment report. | NLGM Construction Manager, Environmental control officer. | Dust suppression records and dust fallout monitoring results;<br>Site vehicle enforcement regulations, evidence of vehicle speed monitoring on site; and<br>Reduction in |

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| | purposes of EIS | | amenities. | | | ▪ Enforcement of low vehicle speeds on site; and<br>▪ All measures in the air quality assessment study pertaining to dust suppression will be adhered to. | | | visible dust as a result of project construction activities. |
| 3. | | Lighting at night | Site camp and construction plant lights can potentially be highly visible and intrusive | Moderate | Moderate | ▪ During construction, the Construction Contractors will utilise security lighting that is movement activated rather than permanently switched on, to prevent unnecessary constant illumination; and<br>▪ During construction selective lighting for the construction camps and other secured areas will be employed. Up-lighting of structures will be avoided. | Throughout the construction phase. | NLGM Construction Manager | Installation of censored lighting during construction; and Installation of selective lighting for construction camp and other secured areas and monitoring of these. Reduction/elimination of light from surrounding receptor locations |
| **Visual Aesthetics – Operational Phase** | | | | | | | | | |
| 1. | Section 15 Liberia Environmental Protection and Management Law (2006) | Physical structures | The physical structures namely, open pit, waste rock dump, tailings storage facility | Moderate | Moderate | ▪ Due to practical / operational, safety and cost implications, the mitigation potential in this regard is somewhat limited. However, the following measures will be implemented:<br>- All areas that are to be visited by | | NLGM Operations Manager, with assistance from the Environmental | There are no foreseen KPI's |

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| | | | and main plant are expected to some extent have an impact on the visual amenities of the area as it impacts the sense of place and is visually intrusive to the surrounding landscape. These structures impact the visual baseline and will also be visually intrusive, due to the size and geometric shapes of the elements being introduced. | | | persons not employed at the plant (i.e. offices, workshop areas) as well as any residential quarters should be landscaped to improve visual quality and a vegetative screen should be established around the perimeter of these areas; and<br>- Progressive rehabilitation of all areas affected by mining will be done throughout the operational phase. | | Manager | |
| 2. | Liberia Air Quality Standards<br><br>Section 69 Liberia Environmental Protection and Management Law (2006) | Emission plumes | A source of operational impact is the emission plume from the plant stack and burning of waste, which under certain conditions may be visible over | Moderate | Moderate | ▪ Equip the stacks with dust filters to reduce fugitive dust emissions from the plant;<br>▪ Suitable mitigation measures for the fitting of the stacks should be implemented, such as bag filters, electrostatic precipitators and / or other suitable emission filters;<br>▪ Waste should be burnt during the wet season and on days that have a low wind potential; and | Throughout the operational stage of the mine. Stack filter/emissions sampling as prescribed in the air quality assessment report | NLGM Operations Manager, with assistance from the Environmental Manager | Dust suppression records and PM10 and dust fallout monitoring results. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| | WHO limits used for purposes of EIS | | large distances. | | | ▪ Certain waste types, that would in any way be particularly harmful i.e. synthetic and high smoke-yield materials, should be taken to a suitable disposal site. | | | |
| 3. | Liberia Air Quality Standards<br><br>Liberia Environmental Protection and Management Law (2006)<br><br>WHO limits used for purposes of EIS | Fugitive dust | Impact of fugitive dust during the operation stage from exposed surfaces, vehicular traffic and the waste rock dump. The severity of dust pollution will be determined by a number of different factors such as prevailing wind strength and the extent of the area/s cleared by quarrying operations. | Moderate | Low | ▪ All measures in the air quality impact assessment study pertaining to dust suppression will be adhered to. | Throughout operational phase | NLGM Operations Manager, with assistance from the Environmental Manager | Dust suppression records and PM10 and dust fallout monitoring results. |
| 4. | | Lighting at night | Light pollution and flares | Moderate | Low | ▪ The height from which floodlights are fixed will be reduced to be as low as possible whilst still maintaining the required levels of security illumination. Area lighting on tall masts will be confined to the lower landform elevations;<br>▪ Zones of high and low lighting | Throughout operational stage. Visual inspection from all potentially affected receptor locations | NLGM Operations Manager | Monthly monitoring of light fixtures to ensure the lighting is as stipulated in the mitigation measures. |

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| | | | | | | requirements will be identified, with the focus on only illuminating areas to the minimum extent possible to allow safe operations at night and for security surveillance;<br>▪ Buildings that are typically not used at night such as offices and workshops will be fitted with sensors that automatically switch off lights in empty rooms after a certain time, to prevent them from inadvertently being left on;<br>▪ Up-lighting of structures will be avoided – light will rather be directed downwards and focused on the object to be illuminated. (i.e. Avoid directing the light towards the direction from where it would be most experienced by external receptors);<br>▪ Light spill will be minimised. All security lighting will have 'blinkers' or be specifically designed to ensure light is directed downwards while preventing side spill. Light fixtures of this description are commonly available for a variety of uses and will be used to the greatest extent possible. This may require that light pole numbers will increase to give the required illumination on the ground; and<br>▪ Lighting for security and safety will be directed downwards and towards buildings and the plant, to reduce light spill beyond the mine property boundary. | following installation of mitigation measures | | Monitoring of light at night from receptor areas |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| **Visual Aesthetics – Decommissioning & Closure Phase** | | | | | | | | | |
| 1. | Section 9.5<br><br>Liberia Environmental Protection and Management Law (2006) | Decommissioning activities, which will include the dismantling and deconstruction of project-related infrastructure and removing the material from site. | Removal of visually incongruous and intrusive elements from the landscape | Moderate | Low (Positive) | ▪ The removal of mine plant and surface infrastructure will result in an improvement in the visual condition of the site; and no additional mitigation is therefore specified in this regard. | From the start to the end of the decommissioning and closure phase. | NLGM General Manager, with assistance from the Environmental Manager | Decommissioning and closure plan, maps and evidence of demarcation of work areas. |
| 2. | Liberia Environmental Protection and Management Law (2006) | Site rehabilitation | This aspect is expected to result in a significant additional improvement of the visual condition. Once implemented it is expected that visual condition will be very similar to that of the pre-project baseline, and is therefore considered a positive visual impact associated with this phase of the project. | | Low | No additional mitigation is recommended, as rehabilitation will result in an improvement of the visual condition of the site. | Rehabilitation should be concurrent throughout the LOM until closure is achieved | NLGM General Manager, with assistance from the Environmental Manager | Compliance with afore-mentioned closure measures and rehabilitation plan; and Monitoring results of the vegetation density, species analysis and soil fertility |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
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| **Waste Management – General waste and hazardous waste (and cyanide)** | | | | | | | | | |
| 1. | Liberia Environmental Protection and Management Law (2006)<br><br>Liberia waste related legislation<br><br>Aureus Environmental Policy | General waste | Pollution from general waste | N/A | N/A | ▪ An Integrated Waste Management Plan will be developed and implemented for the Project, including objectives for the collection, storage, transport, minimization and disposal of all wastes generated at the plant;<br>▪ Demarcated areas with suitable waste bins will be provided for non hazardous household and industrial waste;<br>▪ Waste will be separated and recycled at source as far as possible to minimize volumes requiring landfilling; and<br>▪ Employees and the community will be educated to ensure the objectives of the Integrated Waste Management Plan are achieved. | On-going throughout Project life | NLGM General Manager, with assistance from the Environmental Manager | Integrated Waste Management Plan, and Monitoring data and reports. Also, auditing reports. |
| 2. | Liberia Environmental Protection and Management Law (2006)<br><br>Liberia waste related legislation<br><br>International Cyanide Code<br><br>Aureus Environmental Policy | Hazardous waste and cyanide | Pollution and environmental disturbance from hazardous waste spills, including cyanide | N/A | N/A | ▪ Development and implementation of an Integrated Waste Management Plan for the Project, including objectives for the collection, storage, transport, minimization and disposal of all hazardous and non hazardous wastes generated at the plant;<br>▪ Cyanide should be transported to site, stored on site and managed according to the principles and management measures noted in the International Cyanide Code;<br>▪ All hazardous waste streams should be identified (inventory) and classified to | On-going throughout Project life | NLGM General Manager, with assistance from the Environmental Manager | Integrated Waste Management Plan, and Monitoring data and reports. Also, auditing reports. |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ensure their toxic components are known and to ensure it is managed and disposed of in a safely manner;<br>▪ Hazardous wastes should be stored in sealed containers constructed of a suitable material and will be labelled as required by the relevant Togolese regulations and best international practices;<br>▪ All hazardous waste should be stored, transported, and disposed of in compliance with the relevant legislation for hazardous waste; and<br>▪ Hazardous waste storage areas on site should be positioned away from any stormwater drains and watercourses and away from moving vehicles and equipment to prevent pollution during container leakages and accidental spills.<br><br>The storage/sorting site should at least comply with the following:<br>▪ The migration of any accidental spillage of hazardous liquids or materials into the soil and groundwater regime around the temporary storage area should be prevented;<br>▪ The site should be provided with an impervious base to prevent ingress of leachate;<br>▪ The hazardous storage area should be provided with a roof;<br>▪ The processing plant should be provided | | | |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | with a spill containment sump to accommodate a volume equal to 1.5 times the volume of all containers stored on it, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, whichever is greater;<br>▪ Any leachate generated at the processing plant should be stored in a contaminated liquid impoundment and treated before re-use or being released;<br>▪ Different and incompatible wastes should be clearly labelled and stored separately to prevent any chemical reactions such as combustion and fire hazards from occurring;<br>▪ Throughout the rainy season, temporary containment facilities should be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs;<br>▪ Drums should not be overfilled and different wastes types not be mixed;<br>▪ Unless watertight, containers of dry waste should be stored on pallets or similar; and<br>▪ Hazardous Waste containers or tanks whilst on site should be clearly labelled with the words “Hazardous Waste”.<br>▪ The generation of hazardous waste | | | |

| No. | Ref | Aspect | Potential Impact | Impact rating prior to mitigation | Impact rating after mitigation | Mitigation & Control Measure(s) | Timing, frequency and duration of mitigation measures | Resp. Person | Key Performance Indicators (KPIs) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | should be minimized as far as possible;<br>▪ Containment berms should be provided in fuelling and maintenance areas and where the potential for spills is high;<br>▪ Liquid or semi-liquid hazardous waste in should be kept in appropriate containers (closed drums or similar) and in bonded area and under cover;<br>▪ Used and empty hazardous containers should be punctured and flattened (to the extent possible) before disposal to prevent it from being re-used;<br>▪ The original label of liquids and materials should not be removed as it contains important safety and disposal information;<br>▪ Hazardous waste should be separated and recycled as far as possible to minimize volumes requiring landfilling; and<br>▪ BMMC employees should be educated to ensure the objectives of the Integrated Waste Management Plan are achieved. | | | |

## 9.4 Geochemistry related Mitigation Measures

From the Phase 1 Preliminary Geochemical Risk Assessment conducted as part of the EIA, the following key mitigation measures were noted from a geochemistry perspective:

### Waste Rock Dump:

Proposed mitigation measures for the operational phase:

- Stormwater containment and clean and dirty water separation;
- Engineered barrier for the base of the WRD;
- Selective placement of waste rock materials;
- Compact transitional sulphide waste rock materials after placement; and
- Keep the operating windows of the WRD free draining.

Proposed mitigation measures for the closure phase:

- Recommendations related to stormwater management for the operational phase is also valid for the post closure phase;
- Prediction of post closure drainage chemistry based on site specific kinetic data and as a function of closure design and measures;
- Closure surface that is free draining with slopes that will minimise the risk of erosion; and
- Provision of an engineered cover to provide surface stability and prevent the ingress of water and oxygen into the waste rock materials.

### Open Pit:

Proposed mitigation measures for the operational phase:

- Intercept pit groundwater seepage before it enters the pit by dewatering boreholes. This will prevent contamination of the groundwater and can potentially be discharged directly to environment; and
- The likely and possibly acid forming waste rock materials (SMUS and contact zone Gnqf) should be placed in the deepest parts of the pit or as a minimum in parts of the pit where it will be inundated after re-watering of the pit. These materials should also be compacted and kept free draining to limit water and oxygen ingress.

Proposed mitigation measures for the closure phase:

- Rebound of the groundwater in the pit is an effective measure to reduce post closure ARD and ML due to the reduction in oxidation rates under a water cover; and
- The post closure pit water quality should be assessed and modelled during the operational phase in order to refine the requirements for long-term water treatment to prevent downstream groundwater impacts.

### Rom Ore Stockpiles:

Proposed mitigation measures for the operational Phase:

- Stormwater containment and clean and dirty water separation; and
- Engineered barrier for the base of the ROM pad and/or the process water pond.

Proposed mitigation measures for the Post Closure phase:

- It is understood that the ROM pad will be removed at closure, potentially leaving a contaminated footprint. This footprint should be remediated using standard in situ soil remediation methods.

### Tailings Storage Facility:

Proposed mitigation measures for the Operational phase:

- Stormwater containment and clean and dirty water separation;
- Engineered barrier for the base of the TSF; and
- Reduction in the pool size to minimise seepage rates.

Proposed mitigation measures for the Post Closure phase:

- Recommendations related to stormwater management for the operational phase is also valid for the post closure phase;
- Closure surface that is free draining with slopes that will minimise the risk of erosion; and
- Provision of an engineered cover to provide surface stability and prevent the ingress of water and oxygen into the waste rock materials.

The proposed mitigation measures are robust against the uncertainties of the geochemical characterisation and will reduce the risk of ARD and ML to acceptable risk levels if implemented.

In addition to the recommendations made to mitigate the facility specific ARD and ML risks, the following general recommendations are made for the further assessment and management of ARD and ML risks at the proposed mining site:

- Develop, implement and maintain an ARD and ML monitoring program. This monitoring program should be integrated with the site wide environmental monitoring program;
- Conduct Phase 2 of the proposed geochemical characterisation program, including kinetic testing of waste rock materials, in order to develop first order predictions of mine drainage from the various mine facilities; and
- Develop an ARD/ML management plan for the site based on the geochemical characterisation, monitoring, mine planning and closure planning of the mine site. This document will be a dynamic document that acts as a planning tool (contains actions etc) and also interlinks with the site water management and closure plans.

## 9.5 Cost Estimate for Mitigation

As per the Liberian EPA EIA Guidelines (2006), a high level cost estimate is required for implementing the key mitigation measures as outlined in the EMP and in the EIS as a whole. Table 53 below provides an indicative cost estimate for implementing the key mitigation measures associated with the proposed Project. (It must be noted that the cost estimates provided below are indicative, and may thus change over time).

**Table 53: Cost estimate for implementing key mitigation measures related to the Project**

| Mitigation Measures | Frequency | Cost Estimate (US$) |
|---|---|---|
| Pre-Construction Phase | Once off | 30,000 |
| Construction Phase | Once off | 50,000 |
| Operational Phase | As per EMP | 110,000 |
| EMP mitigation measures | As per EMP | 500,000 |
| Social mitigation measures | As per EMP | 1,200,000 |

# 10.0 IDENTIFICATION OF ALTERNATIVES

Assessing alternatives helps to identify the most appropriate method of developing the Project, taking into account location, activity alternatives, technology alternatives, temporal alternatives and the no-go alternative. Alternatives also help identify the activity with the least environmental and social impact.

The identification of alternatives is a requirement of the Liberian EPA in terms of the EIA Guidelines (2006). This section describes they key alternatives that were considered as part of the NLGM EIS and project infrastructure feasibility studies.

## 10.1 Mining Method

Two mining methods were considered by BMMC, namely open pit mining and underground mining. Open pit mining was selected and this choice of mining method for the Project is based on the depth of the ore body. The average depth of the ore body is 220m below the ground surface, and thus this is best suited to mining from the surface – i.e. open pit mining.

## 10.2 Site Layout

The placement of infrastructure such as the TSF, WRD, processing plant, DC of the Marvoe Creek, staff accommodation, haul roads, workshops, and offices took into account financial, environmental and social considerations to develop a site layout with the fewest impacts as possible.

## 10.3 Processing Plant Location

In terms of the processing plant location, this was selected taking into consideration factors such as the geotechnical conditions, ease of access, elevation profiles and the slope of the ground.

For the processing plant process, flotation versus CIL was studied, and the CIL option was selected based on weighing up factors such as the CAPEX, OPEX, (i.e. economic considerations), gold recovery percentages and efficiencies, and ease of operability and maintenance of the required infrastructure.

## 10.4 Processing Plant Design

The design of the processing plant was based on a number of key considerations and alternatives, the objective being that the plant is efficient and will meet international construction and environmental standards. The key design and location considerations were as follows:

- Technologically proven process design;
- Reliability of the equipment during operation;
- Efficient process design for maximum recovery of gold;
- Ease of maintenance;
- Geology and topography;
- Cost-effective technology;
- Power and fuel efficiency; and
- Compliance with environmental, health and safety standards.

BMMC is completing a feasibility study and detailed design to determine the ultimate capacity and design criteria of the processing plant. Currently, BMMC envisages the process capacity of the plant to be approximately 1,100,000 ore tonnes per annum (i.e. 91,700 tonnes per month) with an average of 17 million tonnes per annum of total rock to be mined.

## 10.5 WRD Location

AMC undertook a high level study aimed at selecting the most preferred location for the WRD from an economical, environmental and social perspective. The main reasons' why the current location for the WRD, south of the open pit, was chosen is based on the following:

- The WRD is located as close to the pit as possible, which is more economical because the haulage distances of waste rock from the pit to the WRD are shorter;
- The topography of the area is favourable for the location of the WRD, in that it is relatively flat ground;
- The WRD could not be located to the north of the open pit because the DC will be located there (with associated contamination risks). It also could not be located to the east of the open pit because this is where the processing plant and associated infrastructure will be located. Lastly, it could not be located to the west of the open pit because the DC goes into the Marvoe Creek in this area; and
- The relative ease of closure was also considered when selecting the WRD location.

## 10.6 WRD Design and Volume

AMC also undertook a study to design the most optimal WRD from an economic, environmental and best practice standards perspective. Aspects considered in the WRD design include:

- A 100 m standoff distance from the pit to reduce the surcharge load on the south wall of the pit from the WRD;
- The WRD has been aligned parallel to the pit to reduce the footprint of the mine to the south;
- The height of the WRD has been restricted to better blend into the existing topography;
- The height of the WRD has also been restricted on economic grounds as it is more expensive to haul up-hill (vertically) than the cost of hauling laterally. (The maximum height will be 68 m); and
- The overall slope angle of the WRD has been selected to facilitate rehabilitation.

The volume (and thus the area to be occupied by the WRD and its maximum height), were determined based on BMMC's mine plan and the anticipated volumes of waste rock that will come out of the open pit for storage on the WRD.

## 10.7 TSF Location

Golder's engineering team carried out a TSF site selection study during the pre-feasibility study on a 5 m contour map available for the Project site (Golder, 2006). Five potential TSF sites were identified. The semi-qualitative comparison of the sites is presented in Table 54.

Site 1 remains the preferred TSF site for the following reasons:

- It has the storage capacity for the current tailings volume;
- It is the nearest site to the mill (<1.5 km);
- The non-contact water diversion requirement of the site is one of the smallest (~3 km); and
- It is located outside the 50m buffer zone for the open pit operation.

Site 2 is not considered suitable as it is located along the preferred DC alignment and it is located within the 50 m buffer zone for the open pit operation.

Site 5 has a good topographic containment and it is capable of storing the current tailings volume. Water management will be a significant issue for the site as its footprint area is very large which will increase the volume of the contact water and it has a large catchment area which requires constructing more than 6km of diversion channel. Additionally, the site is located about 3 km away for the Process Plant.

Sites 3 and 4 do not have the capacity to store the current tailings unless large perimeter dams are constructed. They are also located far from the Process Plant site.

**Table 54: Comparison of Potential TSF Sites**

| Constraint | TSF Sites | | | | |
|---|---|---|---|---|---|
| | **Site 1** | **Site 2** | **Site 3** | **Site 4** | **Site 5** |
| Proximity to mill (km) | 1.5 | 2.5 | 3 | 2.5 | 2.5 |
| Extent of catchment area | Small | Very small | Large | Large | Very Large |
| Run-off diversion length (km) | 3 | 2 | 4 | 4 | 6 |
| Storage capacity (M-$m^3$) | 4.6 | 2.1 | 3.2 | 1.2 | 4.1 |
| Valley dam fill volume (M-$m^3$) | 0.4 | 0.7 | 0.5 | 0.1 | 0.9 |
| Storage to dam fill ratio (-) | 11.5 | 3 | 6.4 | 12 | 4.6 |
| Perimeter dam fill required for 6 M-$m^3$ tailings? | Very small | Significant | Significant | Significant | Small |
| Footprint area (ha) | 78 | 47 | 67 | 40 | 132 |
| Elevation difference from plant (m) | 25 | 15 | 25 | 25 | 15 |
| Within the open pit buffer zone? | No | Yes | No | No | No |
| Located along the Marvoe Creek diversion channel alignment? | No | Yes | No | No | No |

## 10.8 Diversion of the Marvoe Creek

A number of alternatives were assessed for the proposed diversion of the Marvoe Creek so as to allow mining of the ore deposits. These alternatives were assessed based on topography, resource location and environmental and social impacts. Currently, the most promising alternative aims at diverting the creek around the mining area to the west before re-joining its original course.

Golder carried out a Marvoe Creek alignment selection study on the 2006 Helicopter digital terrain model (DTM) available for the Project site (Golder 2010). Four potential alignments were identified. The qualitative comparison of the alignment options is provided in Table 55.

Options 1 and 4 are the cheapest options but they were not selected for the following reasons:

- Significant environmental impact is expected from both of these options as the ponds created cover a very large area;
- In both options, one of the ponds is located adjacent to the proposed open pit and this would pose significant risk to the operation of the open pit; and
- In Option 4, the diversion channel is located close to the alignment of the ore bodies and potentially it might be sterilizing future ore body expansion.

Option 2 is the preferred option as it is associated with minimal environmental impact and condemnation holes drilled along the alignment of the ore body confirmed that it is not underlain by the mineralized zone.

**Table 55: Comparison of Marvoe Creek DC Alignment Options**

| Constraint | DC Alignment | | | |
|---|---|---|---|---|
| | Option 1 | Option 2 | Option 3 | Option 4 |
| Total length of channel (km) | 2 (primarily excavation) | 3.5 (half excavation and half berm) | 4.5 (60% excavation and 40% berm) | 2 (primarily excavation) |
| Total footprint area disturbed by channel (ha) | 16 | 15 | 24 | 23 |
| Maximum anticipated channel depth (m) | 13.5 | 13.5 | 14.5 | 19.5 |
| Number of ponds created | Three | One | One | Two |
| Total area of ponds created (ha) | 60 | 10 | 4 | 74 |
| Excavation quantities (M-m$^3$) | 0.7 | 0.6 | 0.16 | 0.10 |
| Fill quantities (M-m$^3$) | 0.11 | 0.28 | 0.22 | 0.05 |
| Geotextile quantities (m$^2$) | 124,500 | 153,600 | 186,600 | 99,600 |
| Riprap quantities (m$^3$) | 34,700 | 42,700 | 52,000 | 27,700 |
| Order of magnitude cost (Million $US) | 5.1 | 6.0 | 8.1 | 5.7 |

## 10.9 Resettlement Village Location

As noted previously in this EIS, the development of the Project will require the resettlement of approximately 300 households (1,800 people) currently residing in the villages (‘towns’) of Kinjor and Larjor. The acquisition of replacement land is currently in progress and the process followed thus far is briefly described below:

- Consultations with government agencies and traditional authority structures on the process and requirements of land acquisition for resettlement;
- Information sharing meetings with the Kinjor and Larjor affected communities on the resettlement site selection process to be followed;
- Workshop with the Kinjor/Larjor Resettlement Committee (RC) to identify a range of preferred resettlement site options;
- Physical inspection of the site options by members of the RC;
- Presentation of selected site options to Aureus for consideration
- Presentation of selected site options to the Darblo Clan (on who’s land the sites are located);
- Inspection of resettlement site option proposed by the Darblo Clan leadership;
- Follow up consultations with the Darblo Clan and RC to reach agreement on the preferred site; and
- Appointment of a site selection committee to physically inspect the preferred site.

The outcome of the above site selection process will be presented to the affected communities for approval, upon which negotiations with the land deed holders and the relevant authorities will commence. Kinjor and Larjor residents will be provided with an opportunity to physically visit the preferred resettlement site for inspection.

Key resettlement village location criteria included the following:

- Physical location;
- Proximity to surface water resources;

- Proximity to Bea-MDA license area;
- Proximity to the NLGM Camp;
- Land owner/deed holder;
- Land acquisition requirements;
- Proximity to home village site;
- State land/Protected land;
- Cultural and/or heritage sites/graves present within the vicinity;
- Nearest villages and large town;
- Accessibility (road network);
- Human settlement;
- Public services and facilities;
- Topography;
- Current land use;
- Agricultural land availability;
- Land quality/carrying capacity;
- Access to natural resources;
- Access to current/existing economic activities;
- Access to employment opportunities;
- Access to existing business opportunities;
- Access to existing market opportunities;
- Livelihood restoration potential; and
- Host community characteristics.

During the first resettlement site selection workshop with the RC, four site options were identified. After consultations with the Darblo clan, a fifth option was added to the list. Site Option 2 (Lealema Creek) was subsequently selected as the preferred resettlement site option based on a consideration of the criteria listed above. Proximity to the proposed mine in terms of the Project labour force requirements and opportunities for the affected communities to benefit from the Project were key considerations during the selection process.

## 10.10 Go-No-Go Project Alternative

The current land use consists of limited agricultural and logging operations. The no-project option will result in the continuation of such land uses. Although economically viable, the continuation of subsistence agriculture will not provide the level of short-term and long-term economic growth to the area that this Project would offer. The economic benefits of the Project potentially include:

- Increased employment opportunities for local people in the area;
- Improved livelihood opportunities; and
- Greater development and associated socio-economic development of the NLGM area, Grand Cape Mount County and Liberia as a whole.

If the Project were not to proceed, the additional economic activity, skills development and availability of jobs would not be created. In addition, the gold reserves would remain unutilised and there would be little or no economic growth developing in the region and country. If the Project were not to go ahead there would be no royalties/revenues paid to the Government of Liberia.

# 11.0 ENVIRONMENTAL MANAGEMENT AND TRAINING

The key objectives of the BMMC environmental training program that will be implemented before and during the construction phase, and throughout the life of the mine, are to safeguard all employees, contractors and visitors to the NLGM site and to help implement the environmental program, in line with the EMP presented in Section 9.

To achieve these objectives, new employees will all receive training on general health and safety, environmental precautions and emergency procedures relating to their area of responsibility, as well as general training on environmental procedures at the NLGM site. In addition, employees will receive daily Health, Safety and Environment briefings conducted by shift supervisors.

Health, Safety and Environmental Inductions will be carried out for new employees and contractors covering the use of personal protective equipment (PPE), dangerous areas, appropriate conduct, emergency response procedures and waste management.

Particular focus of all training in health and safety will be given to cyanide procedures.

In addition to health, safety and environmental training, BMMC will develop a strategy for training its employees and will provide bursaries for further training for selected employees.

Inductions on the cultural aspects of Liberians and Liberian life will be provided to expatriate employees and visitors, in order to minimise any cultural misunderstandings. Training in appropriate methods of consultation and meeting recording will be given to all personnel that may be involved in stakeholder engagement.

# 12.0 MONITORING PROGRAM

The objectives of the monitoring program that will be implemented at the NLGM site include:

- To determine whether all aspects of the EMP and associated monitoring networks have been implemented and are operating efficiently to their designed effect;
- To monitor environmental compliance against both national Liberian and international environmental standards;
- To detect any changes to the receiving environment and enable analysis of their cause; and
- To enable effective liaison with the local communities through meeting records.

The Environmental Department will be responsible for all environmental monitoring with the Community Relations Department in charge of social program monitoring.

Based on the findings of the impact assessment and EMP, Table 56  highlights the key monitoring measures to be implemented on site by Aureus/BMMC. The monitoring program will be updated by BMMC on an annual basis.

**Table 56: NLGM Environmental Monitoring Program**

| Component Monitoring | Monitoring category | Objectives | Aspect | Monitoring locations | Frequency | Parameters |
|---|---|---|---|---|---|---|
| Meteorology | Ambient | To ensure that NLGM employees and the local community are protected against any adverse health effects due to project related changes to air quality or noise impacts. | Seasonal changes | Current and additional (if required) New Liberty Gold Mine Meteorological Monitoring Station | 10 minute, hourly and daily | Rainfall, Wind Speed and Direction, Temperature, Humidity, and Solar radiation |
| Climate change | Ambient | Keeping track of progress and external factors, on a continuous basis, to inform management decisions and allow the timely adoption of corrective measures, where necessary, to 'stay on track' | Global Warming | New Liberty Gold Mine Weather/Meteorological Station | Monthly/Quarterly | Rainfall, Wind Speed and Direction, Temperature, Humidity<br>Carbon Dioxide (CO2), GHG |
| Blasting | Operations | To determine the effectiveness of blast controls | Flyrock generation during excavation/mining operations within the pit | Open pit – 500m blasting zone | During blasting | Size and distance flyrock travelled |
| Characterisation Monitoring | Operations/discharge/ambient | To characterise operational conditions during first year of project operation | Pit, WRD, Creek Diversion, Village sources (spring) | WRD Monitoring boreholes, WRD runoff, WRD seepage, site water facilities, pit dewatering , Diversion Chanel, Marvoe Creek up- mid- downstream water quality, village water sources etc. | Weekly | **Weekly:** Temperature, pH, conductivity, salinity, dissolved oxygen, turbidity, oxidation and reduction potential |
| Soil monitoring | Operations | To determine the status and contamination levels of the soils in the mine area | Soils within the NLGM mine site | Open pit, WRD, adjacent to Marvoe Creek DC, adjacent to ROM pad, near areas where hydrocarbons are stored etc. | Annually | EC, pH, hydrocarbons, metals etc. Depending on potential sources |

| Component Monitoring | Monitoring category | Objectives | Aspect | Monitoring locations | Frequency | Parameters |
|---|---|---|---|---|---|---|
| WRD drainage | Discharge | To determine the effectiveness of ARD drainage & sediment erosion controls in protecting water quality downstream of the pit and WRD | Run-off & Seepage from WRD | Groundwater boreholes at the NLGM site<br>Surface drainage at foot of WRD | Monthly/Quarterly/ Annually | **Monthly, Quarterly & Annually:** pH, temperature, conductivity, turbidity, ORP, acidity and alkalinity. |
| Acid Rock Drainage | Geochemical changes and impacts during operations | Evaluate changes in the geochemical characterisation of waste rock, ore and tailings, and identify and manage associated risks | Geochemical impacts related to WRD | Waste Rock, Ore Stockpiles, Tailings | Annually | **Annually:** Acid Base Analysis of waste rock, stockpiles and tailings |
| Open pit dewatering | Discharge of releases to downstream drainage or rivers/streams | To determine whether the lowering of the water table around the pit will cause sulphide oxidation and result in ARD or metaliferous groundwater.<br>To assess whether pit dewatering water is likely to cause downstream impacts | Discharge from pit into site water system<br>Discharge ROM pit to the sediment trap & environment | Point of discharge | Monthly/Quarterly/ Annually | **Monthly:** pH, temperature, conductivity, turbidity, ORP, acidity, alkalinity, SO4, As, Pb. |
| Site water management system | Discharge | To determine the effectiveness of the site water management system (including dewatering, pipes, interception channels and basin) in protecting water quality uses and values downstream of the project area | Basin water | Basins in project area | Monthly/Quarterly prior to any discharge: | **Monthly:** pH, temperature, conductivity, turbidity, dissolved oxygen, ORP.<br>**Quarterly:** pH, temperature, conductivity, turbidity, dissolved oxygen, ORP, turbidity, alkalinity, TSS, major ions and ligands (Ca, Mg, K, Na, Cl, SO4, NO3, NH3, Fe, and NO2) and metals (Al, Sb, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Zn). |

| Component Monitoring | Monitoring category | Objectives | Aspect | Monitoring locations | Frequency | Parameters |
|---|---|---|---|---|---|---|
| Village drinking water | Groundwater | To determine whether village water sources (surface water, groundwater or rain-fed) are being adequately protected by monitoring the quality of: - Any village drinking water sources at risk of contamination due to the NLGM project operations.<br>- Drinking water sources provided to the local community by AMGM. | Water sources vulnerable to contamination | Marvoe Creek water monitoring points (up, mid & down-stream) – in conjunction with the water level of the Marvoe Creek DC downstream | Quarterly (during periods of rising water level, and following downsteam release of site drainage or pit dewatering waters. (6 monthly) | **Quarterly:** pH, temperature, conductivity, turbidity, TSS, major ions and ligands (Ca, Mg, Na, K, Cl, SO4, NO3, F, NO2, NH3), metals (Al, Sb, As, Ba, B, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Zn), E. coli and total coliforms |
| Borehole Groundwater quality | Groundwater | To determine | | Groundwater boreholes at the NLGM site and/or rain-fed springs | Quarterly or if inundated by contaminated water. **Immediately**: following detection of any seepage contamination in monitoring boreholes and creek monitoring points | **Quarterly:** pH, temperature, conductivity, turbidity, TSS, major ions and ligands (Ca, Mg, Na, K, Cl, SO4, NO3, F, NO2, NH3), metals (Al, Sb, As, Ba, B, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Zn), E. coli and total coliforms |
| Potable Water Quality – i.e. from wells/boreholes | Operations | To determine the quality and safety of drinking water for employees and communities | Non-compliant Water quality | Water Quality of potable water used at mine site | Daily | pH, Turbidity, TDS, TSS, EC, Ca, Mg, Na, K, Cl, As, Sulphates, Bicarbonate, Ecoli & Faecals etc. |
| Water Quality from rivers – i.e. Marvoe Creek | Ambient | To determine the quality and safety of drinking water for employees and communities | Non-compliant Water quality | Three points, locations will be suggested when final site layout became available | Quarterly & Annually | pH, temperature, conductivity, turbidity, TSS, major ions and ligands (Ca, Mg, Na, K, Cl, SO4, NO3, F, NO2, NH3), metals (Al, Sb, As, Ba, B, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Zn), E. coli and total coliforms |

| Component Monitoring | Monitoring category | Objectives | Aspect | Monitoring locations | Frequency | Parameters |
|---|---|---|---|---|---|---|
| Water quality from mine infrastructure | Operations | To determine the quality and safety of water for discharge purposes | Non-compliant Water quality | Pit, TSF, water dams and ponds | Monthly | pH, temperature, conductivity, turbidity, TSS, major ions and ligands (Ca, Mg, Na, K, Cl, SO4, NO3, F, NO2, NH3), metals (Al, Sb, As, Ba, B, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Zn) |
| Surface water flow | Ambient | Comply with legislation and standards | Flooding | Up & down stream of the Marvoe creek | Monthly | pH, temperature, conductivity, turbidity, TSS, major ions and ligands (Ca, Mg, Na, K, Cl, SO4, NO3, F, NO2, NH3), metals (Al, Sb, As, Ba, B, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Zn) |
| Pumped volume | Operations | Measure water use - Conserve Natural resource - Comply and maintain water balance | Illegal discharges, flooding | Pit - TSF - DAMS - Water Treatment plant - ponds & traps-boreholes | Daily | Re-use, Re-cycle - Recover - flows - m3p/day |
| Hydrology & geomorphology | Surface water | To identify, quantify, monitor and manage any project impacts, including: hydrological impacts (e.g. temporary reduction in flow during commissioning of the River Diversion); and water quality impacts (e.g. changes to downstream sediment or contaminant loads as a result of drainage from mine facilities) | Hydrology of the Marvoe Creek | Diversion Channel & Dam | Daily | Flow depth (and discharge). Volume of water extracted from Thigithe diversion dam. Volume of pit dewatering water released to the creek downstream of the diversion and dam |
| | | | Rainfall | Weather station | Daily | Rainfall |
| | | | Geomorphology(formation, alteration, and configuration of landforms and their relationship with underlying structures) | Creek diversion dam | Annual (at start of each dry season) | Capacity of Creek dam |
| | | | | Creek downstream of the diversion - sand bars, water holes & breaks in gradient in the creek. | Three times yearly (early November, late Feb, & late May) Following major flood events. | Photography and visual inspection of Creek bed and banks. Semi-quantitative methods, e.g. cross-sectional profiling |
| | | | DC of the Marvoe | Creek diversion channel and | Three times yearly | Photography and visual |

| Component Monitoring | Monitoring category | Objectives | Aspect | Monitoring locations | Frequency | Parameters |
|---|---|---|---|---|---|---|
| | | | Creek | energy dissipation structures at discharge point | (early November, late February, late May) Following major flood events | inspection of diversion channel integrity and condition of energy dissipation structures |
| Air quality monitoring | Emissions and ambient air quality | To ensure that NLGM employees and the local community are protected against any adverse health effects due to project related changes to air quality | Dust emissions | Pit and waste dump, haul road Licence boundary, any other areas where significant dust is generated. | Continuous | TSP, PM10 |
| | | | Depositional dust | Site boundary (upwind and downwind) | Monthly | TSP, metal concentrations |
| | | | Pollutants in the air related to vehicle emissions | Site vehicles | Quarterly | $NO_x$, $PM_{10}$ and $CO_2$ |
| Continuous emissions monitoring system (CEMS) | Emissions and ambient air quality | To monitor point source emissions to air during mine operations | Emissions from the processing plant | On smelter house emission points, within the processing plant | Constant | $NO_x$, $NO_2$, CO, $SO_2$, $PM_{10}$, Ammonia, Hydrogen Cyanide and any other trace metals which may be present in the natural geology |
| Deposited Dust | Ambient | To establish workplace dust concentration impacts on the environment and surrounding areas. | Air pollution | Various locations around the Site boundary and at local receptors | Monthly | Dust fallout - Pm 10 and other toxic elements |
| Diffusion Tubes | Ambient | To ensure that NLGM employees and the local community are protected against any adverse health effects due to Project related changes to air quality | Air pollution | Various locations around the NLGM site boundary and at local receptors | Monthly | NOx, NO, SO2 and optional VOC measurements (nox & Sox's) |

| Component Monitoring | Monitoring category | Objectives | Aspect | Monitoring locations | Frequency | Parameters |
|---|---|---|---|---|---|---|
| Noise monitoring | Ambient | To protect BMMC employees and the local community against any adverse health effects due to project related changes to air quality or noise impacts. | Noise from open pit mining operations, WRD & haul road | Those used during the NLGM EIA Noise Study: Nearby habitations - NLGM1, NMLG2 and NLGM4 | Quarterly (daytime & night, measuring noise levels each hour) | Noise Levels (1 hour) |
| Terrestrial Ecology | Terrestrial Biodiversity | Evaluate the changes over time in habitat structure, function, composition in response to natural factors, human activity or management | Degradation of terrestrial eco-systems and loss of biodiversity | Three sites per vegetation community, in all vegetation communities adjacent to the NLGM mining development. | Bi-annually (one wet season and one dry season survey) | All taxa plants, arthropods, reptiles, amphibians, small mammals and birds. |
| Aquatic Ecology | Aquatic Biodiversity | Evaluate the changes over time in aquatic ecological structure, function, and composition in response to natural factors, human activity (i.e. the mine) or management | Degradation of aquatic eco-systems and loss of biodiversity | Biomonitoring sites in the Marvoe Creek upstream and downstream of the project area, as well as within the diversion. Also in the Mafa River upstream and downstream of the confluence with the Marvoe Creek | Bi annually (high and low flow seasons) | Aquatic Macroinvertebrate Abundance and Diversity; percentage contribution of EPT taxa to aquatic macroinvertebrate community; fish species diversity and abundance; continued presence of *Amphilius atesuensis cf.*, and *Doumea chappuisi* and suitable riffle/ rapid habitats downstream of the NLGM site; continued presence of Red Data fish species *Malapterurus stiassnyae cf.* and *Doumea chappuisi* in suitable habitats associated with the Project area; establishment of diverse fish populations within the Marvoe Creek Diversion; and metal concentrations in fish and crab tissues |
| Social | Socio-economic and | Evaluate and monitor | Socio-economic and | With the BMMC employees | Bi-annually | Population figures to |

| Component Monitoring | Monitoring category | Objectives | Aspect | Monitoring locations | Frequency | Parameters |
|---|---|---|---|---|---|---|
| | community health variables | sociio-economic and health variables with the BMMC employees (i.e. internally) and externally, within local communities in the NLGM study area, particularly in directly affected communities and in the resettlement village | health impacts associated with the Project – both positive and negative | and notably in the resettlement village, and in Jikando and Jawajei. | | determine the approximate number of people moving into and out of the NLGM area, household income levels, general health status of local population, notably HIV/AIDS, record benefits and associated with the Project, including BMMC CSR initiatives |

# 13.0 CLOSURE OBJECTIVES AND CLOSURE COSTING

As part of the EIA, a closure study was undertaken. This study focused on developing closure objectives for the proposed mine site, as well as producing a high level closure costing table for the site.

## 13.1 Closure Approach

Rehabilitation and closure planning at NLGM's will be ongoing, evolving over the following stages:

- **Stage 1:** Compilation of the closure objectives to set the context for the closure planning of the mining operation;
- **Stage 2:** Compilation of a conceptual closure plan (once specialist studies informing the EIA/EMP have been finalised) forming part of the project EIA;
- **Stage 2:** Compilation of an interim closure plan once operational activities have begun to guide the rehabilitation and closure planning of the mining operation and associated closure-related costing over its operational life;
- **Stage 3:** Execution of the monitoring and investigations/assessments/trials as stipulated in the interim rehabilitation and closure plan;
- **Stage 4:** Compilation of final closure plan within three years of decommissioning of mining operations and/or closure of portions of the mining operation;
- **Stage 5:** Execution of the engineering design of closure measures; and
- **Stage 6:** Compilation of a final closure plan within the required regulatory timeframes before decommissioning, taking cognisance of the information/work from the previous stages to finalise closure planning.

The work related to the above stages should take place during NLGM's operational period (roughly 2014 – 2022). Thereafter it will be followed by decommissioning. This will include care and maintenance of the reclaimed portions of the mine site, as well as the demonstration of the performance of the rehabilitation and closure measures. Post-closure care and maintenance should continue until the environmental and post-mining land-use objectives have been met, followed by site relinquishment.

## 13.2 Closure Goal

The overall closure goal for NLGM is to progressively re-instate native forest areas that are safe, stable and non-polluting, mimicking the current land use, and taking into account the unavoidable remaining mining residue and/or disturbances towards leaving behind a positive post-mining legacy.

## 13.3 Closure Objectives

The above closure goal is underpinned by the more specific objectives listed below. These objectives are stated qualitatively and become more specific as the actual rehabilitation and closure measures are devised. The objectives apply to the mine site in its final closed state and not whilst it is transformed towards this state.

### 13.3.1 Physical stability

To remove and/or stabilise surface infrastructure, unavoidable mining residue and open pits which are present on the mine to facilitate the implementation of the planned land use, by:

- Stabilising the upper surface and outer slopes of the WRD and routing the upper surface runoff to the remaining void;
- Stabilising the upper surfaces and outer slopes of the remaining TSF by means of shaping and constructing a suitable cover to limit water ingress and erosion;
- Closing, dismantling, removing and disposing of all surface infrastructure that has no beneficial post-closure use; and
- Ripping, shaping, and encouraging natural re-establishment of vegetating of reclaimed footprint areas as well as haul roads with no beneficial post-closure use and the integrating of these into the surrounding areas.

### 13.3.2 Environmental quality

To ensure that local environmental quality is not adversely affected by possible physical effects and chemical contamination arising from the mine site as well as to sustain catchment yield as far as possible following closure, by:

- Implementing appropriate procedures to manage radioactive waste in such a way as to provide acceptable levels of protection to humans, animals and the surrounding environment;
- Ensuring that radiation levels at risk sites are within accepted regulatory standards after mine closure in order to obtain exclusion from regulatory control;
- Limiting/preventing the potential for cyanide contamination during the following:
  - Mine operations to ensure that poor operational practice do not compromise mine closure; and
  - Mine decommissioning to ensure that secondary contamination does not take place that could pose health risks to local fauna and landowners post mine closure.
- Limiting dust generation on the rehabilitated infrastructural areas that could cause nuisance and/or health effects to surrounding landowners/communities;
- Conducting dedicated soil surveys over the operational footprint area and removing the possible pockets of contaminated soil where it could have occurred;
- Cleaning up of the sources of possible soil contamination still present on the respective sites to protect the downstream receiving environment;
- Providing the required measures to limit at source the generation of contaminants which could adversely affect local groundwater quality;
- Ensuring that the respective rehabilitated sites are free-draining and run-off is routed to local/natural drainage lines as far as possible.

### 13.3.3 Health and safety

To limit the possible health and safety threats to humans and animals using the rehabilitated sites as it becomes available, by:

- Placing an appropriate enviro-bund around the perimeter of the remaining open void, connecting to the eastern and western extents of the WRD located south of the open pit;

- Shaping the WRD and TSF to stable and safe outer slopes and upper surfaces;
- Demonstrating by means of suitable sampling and analysis that the threshold levels of salts, metals and other potential contaminants over the rehabilitated site in terms of the long-term land use planning for human and animal habitation are acceptable;
- Removing, for safe disposal, all potential process-related contaminants to ensure that no hazardous waste is present on the mine site once these have been rehabilitated; and
- Demonstrating through a review of monitoring data that no possible surface and/or groundwater contaminant sources remain on the rehabilitated sites that could compromise the planned land use and/or pose health and safety threats.

### 13.3.4 Land capability/land-use

To re-instate suitable land capabilities over the affected site to facilitate the progressive implementation the planned land use of forest, by:

- Upfront zoning of the overall mine site and obtaining agreement with stakeholders on this, focusing on the current importance of fishing within the Marvoe Creek, hunting, harvesting of forest foods (honey and medicinal plants), use of thatching grass and bamboo, collection of fuel wood and/or subsistence and commercial timber harvesting/logging;
- Upfront materials balancing and handling to ensure that the soil types are stockpiled separately and subsequently placed, during site rehabilitation, to allow the desired land capability and end land use to be re-instated;
- Ensuring that the respective rehabilitated sites are safe and stable in the long-term;
- Cleaning-up and rehabilitating contaminated soil areas; and
- Limiting the possible loss of topsoil by committing the available topsoil to key pre-determined rehabilitation areas.

### 13.3.5 Aesthetic quality

To leave behind a rehabilitated site that, in general, is not only neat and tidy, giving an acceptable overall aesthetic appearance, but which in terms of this attribute is also aligned to the respective land use/s, by:

- Tiding-up the rehabilitated site from demolition waste, rubble, etc.;
- Landscaping the covered WRD and TSF to render them “soft”, blending in with the surrounding landscape, as far as possible;
- Shaping and levelling reclaimed areas to create landforms that emulate the surroundings and would facilitate drainage, by giving attention to the profiling of the final rehabilitated landform;
- Ensuring that the rehabilitated site is free draining;
- Ensuring that all other remaining embankments are shaped and trimmed and that these are free draining;
- Shaping and levelling and ripping of access roads and hard stands to roughly emulate the surrounding surface topography; and

- Encouraging natural re-establishment of vegetation on the above rehabilitated areas, as required, to be aesthetically pleasing.

### 13.3.6 Biodiversity

To encourage, where appropriate, the re-establishment of native vegetation (forest) on the rehabilitated site such that the terrestrial biodiversity is largely re-instated over time, by:

- Integration of drainage lines from the rehabilitated overall reclaimed mining area either into the upper reaches of the Marvoe Creek, or into the created in-pit lake;
- Re-instatement (as far as possible) of aquatic habitats and/or mitigation of possible conditions which could inhibit the return of aquatic health within the Marvoe Creek diversion;
- Stabilising disturbed areas to prevent erosion in the short- to medium-term until a suitable vegetation cover has established;
- Encouraging establishment of viable self-sustaining forest vegetation communities that will encourage the re-introduction of local fauna as far as possible;
- Assessing whether the rehabilitated facilities, with limited intervention and change, could be adapted to provide suitable habitats for small mammals, improving the overall biodiversity;
- Identify those aspects/obstacles once site rehabilitation has been completed which could inhibit and/or deter animal life from returning to the rehabilitated sites; and
- Remove the identified obstacles without compromising the adopted final land use(s).

### 13.3.7 Socio-economic aspects

To ensure that measures and/or contributions made by the mine towards the long-term socio-economic benefit of employees, local communities and the surrounding municipal area are sustainable, by:

- Identifying alternative BMMC operational areas (mining license issued by the Liberian Ministry of Land, Mines and Energy to mine the New Liberty Gold Mine (NLGM) deposit for a period of at least 25 years) to which skilled labour could be transferred to reduce job losses; and
- Identifying training/re-skilling programmes to empower employees to engage in alternative entrepreneurial opportunities, should transfer to other operational areas not be viable; and
- Engaging with Liberian Ministry of Land, Mines and Energy and other regulatory authorities to ensure buy-in and approval of the closure plan, as well as rehabilitation practices.

## 13.4 Closure costs

The cost estimate quantities were taken from available plans and maps supplied by Golder and Aureus. Unit rates were obtained from Golder's data base and/or in consultation with demolition practitioners.

The closure costs were determined for scheduled closure (2022), as well as unscheduled closure as at May 2012. The estimated closure cost for unscheduled and scheduled closure for the respective areas as at May 2012, amounts to approximately USD1.07 million and USD1.20 million, respectively, as indicated in Table 57 below.

**Table 57: Unscheduled and scheduled closure costs for NLGM**

| New Liberty Gold Mine - Unscheduled and Scheduled Closure Costing Summary Spreadsheet - May 2012 | | | |
|---|---|---|---|
| | **Closure components** | **Unscheduled closure (May 2012)** | **Scheduled closure (2022)** |
| **1** | **INFRASTRUCTURAL AND RELATED ASPECTS** | | |
| 1.1 | Infrastructural aspects | $0.00 | $0.00 |
| 1.2 | Mining aspects | $134,980.30 | $709,286.19 |
| 1.3 | General surface reclamation | $134,980.30 | $10,419.50 |
| 1.4 | Water management | $31,494.14 | $3,877.12 |
| | **SUB-TOTAL 1** (for infrastructure and related aspects) | **$807,751.44** | **$723,582.81** |
| 5 | Post-closure aspects | $88,462.84 | $312,594.79 |
| | **SUB-TOTAL 2** (for post-closure aspects) | **$88,462.84** | **$312,594.79** |
| **6** | **ADDITIONAL ALLOWANCES** | | |
| 6.1 | Preliminary and general | $96,930.17 | $86,829.94 |
| 6.2 | Contingencies | $80,775.14 | $72,358.28 |
| | **SUB-TOTAL 3** (for additional allowances) | **$177,705.32** | **$159,188.22** |
| | **Grand-Total** (for sub-total 1+2+3) | **$1,073,919.60** | **$1,195,365.82** |

The full NLGM Closure Objectives and Costing Report can be found in **Volume II of the EIS, Section L**, including the spreadsheets detailing the closure costs.

# 14.0 PUBLIC CONSULTATION

Public consultation forms an integral part of the EIA as it provides interested and affected parties (I&APs) with project information and an opportunity to comment. It is also a requirement of Liberian guidelines and is in line with international best practice.

The objectives of public consultation in an EIA are to provide sufficient and accessible information to stakeholders in an objective manner to assist them to:

- **During the Announcement/Scoping Phase:**
  - Raise issues of concern and suggestions for enhanced benefits;
  - Contribute relevant local information and knowledge to the environmental assessment;
  - Make suggestions for reasonable alternatives; and
  - Verify that their issues, comments and suggestions have been captured.
- **During the Impact Assessment Phase:**
  - Verify that their issues, comments and suggestions have been considered in the environmental investigations; and
  - Comment on the findings of the environmental assessments.
- **During the Decision-making Phase:**
  - Be notified of government comment and decision on whether or not the Project may proceed.

## 14.1 Identification of Interested & Affected Parties

Interested & Affected Parties (I&APs) were initially identified through a process of networking and referral, liaison with affected community leaders and representatives, local community organisations, non-governmental organisations (NGOs), and government authorities. The stakeholder database comprises a total of 24 individuals representing a broad spectrum of society, from both within the Project area and beyond its boundaries (Table 58). The database includes government authorities, those who attended meetings and/or submitted comments, and people who submitted comments after receiving the BID. (Note: The stakeholder database does not include all individuals consulted during the public consultation process completed as part of the EIA, but only those who provided their addresses and contact details. Most of the stakeholders who took part in the EIA public consultation process resided in the villages within the Project area and the villages in the greater study area. These stakeholders do not have official addresses, and thus their names and village where they live were recorded in the attendance registers for each meeting).

Please note that those community members, who were consulted, do not have contact details and are not included on the database. Notification of opportunities to comment is communicated to communities via Chief's and Ward Councillors, through personal contact. (BMMC, Golder and EarthCons made sure that the relayed messages to the various stakeholders via the village leadership were correct as there was on-going consultation between the BMMC social leader and the leadership representatives, throughout the EIA. The BMMC social leader was present when EIA and Project related information was relayed to stakeholders).

**Table 58: Sectors of Society Represented by Stakeholders**

| **Summary of Consulted Stakeholders** |
|---|
| ■ National government<br>▪ Environmental Protection Agency;<br>▪ Ministry of Lands, Mines and Energy;<br>▪ Forestry Development Authority (EIA Department, Conservation Department, GIS Department);<br>▪ Hydrological Service of Liberia; and<br>▪ Ministry of Internal Affairs. |
| ■ Regional and district government<br>▪ Superintendent of Grand Cape Mount County and her representatives. |
| ■ Community stakeholders (i.e. the public, including the Chiefs, their elders and representatives, youth group leaders, women's group leaders and the general population in each village) were consulted at the following locations:<br>▪ Mecca, Cape Mount County;<br>▪ Kinjor and Larjor Villages;<br>▪ Jawajei Village; and<br>▪ Sinje Town.<br>(Also by means of focus group meetings during the SIA and RAP). |
| ■ Environmental bodies, both as authorities and NGOs, (for example, Conservation International) |
| ■ The media |

As part of the RAP for the Project, interested and affected parties have been further identified. A resettlement committee has been established although it is not yet formalised.

## 14.2 Announcement/Scoping Phase Consultation

During the public consultation process for the EIA, the Project was announced during September 2010 through the distribution of a Background Information Document (BID) and letters of invitation to stakeholders to participate. People were informed of the opportunity to comment through announcements on local radio and through community and focus group meetings. Approximately 250 individuals and organisations participated in the community and focus group meetings. Written comments were also received. All comments, concerns and suggestions received from stakeholders are recorded in a Comment and Response Report (**Appendix F**).

The opportunity to comment on the development of the NLGM Project and EIA was announced in September 2010 as follows:

- A letter of invitation to comment, accompanied by a BID, was distributed to approximately 200 stakeholders in Monrovia and the Project area during community and focus group meetings. The BID contained details of the proposed Project, a map showing the location of the Project area within Liberia, a picture of an open-cast gold mine and details regarding the scheduling of the EIA. The BID was accompanied by a comment sheet for stakeholders to submit their comments (see **Appendix G**). A summary of the distribution of announcement documents is provided in **Appendix H**.
- An announcement about the proposed Project and the EIA was broadcasted on Radio Cape Mount at Sinjé Village from Friday, 17 September 2010 for two (2) weeks; and
- Posting the invitation letter, BID, registration and comment sheet on the Golder website at www.golder.com/public.

Initial comments were based on the BID and verbal explanations of the proposed Project were given during meetings. Stakeholders could contribute comments in writing (by completing and returning comment sheets), verbally by telephone or by attending Community or Focus Group Meetings.

The majority of comments from stakeholders were verbal during community meetings and focus group meetings. Three (3) community meetings and five (5) focus group meeting were held during announcement of the EIA, and were attended by approximately 250 stakeholders.

During these meetings, an overview of the Project, as well as the motivation for the proposed Project was presented. The EIA process and specialist studies to be conducted were also discussed and inputs received. Stakeholders had the opportunity to raise comments, issues of concern and suggestions for enhanced benefits to be evaluated during the EIA specialist studies. An interpreter was available at all meetings to translate the discussions into Vai.

Community meetings were mostly attended by residents of the Project area, including traditional leaders, elders, representatives from women's groups, the youth, as well as community-based organisations. In Monrovia, meetings were held with representatives from national and regional government. Comments raised during all meetings are captured in the Comment and Response Report.

## 14.3 EIS Report Public Consultation

EIS public consultation during the impact assessment phase of the EIA will include a presentation of the findings of the EIA, which are presented in the EIS (i.e. this report).

Once the EIS has been submitted to the EPA for review, BMMC, EarthCons and Golder will organise to meet with the EPA and other applicable authorities so that an overview of the EIA and key findings can be presented to the government authorities.

Once the government authorities have reviewed the EIS, it is BMMC's understanding that based on Liberian legislation, the EPA will potentially call for a public meeting. BMMC, EarthCons and Golder will then attend the public meeting and present the findings of the EIA, as presented in this EIS, to the Project stakeholders.

During the meeting, comments and issues will be recorded so that a Comment and Response Report for the impact assessment phase can be developed and relayed to stakeholders.

# 15.0 EMERGENCY RESPONSE PLAN

BMMC will need to conduct the first step in developing a comprehensive Emergency Response Plant for the proposed mine, which includes conducting a health and safety risk assessment.

From the impact assessment, key risks from a health and safety perspective at the proposed mine site may include:

- Fire at the diesel storage facilities or power plant, following any leakage of diesel, lubricant oil or transformer cooling oil or ignition of vapour accumulated in tanks during maintenance;
- Spillage of cyanide or cyanide solution during transfer, handling or storage causing harm to people and the environment;
- Accidental mixing, heating of cyanide or cyanide in solution causing release of toxic hydrogen cyanide;
- Accidental spills of other harmful chemical products;
- Accidental explosion of ANFO during explosives preparation;
- Open pit failure, caused by unstable geotechnical conditions;
- WRD or TSF failure caused by extreme climatic conditions such as extreme rainfall events, which significantly exceed the design criteria for the TSF; and
- ARD.

During the early part of the construction phase, BMMC will develop a comprehensive emergency response plan. This plan will define:

- Roles and responsibilities in relation to emergency response;
- Communication Systems - i.e. Alarms and lines of communication to alert employees, the wider community and government agencies (hospitals, emergency services as necessary);
- Emergency Response Procedures – defining the procedures to be implemented in the event of an Emergency;
- Emergency Resources – defining the what systems and equipment will be in place at the construction sites (i.e. fire extinguishers, first aid kits, etc); and
- The training program for all employees to ensure that employees are aware of emergency procedures (i.e. through specific emergency equipment training, safety inductions and drills).

## 15.1 Cyanide Management

The process adopted for gold extraction at the NLGM processing plant includes the use of sodium cyanide in the CIL process. This process is used at gold mines throughout the world, and the technology is proven as a safe and efficient method of gold extraction.

Cyanides are extremely toxic to humans and animals, as they bond with enzymes containing iron required by the cell to use oxygen. Cyanide may penetrate the body by inhalation, absorption through the skin and by ingestion and the effects are similar in each case. (It must be noted that cyanide at low concentrations are metabolised without significant health effects).

Weak acid cyanides and hydrogen cyanide (HCN) are the most toxic forms of cyanide in the air. The toxicity of cyanide compounds are generally acute rather than chronic, as acute toxicity is generally associated with an immediate fatal effect on the body exposed to high concentrations of the compound.

A number of safeguards will need to be put in place by BMMC to ensure the safe handling, storage and use of cyanide at the NLGM Mine site. These safeguards include:

- The use of a certified international company to supply cyanide to the mine – this company must be a signatory of the international cyanide management code and have developed procedures for the safe transfer, storage and use of cyanide at mines in Africa;
- Developing and implementing a plan for the transport, storage and handling of cyanide and disposal of cyanide packaging in line with International Cyanide Management Code (ICMC) procedures;
- Providing specific training on cyanide handling, storage, use and emergency procedures to all mine staff particularly staff involved in the direct handling of cyanide at the mine;
- Ensuring close control of cyanide in the process and maintaining high pH levels in the solutions to prevent hydrogen cyanide gas (HCN) from being released during the process;
- During the final design of the processing plant, cyanide management and risks will need to be considered and be compliant with the ICMC guidelines, to help prevent cyanide associated risks; and
- Continuously monitoring cyanide levels in the process and at strategic areas of the processing plant.

# 16.0 CONCLUSION AND RECOMMENDATIONS

The EIA process has identified a number of potential impacts and risks associated with the proposed Project. The key impacts relate to:

- The disturbance, erosion, contamination and sterilization of soils;
- Loss of arable land;
- The permanent diversion of the Marvoe Creek;
- The use and contamination of surface water, notably in the Marvoe Creek;
- Groundwater impacts including impacts on groundwater levels and quality;
- Geochemical related impacts, notably related to ARD and ML;
- Emissions from the processing plant and associated impacts on air quality;
- Combustion emissions from power generation;
- Increased dust generation and dust in the air from the mining development;
- Increased noise levels at nearby receptors associated with mining related activities and the processing plant;
- Loss of or alteration to terrestrial habitats and associated flora and fauna, and reduction in biodiversity on-site;
- Loss of or alteration to aquatic habitats and associated species;
- Physical displacement impacting built structures and sites of religious significance;
- Economic displacement impacting agricultural land and natural resources, and artisanal mining opportunities;
- Creation of employment opportunities – positive impact;
- Increase in business opportunities in local services – positive impact;

- Loss of and/or contamination of cultural heritage resources; and
- Visual impacts associated with the mining infrastructure.

Managing these impacts to acceptable levels will require effective, continuous and committed implementation of mitigation measures by BMMC, with internal and external monitoring. The key mitigation measures currently being proposed, as per the EMP include:

- Implementing the EMP effectively; and
- Undertaking and implementing a detailed RAP in line with Liberian and IFC standards – currently being undertaken by Digby Wells Environmental.

Key recommendations that come out of the EIA include:

- The RAP must be completed in line with Liberian legislative requirements and IFC Performance Standard 5;
- BMMC needs to undertake quantitative groundwater modelling to ascertain the potential impact on groundwater levels, quality and contamination in the surrounding streams, rivers and boreholes, and committing to establish a comprehensive ground and surface water monitoring program on site;
- In association with the quantitative groundwater study, BMMC needs to undertake a Phase 2 Geochemical Assessment, which includes kinetic testing;
- BMMC needs to undertake quantitative air quality modelling, aimed at further assessing and managing air quality and dust impacts associated with the Project; and
- BMMC needs to implement the EMP mitigation measures and the associated environmental and social monitoring measures as outlined in this EIS.

In conclusion, the technical challenges faced by BMMC to manage and mitigate the environmental and social impacts associated with the NLGM Project are amenable to standard technical solutions. No issue has been identified that presents a technical challenge beyond that which is regularly encountered and resolved by comparable mining operations elsewhere in Africa.

The proposed Project will result in both temporary and permanent changes to land use and vegetation within the Project footprint. However, provided that the management and mitigation measures outlined by the EMP are adopted and implemented properly, and the site decommissioning is planned diligently and undertaken in line with Liberian legislative requirements and best practice principles, the potential Project impacts are likely to be manageable and within acceptable significance levels.

The largest socio-economic impact associated with the proposed NLGM Project is the involuntary relocation of two communities that will need to take place, as well as the associated potential economic displacement. The socio-economic effects of the NLGM Project are expected to be generally positive and result in an overall improvement in the material, physical and social well-being of the communities living within the vicinity of the Project site. However, wherever possible, it is important that health and community programs supported by BMMC are culturally appropriate and sustainable beyond the life of the project.

Environmental management of the NLGM Project will be an evolving process over the life of the mine. In particular, the environmental management and mitigation measures and the monitoring program outlined in this EIS must be regularly updated for continual improvement to occur and for management practices to remain current and aligned with Liberian legislation and industry best practice.

# 17.0 REFERENCES

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***Note:*** For the references related to each specific specialist study that was undertaken as part of the EIA, please refer to the EIS Volume II, which includes each of the specialist assessment reports.

**GOLDER ASSOCIATES GHANA LTD.**

Chris Fell
Environmental Consultant

Brent Baxter
Senior Environmental Consultant & Review Manager

CF/BB

CA-35, 031
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# APPENDIX A

## Key Assumptions and Limitations regarding the EIA specialist studies

## Appendix A

The Table below highlights the key assumptions and limitations related to each of the specialist studies that were undertaken as part of the NLGM EIA .

**Appendix A Table: Key assumptions and limitations related to each NLGM EIA specialist study**

| Specialist Study | Key assumptions and/or limitations |
|---|---|
| Soils | • The soil contamination assessment was conducted at a screening level and is only indicative of contaminants and areas of current concern. |
| Surface water | • There is limited historical daily rainfall data for the proposed project site. Historical monthly data was available at sites remote from the project area. Furthermore the available monthly data ended in the 1980s;<br>• No evaporation data was available for the study area. Regional information was collated and monthly average evaporation depths recommend for the Project site;<br>• The 24 hour rainfall storm event depths were estimated using the TRMM satellite data available for the period of 1 January 1998 to 30 June 2011;<br>• The limited rainfall data prevented the extent to which a daily or a monthly water balance for the site could be developed as daily/monthly historical rainfall data are not available. This limits the accuracy of sizing of pollution control facilities and pump rates;<br>• The topography provided was at 5m contour intervals which is not appropriate for a feasibility level study to place infrastructure such as the river diversion;<br>• The work on developing the stormwater management system was completed before the latest mine infrastructure layout (17 May 2012) became available;<br>• The design of the proposed stormwater system has been carried out at a conceptual level. A detailed design process should be followed which involves further hydraulic analysis, geotechnical work, identification of infrastructure such as pipes and cables that could be impacted on by the proposed system, specification and tender documents developed to allow for the construction tender process;<br>• Runoff coefficients for the estimation of monthly runoff volumes from natural ground were estimated based on local stream flow data collected during the monitoring period while runoff coefficients for other types of surface are based on published values and professional experience;<br>• The design criteria for stormwater management system was based on the Environmental, Health and Safety (EHS) Guidelines of the International Finance Corporation for mining where stormwater management systems must be sized to convey at least the 25 year 24 hour storm flood peak for temporary structures and the100 year flood peak for permanent structures. The South African Regulation 704 requires that stormwater management system conveys the 50 year flood peak. For the NLGM project, the stormwater system on site has been sized for the 50 year flood peak which meets the IFC and South African requirements;<br>• The stormwater and water balance development were based on available topography and the mine infrastructure layout. Once detailed designs for the proposed facilities are available those models should be updated to reflect the changes made; and<br>• The Marvoe Creek river diversion is a permanent structure and is therefore sized for the 100 year recurrence interval flood peak. |
| Groundwater | Given the identified data gaps discussed in the section below, the potential groundwater impacts that are likely to arise as a result of the proposed project |

| Specialist Study | Key assumptions and/or limitations |
|---|---|
| | were assessed on a qualitative basis.<br>The following uncertainties/gaps were identified during the groundwater baseline study:<br>• The aquifer transmissivities are unknown at this stage. The inclined exploration boreholes limit the installation of a pump for carrying out a pumping test. The use of inclined, uncased exploration boreholes does not allow for hydrogeological assessment of a specific lithological unit. The depths to water strikes were not observed during the exploration drilling. Therefore, lithological positions of major aquifers in the area are not clear at this stage.<br>• Similarly, it is questionable to associate hydraulic conductivities values presented in the conceptual model with any lithological unit, when the water strikes depth/ tested aquifers are unknown. The hydraulic conductivity values presented here are most likely representative of the cumulative value for all aquifers penetrated by drilling and not an individual aquifer.<br>• The water table measured in the holes is an amalgam of all the vertical heads acting throughout the water column. It is therefore not possible to associate any of the water level figures to a specific aquifer. Nested multiple depth vertical boreholes would allow the interaction between the Saprock and the deeper fractured rock aquifer to be assessed;<br>• It is possible that the majority of water inflow to the holes is from the upper weathered zone or a single deeper fissure. However, it is not possible to conclude on that when there is no hydrostratigraphic data summarising the water strike depth and the blowout yield of each water strike;<br>• It is reported by Aquaterra (2012) that the flow rate from the holes consistently dropped with time during testing. This could suggest the fissure network is of limited connectivity and extent but could also suggest the saprock is the main source of water which is limited in its vertical and horizontal extent. But can only be confirmed once the information is available on which aquifer was affected by the test;<br>• The airlifting method used by Aquaterra is limited by the abstraction rate and drawdown which can be achieved. Vertical holes would allow for the installation of submersible pumps at depths which could generate a greater abstraction rate and more drawdown and therefore make it possible to determine transmisivity for the saprock and/or fractured rock aquifer; and<br>• The ore body fractured aquifer needs thorough investigation. The transmissivity of this zone will be essential for assessment of the mine dewatering requirements. |
| Geochemistry | Uncertainties regarding the source-based ARD and ML risks identified in this report may relate to any one or more of the following aspects:<br>• The conceptual models may not be accurate or complete and is based on a mine layout provided at the time of writing of this report;<br>• Natural environmental variability may not represent conceptual model assumptions;<br>• The samples tested may not be representative of the geological and waste materials that will be disturbed, exposed and/or deposited during the proposed mining operations. This concern is particularly relevant in regards the pilot plant tailings samples that were supplied for testing.<br>• Sample measurements may be inaccurate due to error or bias in sample collection, handling or analysis; and<br>• Reaction kinetics and mineral solubility equilibria may not support the |

| Specialist Study | Key assumptions and/or limitations |
|---|---|
| | findings of the static test results, particularly in regards to the waste rock materials which were not subjected to kinetic testing. |
| Air Quality | The following limitations have been identified with respect to the air quality baseline monitoring;<br>- At the request of Aureus, air quality (AQ) and dust monitoring was undertaken for a period of 6 months. In many instances baseline monitoring is undertaken for 12 months to be representative of both the wet and dry seasons, however, the 6 month sampling period captured some time in both the wet and dry period;<br>- Dust monitoring was undertaken until the collection bottle was full (with rainwater) each month or for the entire month if it did no fill completely. Therefore the data collection time may differ slightly;<br>- A conversion factor does not exist for 10 minute time averages for $SO_2$; therefore a 15 minute average has been used for short- term $SO_2$;<br>- Some data were lost due to missing, mislabelled or damaged tubes; these are recorded in the detailed reports;<br>- $PM_{10}$ and $PM_{2.5}$ baseline monitoring was not undertaken; and<br>- The only met data available was from the NLGM met station on site; meteorology could be different at other locations within the Project area.<br>The following assumptions and limitations have been identified with respect to the air quality assessment:<br>- Limited data was made available due to the early stage of the site operational design, notably regarding the processing plant. As such no detailed air quality assessment for combustion and processing emissions was possible. Such an assessment is strongly advised to be undertaken once detailed processing plant design information is available.<br>- For the significance tables, the traffic consideration ($NO_2$ and $PM_{10}$) is based on the assumption that there are less than 100 additional vehicles associated with the mine site. In the absence of specific guidance on road traffic assessment in Liberia, the UK Design Manual for Roads and Bridges, Volume 11, Section 3, Part 1 Air Quality, May 2007 ('DMRB') has been used as a basis for a simple assessment of significance.<br>- For the significance tables, the power plant consideration is based on the assumption that there are 8 Caterpillar engine powered generators, with specifications as per the process sheets (temperature of 410 degrees). Stack heights of at least 25 m (e.g. above the height of the building which may be between 15-25 m) and diameter of 254 mm. Likely emissions include $NO_x$, $SO_2$, $PM_{10}$, HC, CO (emission factors of most of which are provided in the specification sheet. A simple UK matrix screening assessment has been undertaken to inform the significance tables of the likely impacts.<br>- For the significance tables, the gold processing plant consideration is based on the assumption that there are two stacks of at least 15 m in height, stack diameter or less than 300 mm and gas temperature of less than 300 degrees). It is not clear that these data are correct unless the plant is already proposed with mitigation included. Likely emissions include $NO_2$, |

| Specialist Study | Key assumptions and/or limitations |
|---|---|
| | $SO_2$, $PM_{10}$, HCN, $NH_3$ and metals but these will depend on the processing and mitigation detailed design, details of which are not yet available. No process flow rates have been made available. As such, no simple screening assessment has been undertaken to inform the significance tables of the likely impacts and estimates are based on previous experience only.<br>• The study area considered is 2 km surrounding the mining infrastructure area, but this is likely to increase once the detailed Air Dispersion Modelling Assessment is undertaken. At this stage the full extent of impacts from the Project are unknown;<br>• As a detailed air dispersion modelling assessment could not be completed, it remains unclear regarding the exact relationship between the siting of the processing plant and the potential sensitive receptors, both site camps and resettled villages.<br>• No assessment has been undertaken of the associated mine camp townships and infrastructure e.g. transport, power, waste facilities etc.<br>• Significance tables and potential impacts are based on grouped sources and not individual emission points;<br>• An emissions inventory has not been included due to sufficient data being unavailable;<br>• It is not possible to include costs for the management and mitigation measures as until the design is finalised and a detailed dispersion modelling assessment has been undertaken the scale of the management and mitigation measures will not be known;<br>• No on- site impacts of worker exposure impacts have been included; and<br>• The AQ assessment considers human health receptors only. |
| Noise | Using the point source and attenuation-by-distance model, the following assumptions were made for the noise study:<br>• Acoustically hard ground conditions. This assumes that no attenuation due to absorption at the ground surface takes place. The effects of frequency-dependent atmospheric absorption were also ignored. Both assumptions represent a pessimistic evaluation of the potential noise impact.<br>• Meteorological conditions. Neutral weather conditions, i.e. windless and inversionless, and standard conditions of temperature and humidity (20 C and 50%RH) were assumed, representing a neutral evaluation of the noise impact.<br>• Noise measurements were representative of normal operation. Equivalent continuous A-weighted noise levels, LAeq,I, measured for each type of operation correctly represent the noise from that operation. Impossible-to-predict (random) single noise events louder than the continuous noise level are not taken into account, although short events which are part of the process, such as the impact noise from material transport, and beepers indicating reversing vehicles, for example, are fully represented in the measurements, representing a neutral evaluation of the noise impact.<br>• Ambient noise levels. Measured levels are assumed typical of the environment, representing a neutral evaluation of the noise impact.<br>• Barrier effect of temporary stockpiles and levees. Because of the highly mobile nature of all operations on the proposed opencast pit, the effect of these temporary structures on the noise climate has been ignored, |

| Specialist Study | Key assumptions and/or limitations |
|---|---|
| | representing a pessimistic evaluation of the potential noise impact.<br>• Current noise control technology is assumed. No allowance is made in the noise level predictions for improvements in noise control techniques or mitigation measures which may be incorporated into the proposed project, representing a pessimistic evaluation of the potential noise impact.<br>• Worst case operational noise level assumption. The highest noise level of plant as measured at the operating sites was used as the criterion value for the noise predictions at the proposed project, representing a pessimistic evaluation of the potential noise impact. |
| Terrestrial Ecology | In line with best practice principles and international standards, wet and dry season surveys were conducted for the NLGM terrestrial ecology study.<br><br>Key limitations regarding the terrestrial ecology study included:<br>• Temporal changes in biodiversity are not taken into account during instantaneous sampling bouts;<br>• Variations in biodiversity due to temporal animal movements, such as migrations, were not taken into account because ecological monitoring was not on-going over an extended period of time;<br>• Unusual environmental conditions (such as unusually high or unusually low rainfall) may cause unusual states of biodiversity during the period of study, which may not exist usually;<br>• Aerial imagery obtained for use during the terrestrial ecology study was only 2.5m per pixel; thus the ability to accurately map vegetation communities was limited;<br>• Access within the study area is limited, thereby limiting sampling efforts; and<br>• Every possible precaution was taken to reduce the effect of the above-mentioned limitations on the data collected for this study. |
| Socio-economic | The socio-economic assessment study assumed that potential impacts relating to noise, air quality and water quality and quantity were addressed in the other respective specialist assessment reports. It is assumed that these assessments will identify suitable mitigation and management measures to ensure that environmentally intrinsic impacts do not negatively impact upon local communities, their quality of life or their health status. |
| Cultural heritage | The cultural heritage assessment was completed for the known cultural heritage sites affected by the proposed Project. It is possible that other sites of cultural heritage interest exist in the Project area that are not currently identifiable, as the basis for site identification was predominantly through community interviews and the disclosure of information to the survey team.<br>On the basis that no archaeological remains were encountered during the baseline survey, it is considered probable the area around the Project site is likely to be devoid of ancient remains. |
| Visual Aesthetics | The following assumptions and limitations are relevant to the field of visual impact assessment (VIA) and specifically the findings of this NLGM VIA study:<br>• This visual baseline was carried out at a desktop level, using photographic data available to the visual specialist at the time of writing. The study was therefore carried out without the visual specialist having personally been to site;<br>• GPS points were taken at each photo location using a Garmin GPS60. The orientation of each view was determined using landmarks as reference points in each photo and correlating them with an aerial photograph of the study area;<br>• In certain instances panoramic views were created, by taking a series of overlapping photographs, which were then digitally integrated to create a |

| Specialist Study | Key assumptions and/or limitations |
|---|---|
| | single view. This process was done using PTGUI Pro (V8.3.10) which is an advanced photo stitching and photo editing software package;<br>• The Digital Elevation Model (DEM) was developed for an area of approximately a 10 km radius around the proposed mining property. The DEM was developed from the 30m ASTER GDEM (release 2) data. ASTER GDEM is a product of METI and NASA.<br>• Viewsheds were developed based on the position and height of key proposed infrastructure. The viewshed was modelled on the above-mentioned DEM using Global Mapper 10® software. The receptor height was set to 1.5m. Viewsheds were created using the following key information provided by BMMC:<br>§ The proposed TSF at 24m above ground level;<br>§ The proposed Waste Rock Dump at a maximum height of 60m above ground level; and<br>§ Ten stacks at the proposed processing plant and associated power plant site:<br>– Two stacks at the processing plant at 15m above ground level; and<br>– Eight generator stacks at 25m above ground level; and<br>• A worst case scenario was assumed whereby all the facilities exist at maximum height for the entire footprint area of the facility. |
| Closure | Based on the most recently available scoping report for the NLGM project, as well as numerous telephonic and electronic correspondence with Ms Patrys Laubscher of Aureus between 16 – 25 May 2012, the following key closure-related assumptions have been made, as signed-off by Aureus:<br>• Mining will be initiated in the Larjor section of the open pit (west) and continue for a period of approximately four years. Waste rock from this pit will be placed adjacent to the pit, on the designated waste rock dump (WRD) footprint area. On completion of mining at the Larjor section, it will be back-filled with the waste rock. Mining will then continue in an easterly direction with the Latiff-Kinjor-Marvoe sections, with all waste rock generated from these areas deposited on the designated WRD footprint area;<br>• All waste rock generated from the Latiff-Kinjor-Marvoe sections will remain post-closure on the designated WRD footprint area, resulting in a post-closure mine void of approximately 48ha. It has been indicated by AM that these sections will not be in-filled as the reserves in these areas will not be fully mined and, to avoid sterilisation of possible future reserves, no backfilling will take place;<br>• The WRD has been designed to cover an area of 540 000 m² and rise to a height of approximately 60 m. The aim of WRD construction would be to place the potentially reactive waste rock (ARD generating) at the base on the dump, ‘encapsulated’ by inert waste rock. Furthermore, the facility will have a store capacity of approximately 56 million tonnes, and will be constructed with outer slopes of 18º;<br>• For the unscheduled closure situation, there are approximately 400 exploration borehole sites, for which a fugitive disturbed area around each one will be determined (based on experience);<br>• AM has an agreement with the Liberian government (Mineral Development Agreement, undated) that all infrastructure with a possible beneficial post- |

| Specialist Study | Key assumptions and/or limitations |
| --- | --- |
| | closure re-use would be transferred to the government at closure of NLGM;<br>• In addition to the above, inhabitants of the Larjor Village, which is currently situated within the planned open pit area, will be relocated approximately 6 km away from the mining area (exact location unknown). This relocation is currently taking place. It will be assumed that the road to be constructed from the main road to this new village will be approximately 6 km long (gravel), and will be transferred to the government post-closure for beneficial re-use;<br>• The Marvoe Creek diversion will remain post-closure and it will be designed in such a manner that it would require minimal ongoing care and maintenance post-closure; and<br>• The final, post-mining land use will be native forest. |

# APPENDIX B

## Golder's Liberian EPA accreditation certificate

REPUBLIC OF LIBERIA
**ENVIRONMENTAL PROTECTION AGENCY OF LIBERIA**
4TH STREET SINKOR, TUBMAN BOULEVARD
P.O. BOX 4024
1000 MONROVIA, 10 LIBERIA

Certificate No. EPA/DC-001/08-11

# ACCREDITATION CERTIFICATE

This certifies that

**GOLDER ASSOCIATES**

Is duly registered and recognized under the Environment Protection and Management Law of Liberia to conduct Environmental Impact Studies in favor of African Aura Mining Inc. in Grand Cape Mount County

*Validity: One year commencing August 18th 2011 to August 17th, 2012 renewable under new terms and conditions.*

Anyaa Vohiri

Anyaa Vohiri
**EXECUTIVE DIRECTOR**

# APPENDIX C

## EIA Team Qualifications and Experience

## APPENDIX C: EIA Team Qualifications and Experience

The EIA team member qualifications and experience is provided below.

### EIA Director

**Dr Brent Baxter – BSc, BSc Hons, PhD**

Since graduating with a natural sciences BSc (Botany/Zoology) in 1988 Dr Baxter has been involved in botanical research (BSc Hons, PhD: 5 years), followed by employment within the mining industry (4 years) and as a consulting environmentalist (15 years). He is a certified Environmental Assessment Practitioner, member of the International Association for Impact Assessment (IAIA), SA chapter of IAIA and a member of the US based Society for Ecological Restoration (SER).

He has specific expertise in ecological assessment, closure and reclamation planning, environmental management and auditing and environmental and social impact assessment.

Brent has led EIA projects for a wide range of mining projects across South Africa and in Africa. He has conducted projects in South Africa, Botswana, Lesotho, Swaziland, Mozambique, Zimbabwe, Namibia, Angola, Zambia, Tanzania, Democratic Republic of Congo, Republic of Congo, Central African Republic, Uganda, Guinea and Kosovo and has advised and directed project teams leading projects in Liberia, Ghana, Togo, Nigeria, Kenya and Sudan.

These projects span a range of mineral types including coal, gold, iron ore, uranium, nickel, chrome, manganese, kimberlitic and alluvial diamonds, mineral sands, copper and cobalt and a range of industrial minerals including andulesite, feldspar, mica and quarrying and aggregate operations.

Dr Baxter has lead Golder Africa's ESIA team, comprising professionals in South Africa, Mozambique and Ghana, for the last 10 years. His passion lies in bringing his botanical and ecological experience to bear to influence project planning, and in rehabilitation, restoration and site decontamination and closure projects.

### EIA Manager/Coordinator

**Chris Fell** is an environmental and social practitioner and is Golder's Regional Manager for West Africa, based in Accra, Ghana. He holds a BSc Forestry from the University of Stellenbosch and a Masters in Philosophy in Environment and Development from the University of Cambridge.

Chris has twelve years work experience in the environmental, social, conservation and community development field. He has worked on a number of community based natural resource management projects in South Africa and Kenya, and from 2003 to 2005 completed a two year contract with IUCN-The World Conservation Union as a community conservation advisor, based at Mole National Park in Ghana, West Africa.

At Golder, other than his West African regional management responsibilities, he is involved in carrying out environmental and social impact assessments to international standards, environmental management plans, environmental and social due diligences/compliance reviews in terms of international/Equator Principle compliance, as well as community development plans and public consultation for mining related, oil and gas, and other development projects. Recently, he has worked extensively in West Africa.

## Liberian EIA Manager

**Michael V. Suah** is an environmental practitioner, geoscientist and lawyer. He is the General Manager of EarthCons, Inc., Liberia's premiere environmental firm.

He holds a LLB Degree from the Louis Arthur Grimes School of Law and B.Sc. in Geology from the T. J. R. Faulkner College of Science and Technology of the University of Liberia. He holds a diploma in Exploration Geochemistry and also in Petroleum Policy and Resource Administration from the International Petroleum Administration (PETRAD), Stavanger, Norway.

Michael has more than ten (10) years of experience working as a geologist and environmental practitioner in the Republic of Liberia. He has worked on several projects relating to the mineral and mining industry in the country. He worked as a Geologist for the Liberian Geological Survey. He subsequently worked on several mineral projects, including working as Project Geologist for BHP Billiton, intensely involved in iron ore exploration in West Africa.

At EarthCons, Michael manages the administration of the entity in the undertaking of environmental, geological, geotechnical, survey, petroleum and other related geo-scientific work. He principally handles environmental and geological consulting. He is involved in several mining projects, working with international environmental firms. These activities range from environmental and social impact assessment, environmental audits, and resettlement plans.

## Soil and land use study

**Keith Snyman** is schooled in the earth sciences and agriculture and received a MSc Agric. (Natal) Soil Science in 1985. As a consulting soil scientist and specialist agronomist for the past 23 years, he specializes in assessing natural resources (soils, climate, terrain) and deduces land capability and land potential for specific land use (and management thereof) in the agriculture, forestry, urban, rural, environmental and mining sectors. Specific tasks include soil surveys, site/crop/species matching, yield modelling, irrigation planning, fertilizer prescriptions, land capability assessments, soil impact assessments, wetland and riparian delineation, GIS, GPS.

**Carl Steyn** has been involved in soil contamination evaluation for over 15 years and received a MSc Agric Soil Science in 1995. As soil scientist all aspects of the potential impact of contaminated soil on the environment have been considered. He has extensive experience in the development and quality of analytical methodology for contaminates in soil, plants and food. He further has conducted studies on the determination of background concentrations of a variety of constituents in soil, the bio-availability of soil constituents, the impact of sewage sludge use on soil, and the determination of critical thresholds of contaminants in soil for South Africa. He has further completed a number of site evaluations and risk assessments ranging from sewage sludge disposal sites to a variety of industrial and mining sites.

He is currently working in the Land Contamination Unite of Golder Associates Africa conducting contaminated site assessments, risk assessments and remediation planning. As part of this focus he has been involved in closure planning of a variety of mining operations.

## Surface water study

**Trevor Coleman, MSc Eng**

Trevor Coleman is a Senior Water Resources Engineer (Principal). He is leading the Water Resources Division. His role in the division is discipline leader in surface water which includes hydrology and hydraulics. His current areas of work are the development of mine water management models and the development of integrated water resource management plans for catchments. He has over 20 years experience in hydrological, water quality and water resource systems analysis and modelling.

**Dr Angelina Jordanova, PhD Eng**

Dr Angelina Jordanova is a Civil Hydraulic Engineer in the Water Resources Division. She has over 20 years experience in water engineering field. Her key experience includes environmental and rehabilitation studies for rivers, water balance modelling, flood line analyses, hydrodynamics modelling, environmental impact assessment studies and hydraulics for Reserve determination.

## Groundwater study

**Peter Madanda - Hydrogeologist**

Peter Madanda is a qualified and experienced Hydrogeologist working for Golder Associates with a BSc (Honours.) degree in Hydrogeology obtained from the University of the Free State and a Postgraduate Diploma in Engineering (GDE -Mining) from Wits University.

Peter has working in the consulting industry for approximately eight years, actively involved in various projects in Africa ranging from mining hydrology, groundwater baseline studies, water supply, dewatering, site characterisation & remediation and resources exploration. Peter has extensive experience in groundwater resource investigations; particularly borehole drilling supervision, hydrochemical assessments, aquifer testing and reporting.

**Louis van der Walt – Hydrogeologist**

Louis van der Walt received his training as a geohydrological technician at Pretoria Technikon whilst working for the Department of Water Affairs and Forestry's Geohydrology Directorate. He left the Directorate in 1989 to do freelance work for various companies including Southwits Exploration Company, VSA, EEGS, and JMA on various exploration, engineering, water supply and water pollution projects.

Since 1991 Louis van der Walt has been involved at various levels providing and managing a wide and varied range of technical, GIS and database services to specialists in geohydrology and other related fields on numerous projects.

After a 10 year association with JMA, Louis van der Walt joined JMA as Partner Technical Services Division in October 2000. He left JMA in 2005 to found Core Technical Services cc.

**Thomas Demmer - Hydrogeologist**

Thomas is a specialist Hydrogeologist with 18 years experience in assessing and managing hydrogeological issues in mining and industry. Thomas has worked both for the mining industry and for multidisciplinary environmental engineering consulting firms in South Africa and Australia. He has conducted project work in Southern, Central and West Africa as well as in the state of South Australia.

## Preliminary geochemistry assessment

**Koovila Naicker** is a senior geochemist with Golder Associates Africa. She holds a BSc Hons degree in Chemistry from University of Durban Westville, PhD degree in Environmental Analytical Chemistry from University of Witwatersrand, MDP from Unisa School of Business Leadership and is a registered Pr.Sci.Nat.

Koovila has 12 years technical and project management experience arising from consulting projects. Her projects thus far has been dedicated to S.A mining sector; acid mine drainage and geochemical modelling which resulted in publications in international journals and conference proceedings. She has presented her PhD results and selected project findings at local and international conferences. Her interests are in acid rock drainage risk assessments, remediation and prevention of acid drainage, mobility and transport of contaminants in the source pathway and receptor, geochemical modelling, environmental legislation, and contaminant transport modelling.

## Air quality study

**Craig Woodburn** (MSc, DipWEM, CSci, CEnv, MCIWEM, C.WEM) Craig holds a Masters Degree in Integrated Environmental Control, is a Chartered Environmentalist, a Chartered Scientist and a Member of the Chartered Institute of Water and Environmental Management. He has undertaken IOSH training in carrying out risk assessments.

Craig has had over nineteen years experience working within the Environmental Sector in various organisations. A number of different roles were in the Environment Agency and its predecessor bodies. Jobs included a Technical Specialist covering water quality matters, Team Leader of a Regulatory Compliance Team and a Major Industrial Activities Regulator. The roles included detailed involvement with a wide range of industrial sectors such as surface treatment of metals, waste management, chemical manufacture and power generation. Inspections, investigations and audits were undertaken for potential health, safety and environmental issues, involving Control of Major Accident Hazard Sites, and Environmental Permitted Sites amongst others.

Prior to joining Golder Associates he was employed as a Planning Inspector within the Planning Inspectorate. He determined planning appeals around England, some of which were Secretary of State Referrals covering major environmental matters. In this role Craig was used to asking open questions to probe for information and evidence, skills that are essential for auditors.

**Samantha Arnold** (CSci., C.Geog, PhD, BSc, MIEnvSc, MIAQM) is both a Chartered Scientist and Chartered Geographer specialising in Atmospheric Science. She is a graduate of Kings (BSc) and Queen Mary (PhD) colleges, London University. Dr Arnold has undertaken multi-disciplinary projects for power, waste, manufacturing, and mining clients in the UK and internationally. She has co-ordinated and worked on overseas projects including sites in France, the European Alps, the Falkland Islands, Guinea, Kazakhstan, Liberia, Slovakia, South Africa and Uzbekistan. Samantha maintains an active research position through ongoing CPD. Dr Arnold acts as an advisor for air queries, and writes and reviews reports pertaining to air dispersion and air quality for peer reviewed journals, governmental bodies (DEFRA, Environment Agency, Ministry of Defence, Home Office), university consortium and industry.

**Rachel Saville** (CSci., MSc, BSc, MIEnvSc, MIAQM) is an Environmental Scientist with six years of experience working in consultancy. Rachel joined Golder in 2006 as an Environmental Scientist with the Air team (comprising air quality, meteorology and noise). Her educational background includes a BSc (with honours) in Geography from Aberystwyth University and a MSc in Environmental Monitoring and Analysis from Aberystwyth University. Rachel has worked on projects in the mining, oil and gas, manufacturing, energy and waste clients in the UK and overseas including sites in Turkey, Uzbekistan, Guinea and Ghana. Rachel offers expertise in air quality assessment, air dispersion modelling, environmental impact assessment (EIA) dust and odour assessment, monitoring and management plans, transport work and landfill gas risk assessment.

**Richard Lane** (MRes, MPhys, MIEMA) is a graduate scientist with Golder specialising in Meteorology. He is a graduate of the University of York (MPhys (Hons) and the University Leeds, (MRes (Distinction)) where he studied Physics of the Earth and Atmosphere. During his academic studies Richard also worked with the Universities of Oxford, Reading, Sussex, and other atmospheric institutes including The UK Met Office. Since joining Golder in 2011, Richard is now an integral part of the UK Air team and has undertaken meteorological work both in the UK and for Golder globally.

## Noise study

**John Hassall** is a consultant in Acoustics, Noise Control, Vibration and Signal analysis. John owns his own company, JH Consulting Limited, based in Johannesburg, South Africa, and he thus worked as a sub-consultant to undertake the noise study for the NLGM EIA. John holds an M.Sc. (Applied Acoustics), from the University of London, and a B.Sc. (Aeronautical Engineering), Bristol University, United Kingdom. He has over 35 years of experience.

## Terrestrial ecology study

**Adrian Hudson** is a senior terrestrial ecologist with Golder Associates Africa Pty Ltd. In this role, he provides assessments which encompass all aspects of ecological studies including (but not limited to) baseline ecological assessments, ecological impact assessments and biodiversity action plans. Most projects, unless otherwise requested by the client, are conducted according to the IFC Performance standard 6 criteria and Adrian Hudson is, therefore, *au fait* with the requirements and criteria of the Standard. Adrian has reviewed a number of projects throughout Africa for IFC Performance Standard 6 compliance, including Hassai Gold Mine in Sudan and Konkola North Copper mine in Zambia.

Adrian is a qualified ecologist and ornithologist who holds a Master's of Science degree in Ecology from the North West University and is currently completing his PhD in Ecology at the same institution. Adrian is currently still closely associated with the university as a study leader for Honours and Masters degree students, lecturing of short courses at the university and co-authoring of scientific articles with faculty members of the university. Adrian is a member of the Zoological Society of Southern Africa and the International Society of Conservation Biology. Adrian is also a member of the Department of Environmental Affairs and Tourism (South African Government Department) panel of experts on ecology and desertification and a reviewer for a number of internationally accredited scientific journals. He is also accredited with authorship of a number of articles published in scientific journals.

## Aquatic ecology study

**Peter Kimberg** joined Golder Associates in Johannesburg in 2007 as Aquatic Specialist in the Ecology Division. In August 2009 he took on the responsibility of Divisional Leader within the Ecology Division.

Peter holds a B.Sc (Botany and Zoology) and a B.Sc Hons. (Aquatic Health) (University of Johannesburg). In 2004 he was accredited by the Department of Water Affairs and Forestry (DWAF) to practice the SASS5 protocol in assessing river health in terms of macroinvertebrates. His accreditation was again renewed in 2010. He is currently completing a M.Sc. through Rhodes University and the Water Research Commission (WRC) looking at the impact of an alien invasive fish species *Micropterus salmoides* (Largemouth Bass) on the indigenous fish populations in the Upper Reaches of the Groot Marico Catchment (Crocodile (West) & Marico Water Management Area).

He began his career as a Researcher for the Incomati Tiger Fish Action Group in 2003. In 2004 he joined Ecosun cc. as a junior aquatic scientist.

He has worked on projects throughout South Africa, as well as in Mozambique, Botswana, the Democratic Republic of the Congo (DRC), Zambia, Tanzania, Lesotho, Namibia, Mali, the Central

African Republic (CAR), Togo, Guinea and Liberia. Peter has also lead aquatic survey teams on several surveys in Madagascar.

His main areas of specialisation are Ichthyology, Riverine Ecology, Ecological Situation Analyses and Impact Assessments, Ecological Risk Assessment and development of Biological Monitoring Programs.

## Socio-economic impact assessment (SIA)

**Frank Snijder**

Frank Snijder's professional experience spans more than 20 years across various sectors. Frank has worked in many rural communities across South Africa and in Swaziland, Lesotho, Democratic Republic of Congo, Zambia, Ghana, Tanzania/Zanzibar and Liberia where he worked on projects ranging from rural small-holder irrigation development projects (dealing with sensitivities around land-use rights, rearrangement of landholding, the inclusion of project displaced people as development beneficiaries and the inclusion of women) to participatory research projects determining attitudes and perceptions.

His technical expertise includes social assessments and the social facilitation of project implementation processes; formal research using various qualitative and quantitative techniques; and resettlement planning activities including the establishment of appropriate institutional structures to manage the development and implementation of resettlement action plans. He has trained numerous field research teams in social research techniques and has on several field trips been hosted by villagers as participant observer. Frank also worked on municipal revenue management projects in the South African municipal environment with a specific focus on data management and data integrity audits. Many impact assessment projects have been completed in compliance with international standards and guidelines e.g. World Bank and Equator Principles.

Frank holds a Masters degree in Anthropology and a Master degree in Business Leadership.

**Alex Armitage**

Alex Armitage joined Golder Associates (Pty) Ltd Africa in September 2009 as a Social Researcher after completing her degree in Social Anthropology, specialising in medical practices and modernization in Zambia. Alex's key roles involve conducting field research and socio-economic surveys, the management and analysis of data, undertaking stakeholder engagement and communication processes, and compiling Social Impact Assessment (SIA) and Resettlement Action Plan (RAP) reports in line with country and international guidelines and legislation.

She has worked on SIA and RAP projects in the mining sector, for mine expansions, mine water reclamation projects, linear pipeline and ropeway projects, as well as internationally funded development projects emphasising social development and corporate social responsibility initiatives. These have been based in South Africa, Zambia, Democratic Republic of Congo, Tanzania, Togo, Liberia, Central African Republic and Mozambique. Her knowledge of French allows diversity on project teams and contributes to projects based in French-speaking Africa. She has previously worked as a volunteer French teacher in northern Zambia and as a community peer educator in the UK, expanding her communication and community interaction skills.

**Alet Fell**

Alet Fell is employed by Golder Associates Ghana Ltd as social researcher. She has experience in a wide variety of subjects within the social research arena. Alet holds a Social Science honours degree in environmental management and analysis from the University of Pretoria. Her project experience ranges from resettlement planning. livelihoods analysis, public participation, baseline socio-economic analyses to reviews of Social and Labour Plans for the mining industry and the implementation of Social and Labour Plans. Although based in Ghana, Alet forms part of the Social Sustainability Division of Golder Associates Africa.

## Cultural heritage study

**Paul Wheelhouse** is a Senior Archaeologist for Golder Associates (UK) Limited and has 19 years experience as a professional archaeologist since graduation. He holds a Bachelor of Arts (Honours) degree in Ancient History and Archaeology from the University of Manchester. Since 2005, Mr Wheelhouse is responsible for the coordination and project management of archaeological work for Golder's clients in the UK, Europe, Africa and the Middle East. This regularly involves work on a diverse range of developments, including transportation, mining and mineral extraction, oil and gas, power, land development, manufacturing and waste management. He formulates time-effective archaeological designs, creates management strategies and oversees the implementation of archaeological research and mitigating field investigations. These include desk-based assessments for EIAs/ESIAs, geophysical surveys, evaluations and detailed excavations, in a coordinating and monitoring role; all in accordance with local, national and international guidance.

Paul has recently coordinated cultural heritage ESIA inputs (gap analysis, scoping, baseline, impact assessment and mitigation), conducting reconnaissance surveys and community interviews to map the locations of archaeological and cultural heritage sites for mining projects in West and Central Africa, including: Guinea-Bissau, Guinea, Sierra Leone, Liberia, Togo, Gabon and Central African Republic; working alongside and preparing work plans for locally sub-contracted archaeologists and cultural historians to use, and working closely with our mining clients to ensure appropriate recording and protection of cultural sites identified in the field.

Paul is a full member of the Institute for Archaeologists (MIFA) and an Associate of the Institute for Environmental Management and Assessment (AIEMA).

## Visual study

**Johan Bothma** is a professionally registered Landscape Architect with the South African Council for the Landscape Architectural Profession (SACLAP) since 2007, Johan has 8 years experience and joined African EPA in 2004, which merged with Golder in 2008. He obtained his Bachelor's Degree from the University of Pretoria in 2001 and his Master's Degree in 2004, focusing on climate responsive design and energy efficiency for residential developments.

He has worked on a wide variety of landscape architectural projects; as well as environmental impact assessment and environmental management projects for residential, commercial property development, large-scale industrial and mining project sectors. He also specializes in the field of Visual Impact Assessment and has completed more than 30 VIAs in all of the above-mentioned project fields.

**Talita Germishuyse** is a registered GISc Technologist with 15 years of GIS experience. She is currently employed in the GIS/Graphics Division of Golder Associates Africa and works from the Pretoria office. Talita is responsible for the management of geo-information, spatial analysis and mapping.

Talita is also a registered professional scientist with modelling experience in various fields including hydrology, geo-hydrological, unsaturated flow and crop growth modelling.

**Dawn Lagerwall** is currently employed in the Rehabilitation and Closure division of Golder Associates Africa. Dawn obtained her Bachelor of Science honours degree from Rhodes University in 2010 in Conservation and Biodiversity. She has worked on a wide variety of mine closure and visual assessment projects, and has gained valuable experience in this field.

## Closure objectives and closure costing

**Heleen Pretorius** is a registered professional Landscape Architect and has been with Golder for six years. She gained experience in the field of landscape design, CAD drafting, Environmental Impact Assessments (EIA), Basic Assessments, Public Participation, land use planning and visual impact assessments. During 2010 she joined the closure and rehabilitation team where she has been determining closure costs for various types of local and African mines and industries, both as input to EIA's as well as standalone annual financial quantum submissions to the Department of Mineral Resources.

# APPENDIX D

## Aureus Safety, Health, Social and Environmental Policy

aureus mining

# SAFETY, HEALTH, SOCIAL & ENVIRONMENTAL POLICY

Aureus Mining is engaged in the exploration and development of gold deposits in Africa. We are committed to managing our business activities with the aim of maximizing the positive impacts and minimizing the negative impacts of our projects, from exploration through to mine closure. We will never compromise the health and safety of our employees, our host communities or that of any other stakeholder. We are committed to applying world class safety, health, social and environmental management standards and will continually strive towards zero harm.

**To achieve this we are committed to:**

- Develop, implement and maintain an integrated management system for health, safety, social and the environment, based on recognized international standards;
- Drive continual improvement through setting objectives and targets based on sound risk assessment methodologies, conduct regular reviews and monitoring of the system and measurements of our performance through management self-audits;
- Comply with all applicable legislation, regulations, company policies and procedures;
- Raise awareness of significant health, safety and environmental impacts of our activities;
- Conserve natural resources such as water and energy through engaging and encouraging our employees, contractors, communities and stakeholders to minimize consumption of resources and prevent pollution through innovation and use of the best available technology;
- Take due care to prevent process loss, property damage, work related injuries and ensure that activities are safe for employees, contractors, communities and stakeholders who come into contact with our work environment;
- Work closely with our customers, stakeholders and suppliers to establish and comply with our health, safety and environment standards;
- We will report on health, safety, social and the environmental performances on an annual basis;
- Train employees and contractors on issues of health, safety, and environmental management;
- Communicate our health, safety, social and environmental policy to all employees, contractors and stakeholders and ensure it is available to the public; and
- Regularly review this policy and our systems to ensure compliance with relevant legislation, best practice principle and continual improvement requirements are met.

**David Reading**
**CEO and President**

**Paul Thomson**
**CFO**

# APPENDIX E

## NLGM EIA Terms of Reference

14th December 2011 Project No. GHA1044

Mr. Nathaniel T Blama
Acting Executive Director
4th Street Sinkor
Tubman Boulevard
Monrovia
Liberia

**TERMS OF REFERENCE FOR THE NEW LIBERTY GOLD MINE (NLGM) ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)**

Dear Sir

After a meeting with the Environmental Protection Agency (EPA) at the New Liberty Gold Mine (NLGM) site on Friday 25th November 2011, it was agreed that the next step in the NLGM Environmental and Social Impact Assessment (ESIA) process would be for Bea Mountain Mining Corporation (BMMC), which is wholly owned by Aureus Mining Inc, to submit the draft Terms of Reference (ToR) for the ESIA to the EPA, for review.

The EPA sent a letter to BMMC on the 8th of December 2011 stating that BMMC are requested, through the independent environmental evaluators, EarthCons and Golder Associates, to submit the draft ToR letter to the EPA on behalf of BMMC by the 31st December 2011.

This letter provides the draft ToR for the NLGM ESIA (including both the scoping and impact assessment phase). EathCons and Golder Associates look forward to receiving the EPA's feedback on this.

## 1.0 TERMS OF REFERENCE OUTLINE

The scoping phase of the ESIA is aimed at determining the terms of reference for the specialist assessments. Thus, our proposed approach to the scoping phase comprises of:

- Identifying key environmental and social issues related to the project, so that these can be investigated during the specialist studies;
- Identifying the scope of specialist studies that will be undertaken; and
- Working closely with the BMMC design team and the wider ESIA team to assist in the analysis of alternatives (e.g. positions of waste rock dumps, mine infrastructure, haul roads etc).

The scoping phase of the ESIA will comprise a series of tasks including:

- A desktop study and site visit to the New Liberty Gold Mine concession area to:
  - Develop an understanding of the existing conditions of the project area;
  - Collect baseline environmental and social data and information appropriate for a scoping study;
  - Access current Liberian environmental and other legislation relevant to the project;
  - Identify key stakeholders in the project area e.g. in Kinjor, Robertsport and Monrovia;


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- Develop the detailed ToR for specialist studies (to be undertaken in the impact phase);
- Produce a Draft Scoping Report (DSR) for internal peer review and submission to BMMC for comment;
- Present the DSR to stakeholders through the public consultation process, with at least one EPA representative present at each meeting; and
- Based on the stakeholder inputs and comments received, produce the Final Scoping Report (FSR) for submission to the Liberian authorities.

Once the scoping phase of the ESIA has been completed and the EPA has approved the scoping report and provided permission to proceed further with the ESIA, the impact assessment phase will be initiated. The following specialist assessments are proposed to assess the key impacts of the NLGM Project on the physical, biological and social environment and will be included in the ESIA.

- Soils;
- Surface water;
- Groundwater;
- Geochemistry;
- Air quality;
- Noise;
- Visual aspects;
- Traffic;
- Terrestrial ecology;
- Aquatic ecology;
- Socio-economic aspects;
- Cultural heritage; and
- Closure and rehabilitation.

As part of the ESIA and in line with Liberian legislative requirements, a thorough and transparent public consultation process will be undertaken for each phase of the ESIA.In terms of Section 37 of the Environmental Protection Agency Act of Liberia the following is applicable to public consultation:

- Identify, inform and receive input from effected stakeholders and interested parties;
- Determine and narrow the scope of the issues to be addressed in the ESIA;
- Identify and define, at an early stage of the ESIA process, the significant environmental issues, problems and alternatives related to the different phases of the proposed project or activity;
- Ensure public participation is conducted early in the ESIA process;
- Ensure that all relevant issues and alternatives are adequately addressed in the environmental impact study;
- Provide the applicant with the information necessary for formulating the terms of reference for the environmental impact study and impact statement; and
- Guide the applicant's consultants in preparing the environmental impact statement.

The key issues and specific ToR for each proposed ESIA specialist study are outlined in the sections below.

# 2.0 PHYSICAL ENVIRONMENT

## 2.1 Soils

### Key Issues

The key issue relating to soils is the removal of soils during stripping of the opencast pit areas and the clearing of forest for mine related infrastructure such as the TSF, processing plant, waste rock dumps, roads, and other infrastructure.

Concurrent rehabilitation (i.e. throughout the life of the project) will take place and thus soil management practices will need to take this into account.

### Specific ToR

The proposed scope of work comprises:

- Identification of baseline soil types and distribution within the project area;
- Assess the impacts of the proposed project on soils; and
- Proposing soil mitigation/management measures.

## 2.2 Surface water/hydrology

### Key Issues

The key potential impacts from the proposed project on hydrology include, contamination of local watercourses by dirty surface water runoff from the plant site, seepage running into streams, changes to the surface water flow regime due to the development of the openpit and water discharge from potential pit dewatering into the Marvoe Creek.

### Specific ToR

The scope of work for assessing the key impacts includes the following:

- Baseline hydrology;
- Storm water management;
- Mine water balance; and
- Environmental Impact Assessment.

### Baseline Hydrology:

Use existing information and conduct fieldwork to describe current hydrology baseline conditions. A gap analysis will be carried out on the available climate and hydrological data. Based on the gaps identified during the data overview assessment, the locations of monitoring sites will be selected. A monitoring program will be designed to fill the gaps and the necessary equipment purchased. The monitoring program will involve the selection of the appropriate level of measuring to fill the gaps. Based on the proposed development a monitoring framework will be designed and surface water flow monitoring stations will established to monitor the flow of the Marvoe Creek and any prominent streams in the NLGM study area. These will most likely be gauged sections. The cross-sections will be surveyed, flow measured, gauge plates installed and rating curves developed.

The daily time step ACRU rainfall runoff model will be set up and calibrated using monitoring flow and rainfall data collected over the monitoring period. The simulation results of the calibrated ACRU model will be used to characterise the flow regimes before development. The proposed mining infrastructure will then be input into the model so that the impact of the mining on the surface water flow regimes can be determined. These will be compared to the pre-development flow regimes to assess the impact.

### Storm water management:

Storm water management systems will have to be developed around the proposed development. The system of trenches and diversion berms will have to be sized to meet the design criteria. A storm water model will be set up for the system and used to size the management system. The PC-SWMM model will be set up to identify the clean and dirty water areas and the proposed water management infrastructure and to determine the sizes (conceptual level design only) of the conveyance structures to ensure that the clean and dirty water systems meet the Regulatory requirements.

### Mine water balance:

The site water balance model will be developed to determine mine water requirements and source of water for the mine as well as determination of dewatering volume and assessment of the associated impacts as a result of storm water and groundwater ingress into the openpit. Groundwater contributions into the openpit will be added as an external inflow into the model. The groundwater discharge will be determined by means of the groundwater/hydrogeology specialist study.

### Environmental Impact Assessment:

The impact assessment will include qualitative and quantitative analyses to determine potential impacts. Assessment of the impact on surface water resources due to proposed mining facilities includes the potential impacts of the project on drainage patterns and on the land cover of watersheds within the study area. Recommendations for mitigation, management and monitoring measures to prevent/reduce and/or minimise impacts of significance will be provided.

## 2.3 Groundwater/Hydrogeology

### *Key Issues*

The proposed project will have an impact on the groundwater within the concession area. In particular:

- Pumping groundwater to lower the water level in the open pit may result in wells, boreholes, springs or streams being affected; and
- Groundwater quality could be affected by discharge of dirty water pumped from the open pit into the Marvoe Creek (albeit mostly suspended solids).

Clarification of the recharge mechanisms, quantity, and quality of groundwater is a key issue of the project.

### *Specific ToR*

An investigation is required to assess the groundwater/hydrogeology in the NLGM area. The terms of reference of the hydrogeological study include:

- Characterise the prevailing hydrogeological situation in and surrounding the NLGM mine site, including:
  - Determining the occurrence and depth of aquifers under and surrounding the site;
  - The depth to the static water level. (A static water level refers to the depth to the groundwater level below the surface);
  - The groundwater flow network (i.e. the way that groundwater moves underground);
  - Identification of geological structures that could act as preferential flow paths for the movement of groundwater towards and away from the site; and
  - Determine base line groundwater quality.
- Assess the feasibility of implementing dewatering to maintain dry working conditions in the proposed opencast pits, including:
  - Inflow into the pit(s) during mining, assuming no dewatering and dewatering scenarios;
  - Configuration of a dewatering well field;
  - Dewatering borehole design, depth and spacing;
  - Abstraction rate required to maintain dry working conditions; and
  - Extent of dewatering cone during operational and post closure phases.

- Carry out numerical flow and solute transport modelling to simulate and predict:
  - Inflows into the openpit as mining progresses;
  - Decant locations, volumes and quality on closure. (Decant refers to where the groundwater will be released to surface water streams);
  - The dewatering well field design, if dewatering is shown to be required;
  - Impacts on the surrounding groundwater regime, including impacts on any existing users;
  - Prediction of rate of migration of (any) pollution plumes from the open pits on closure and from mining infrastructure during operational and closure phases; and
  - Recommend mitigation measures as required
- Design a focussed groundwater monitoring programme to obtain wet and dry cycle data as per the relevant Liberian and World Bank standards; and
- Prepare a detailed hydrogeological report for inclusion into the ESIA.

## 2.4 Geochemistry

### *Key issues*

Mining, waste rock deposition and tailings deposition will result in increased weathering rates and leaching. In particular:

- Oxidation of pyrite and other sulphide minerals may lead to acid mine drainage (AMD) which may impact on the quality of surrounding surface water and groundwater resources; and
- Salinity and metals may leach in sufficient concentrations to reduce the quality of local water resources.

### *Specific ToR*

A geochemistry study is required to clarify the potential for AMD and the potential dissolved salt/metal load that may be released from mine components. The geochemistry study should include the following tasks:

- Collect representative samples of ore, waste rock and tailings;
- Conduct geochemical analysis of the samples, including static and kinetic testing;
- Assess the geochemical data to indicate potential impacts on local water resources, considering the proposed mine plan;
- Develop strategies to mitigate AMD/metal leaching impacts.

## 2.5 Air quality

### *Key Issues*

Potential significant air quality impacts arising from the proposed mining development may include:

- Total particle (dust) emissions have the potential to be released during mining activities (due to the nature of the development) and ore processing, resulting in increased dust levels and nuisance;
- Effects on local air quality due to the creation of on-site point sources e.g. diesel generators, the processing plant, vehicles operating on the mine site etc; and
- Effects on local air quality due to an increase in vehicle numbers associated with the mine (including haul roads and access roads).

### *Specific ToR*

To assess air quality impacts a baseline characterisation assessment will be undertaken of current the air quality situation and a full air quality impact assessment will be undertaken.

- The baseline air quality characterisation assessment will include the following:
  - A review of existing meteorological data, where available;
  - A review of publicly available air quality data, where available;
  - A review of relevant legislative and regulatory context i.e, ambient air quality guidelines and standards and any relevant dust guidance;
  - Identification of any other emission sources in the vicinity of the Project Site which may affect local Air Quality;
  - Using existing information, potentially sensitive receptors that have the potential to be susceptible to air quality impacts within the vicinity of the proposed mining operation will be identified; and
  - Fieldwork, whereby air quality sampling and analysis will be undertaken using air quality monitoring instruments.
- The air quality impact assessment will include the following:
  - Identification of all site sources of atmospheric emissions including from proposed quarrying and associated operations;
  - Assessment of emissions to the air from on-site point sources (e.g. diesel generators, the processing plant, vehicles operating on the mine site etc.), using a suitable and internationally accepted atmospheric dispersion model. The results from the modelling assessment will be compared against the relevant air quality standards and guidelines;
  - A qualitative dust nuisance assessment will be undertaken;
  - An assessment of traffic- related air quality impacts will be undertaken..
- A Dust Management Plan (DMP) will be developed for the site looking at source control and mitigation measures to limit the potential air quality impacts on local receptors.

## 2.6 Noise

### *Key Issues*

Noise will be generated by construction activities, opencast mining operations (namely blasting, excavation and haulage) and ore processing (including milling etc.). The impact of noise on sensitive receptors such as nearby villages requires assessment during the ESIA.

### *Specific ToR*

To assess the noise impact the following is proposed:

- Identify noise sensitive locations in the study area;
- Characterise the baseline noise levels within the study area by undertaking a baseline noise monitoring exercise;
- Assess the potential openpit mining and ore processing related noise impacts resulting from the relationship between calculated and predicted operational noise from the proposed project baseline, and recommended noise levels; and
- Describe the proposed mitigation measures and/or management to be considered during the project life, related to noise.

## 2.7 Visual aspects

### *Key Issues*

The visual character of the area is not unique within the sub-region. Impacts on the visual environment would result from the mining infrastructure potentially being seen from sensitive viewpoints (villages near the project area.

### *Specific ToR*

To assess the visual impact the following is proposed:

- Determine the visibility of the project infrastructure by conducting view shed analyses from sensitive viewing areas;
- Determine visual intrusion (contrast) of the proposed project by simulating its physical appearance from sensitive viewing areas;
- Rate the significance of the impact of the project on views from sensitive viewing areas;
- Rate the impact on the scenic quality and sense of place of the study area;
- Determine visual resource management objectives to set limits to the amount of intrusion (contrast) which will be allowed in the study area between the project infrastructure and the existing landscape; and
- Establish mitigation/management measures to reduce the impact of the project infrastructure on the visual aesthetics of the area, where appropriate.

## 2.8 Traffic

### *Key Issues*

The proposed project will lead to an increase in vehicular traffic within the immediate area and in the greater study area, with associated traffic effects on road congestion, accidents, air quality, noise and vibration. Mitigation measures will be identified to reduce potential traffic impacts and a high level Traffic Management Plan will be prepared for inclusion in the environmental management plan (EMP).

### *Specific ToR*

To assess the traffic impacts, the following is proposed:

- Conduct a baseline study to determine existing volumes of traffic in the study area;
- Using information from Aureus on the envisaged/predicted numbers of traffic that will result from the proposed project, conduct a traffic assessment to identify and assess traffic related impacts; and
- Establish mitigation/management measures to reduce the potential traffic impacts in the area.

# 3.0 BIOLOGICAL ENVIRONMENT

## 3.1 Terrestrial ecology

### *Key Issues*

The key potential impacts of the project on terrestrial ecology may include:

- In the natural forest areas there could be a significant loss of natural vegetation. The proposed mining activities could contribute to dust deposition, noise pollution and chemical spills associated with mining development;
- Loss of habitat for terrestrial fauna species; and
- The construction of roads and associated increased access to the forest areas, which is a secondary impact. The subsequent increase in hunting and utilisation of natural products in the forest areas will be

exacerbated by the increased population pressure in the area due to people moving closer to the mine from surrounding areas to look for job opportunities.

### Detailed ToR

The detailed ToR for terrestrial ecology is as follows:

- For Flora, utilise existing information and conduct surveys to:
  - Map and describe the baseline flora of the study area in terms of vegetation communities, including a consideration of structure and species composition;
  - Inventory each vegetation community during the dry season and wet season to determine species richness, diversity and relative abundance;
  - Determine the presence of endemic or Red Data listed species;
  - Assess the condition of the vegetation communities within the study area;
  - Briefly describe the extent of local use of flora for commercial, traditional and medicinal purposes;
  - Provide an indication of the relative conservation importance and ecological function of the study area;
  - Assess the potential impacts to flora by the proposed mining operations;
  - Assess residual impacts to vegetation, given the application of mitigation activities; and
  - Describe the proposed mitigation measures to be considered, during the construction, operation and reclamation phases of the proposed project, related to flora.
- For Fauna, utilise existing information and conduct surveys to:
  - Describe the baseline fauna (including birds, mammals, reptiles, arthropods and amphibians) associated with each vegetation type found in the study area;
  - Conduct a faunal habitat assessment (including habitat potentially suitable for rare, threatened or endangered species);
  - Determine the presence of endemic or Red Data species;
  - Determine key habitats and movement corridors, if possible;
  - Provide an indication of the relative conservation importance and ecological function of the study area in terms of fauna;
  - Estimate the nature and extent of the local use of fauna for commercial, traditional and medicinal purposes;
  - Assess the potential impacts to due to the proposed mining operations; and
  - Describe the proposed mitigation measures to be considered, during the construction, operation and reclamation phases of the proposed project, related to fauna.

## 3.2 Aquatic ecology

### Key Issues

The key potential impacts on aquatic ecology include:

- Changes in stream flows and water availability in streams, notably the Marvoe Creek, due to the development of the openpit;
- Contamination of surface water courses due to mining activities affecting aquatic ecology; and
- Degradation and loss of aquatic habitats.

### *Detailed ToR*

The ToR for aquatic ecology study includes:

- Utilise existing baseline information to:
  - Determine key habitats (critical or sensitive areas such as spawning, rearing, migration corridors);
  - Inventory aquatic resources in addition to fish, including macro-invertebrates;
  - Determine the presence of endemic or listed species; and
  - Describe the local use of fish resources for subsistence and traditional purposes;
- Assess potential impacts to aquatic resources, including fish and fish habitat, invertebrates, riparian areas, and consumptive fish use, from the proposed mining;
- Describe how stream channel alterations, changes to substrate conditions and quality, stream flow alterations, groundwater changes, and water quality alterations may affect fish and fish habitat in the study area;
- Discuss how the proposed project's impacts could affect aquatic biodiversity in the area;
- Describe the proposed mitigation measures to be considered, during the construction, operation and reclamation phases of the proposed project, related to fish and aquatic habitats; and
- Identify any aquatic monitoring programs that will be initiated by the proponent to identify and manage the effects of the project on aquatic resources and confirm the performance of mitigation measures.

## 4.0 SOCIAL ENVIRONMENT

## 4.1 Socio-economic aspects

### *Key Issues*

Key socio-economic issues that are envisaged for the proposed project include the following:

- The creation of employment opportunities and associated indirect economic benefits for local people;
- Potential community development benefits;
- Loss of artisanal mining opportunities and current livelihood support systems;
- Change in subsistence-based livelihoods in villages surrounding the project area;
- Expectations of employment as the project moves closer to the construction phase resulting in a potential population influx causing pressure on land and resources, and a change in the socio-economic environment;
- Loss of land affecting fields, crops and structures;
- Possible negative effects on people's health;
- Loss of access to natural resources; and
- Impact on access routes, potentially affecting access to social infrastructure.

### *Specific ToR*

The socio-economic study will include the following:

- Review of existing available socio-economic information;
- Field research involving key informant interviews, focus group meetings and the administering of a survey questionnaire to elicit socio-economic information on the study area;
- Data capturing, transcription and data analysis;
- The compilation of a detailed social assessment report that will provide a description of the socio-economic environment, and the potential impacts of the proposed project on project affected communities;
- Development of social and economic mitigation and benefit enhancement measures to reduce and, where possible, avoid negative impacts, as well as to enhance positive impacts of the project; and
- Recommendations will be made regarding the establishment of a grievance mechanism, an important requisite when project activities have started, to safeguard free prior and informed consent and to facilitate resolution of the communities' concerns about social and environmental performance.

## 4.2 Cultural Heritage

### *Key Issues*

Key cultural heritage issues that are envisaged for the proposed project include the following:

- Potential moving of cultural heritage resources;
- Potential contamination of cultural heritage remains through pollution and leakages; and
- Potential loss of cultural heritage resources;

### *Specific ToR*

The socio-economic study will include the following:

- A desk-based study, literature review, map regression exercise, and historical research exercise, utilising any readily available archaeological and historical studies within the study area;
- A preliminary field walkover survey, identifying the locations of any known and newly identified sites and areas of interest warranting more detailed recording;
- The detailed recording of identified sites;
- The compilation of a cultural heritage assessment report that will provide a description of the cultural heritage resources in the study area, and the potential impacts of the proposed project on cultural heritage resources; and
- Development of cultural heritage mitigation measures to reduce and, where possible, avoid negative impacts, as well as to enhance positive impacts of the project.

# 5.0 CLOSURE AND REHABILITATION FRAMEWORK

A closure and rehabilitation framework will be developed for inclusion in the ESIA Report, based on information provided by BMMC, the proponent.

## 6.0 CONCLUSION

We hope that the draft ToR for the NLGM ESIA, as detailed in this letter, meets with the EPA's satisfaction. We would like to take this opportunity to thank the EPA for reviewing the ToR. Please do not hesitate to get in touch with us if you have any queries.

We look forward to hearing from you and to working closely with the EPA as the ESIA progresses.

Kind regards,

**EARTHCONS AND GOLDER ASSOCIATES GHANA LTD.**

Michael Suah
Independent Environmental Evaluator

Chris Fell
Environmental Consultant

CF/AE/cf



Golder Associates

REPUBLIC OF LIBERIA
ENVIRONMENTAL PROTECTION AGENCY
P.O. Box 4024
4th Street Sinkor, Tubman Boulevard,
1000 Monrovia, 10 Liberia

*ffice of the Executive Director*

**ED/EPA-06/0079/12/RL**

The Management
Aureus Mining, Inc.
Monrovia, Liberia

26th March, 2012

Dear Management:

I present my compliments and wish to acknowledge receipt of your **Term Of Reference (TOR)** submitted to the Environmental Protection Agency (EPA) on 8th February, 2012 for consideration.

Your submission was carefully analyzed and found to contain the needed information. Not only that, all parameters were adequately discussed.

On the basis of the analysis, I am Pleased to informed you that your **Term Of Reference** has been accepted by the Environmental Protection Agency (EPA).

Meanwhile, it is expected that you conduct your activities in line with the **TOR.**

The EPA renews its commitment to sustainable environmental management in Liberia and avails itself of the utmost cooperation with all developers in the country.

Kind regards,

Nathaniel T. Blama
**ACTING EXECUTIVE DIRECTOR**

NTB/m/g

*Mobile: +231 6514013* *Fax 231 77523432* *E-mail:vohiri@yahoo.com*

# APPENDIX F

## Comment and Response Report

November 2010

COMMENT AND RESPONSE REPORT

# ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE NEW LIBERTY GOLD MINE OF BEA MOUNTAIN MINING CORPORATION, GRAND CAPE MOUNT COUNTY, LIBERIA

## COMMENT AND RESPONSE REPORT

Project number: GHA1044/12898

A world of capabilities delivered locally

african aura mining inc

Golder Associates

# COMMENT AND RESPONSE REPORT

This document records the comments, issues of concern, questions and suggestions for enhanced benefits raised by stakeholders on the Environmental and Social Impact Assessment (ESIA) for the proposed New Liberty Gold Mine (NLGM). Comments were raised in writing and verbally at several focus group and community meetings held in September 2010.

The comments have been categorized as follows and responded to by members of the Golder ESIA team and Bea Mountain Mining Corporation (BMMC) management team.

## Table of Contents

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
|---|---|---|---|---|---|
| **1. NEED AND DESIRABILITY OF PROJECT** | | | | | |
| The Forestry Development Authority is in favour of the project since Liberia will benefit from the development. | Morris B. Kamara | Forestry Development Authority (FDA) | 14 September 2010 | Government focus group meeting: Monrovia | Thank you for your comments. |
| The community is in support of the ESIA and the project to continue. | George Kiawu | Youth Leader, Dablo Clan | 16 September 2010 | Community meeting: Jawajei Village | |
| **2. WATER** | | | | | |
| What will the impact of mining activities be on water resources in the area? | Bokai J. Swarai | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | The impact of proposed mining activities on water resources in the area will be assessed in the ESIA specialist studies, notably by means of the surface water and groundwater assessment studies. Recommendations on how to minimise potential impacts will be included in the ESIA. |
| Larjor does not have safe and clean drinking water. | Chief Larjor (Lahar Dassin) | Larjor Community | 16 September 2010 | Community meeting: Kinjor Village | BMMC will install a hand pump at Larjor. |
| We would like to thank BMMC for the hand pumps and for safe drinking water which they have provided at Jawajei and other villages. | Austin Seh | DEAYELEE Mavo Development Association | 16 September 2010 | Community meeting: Jawajei Village | Thank you for the comment. BMMC is also in discussions with the Minister of Development to investigate how existing pumps in other villages can potentially be upgraded and/or made operational once again. |
| **3. AGRICULTURE** | | | | | |
| Will the mining concession area be suitable for farming after mine closure? Will people be able to live in the area? | Town Chief Kinjor (Momodu Massaquoi) | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | As part of the ESIA, a closure study will be conducted. This closure study will make recommendations on how to rehabilitate the area after mining and the ESIA specialist studies will investigate whether the area will be suitable for farming and other activities once the mine closes. |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
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| **4. ENVIRONMENTAL MANAGEMENT** | | | | | |
| Mining will have an impact on the forest reserves in Liberia and the Forestry Development Authority would like to work with BMMC to ensure that this natural resource is protected. | Mr. Morris B. Kamara | Forestry Development Authority | 14 September 2010 | Government focus group meeting: Monrovia | Thank you for your comment. BMMC will work with the FDA to as far as possible protect forest resources in Liberia. |
| A management regime that supports selective logging is one of the reasons why large parts of the Liberian forest are still intact. | Mr. James Kpadehyea | Forestry Development Authority | 14 September 2010 | Government focus group meeting: Monrovia | Thank you for the comment. |
| BMMC is already impacting the environment in a negative manner. How will the Liberian people benefit from the proposed project? | Mariama | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | The proposed mine will ensure the creation of new job opportunities. The socio-economic study that will be conducted as part of the ESIA will investigate potential impacts on the environment and local people and their livelihoods as a result f the project. Ways of reducing any negative impacts will be investigated and highlighted in the ESIA. |
| How will mining activities affect the forest? | Mr. Bokai J Swarai | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | Sections of forest will be cleared as the mine is developed. However, Government has demarcated areas which should be protected and where BMMC will not be allowed to mine – these are referred to as Forest Reserves. |
| Will the exploration holes be dangerous to animals in the forest? | Mr. Thomas Brown | Blain Community | 16 September 2010 | Community meeting: Jawajei Village | Exploration holes that were drilled are sealed off with concrete slabs to prevent any damage or risk to the community or animals. |
| BMMC have cut down trees without informing the community and the | Mr. George Kiawu | Youth Leader, Dablo | 16 September 2010 | Community meeting: Jawajei Village | Thank you for the comment. Sections of forest will be cleared as the mine is |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
|---|---|---|---|---|---|
| environment is being damaged as a result.<br>BMMC is cutting down trees between Kinjor and Jawajei which causes problems for the community. | | | | | developed. However, Government has demarcated areas which should be protected and where BMMC will not be allowed to mine – these are referred to as Forest Reserves. |
| **5. SOCIO-ECONOMIC** | | | | | |
| Could the ESIA process be used as a mechanism to ensure knowledge transfer to Monrovia students and provide them with valuable experience? | Mr. Carlton Miller | Assistant Minister for Mineral Exploration and Environmental Research, Ministry of Lands, Mines and Energy | 14 September 2010 | Government focus group meeting: Monrovia | This is a good idea and BMMC would support such an initiative and encourage students to visit the exploration site. |
| What will the immediate impact of the mining development be on the lives of people living in the vicinity of the proposed mining concession area? | Mrs. Catherine N. Watson-Khosa | Grand Cape Mount County Superintendent | 15 September 2010 | Government focus group meeting: Ministry of Internal Affairs, Monrovia | The main purpose of the ESIA is to determine potential impacts from the proposed project on the environment and people in the vicinity of NLGM area. Once the ESIA Impact Assessment Phase are completed communication to the community will proceed as part of the EIS process.. |
| The mine should give close consideration to how people in the mining concession area can benefit from this project since they feel that their gold is being taken. | Mrs. Catherine N. Watson-Khosa | Grand Cape Mount County Superintendent | 15 September 2010 | Government focus group meeting: Ministry of Internal Affairs, Monrovia | Thank you for the comment. BMMC will endeavour to maximise benefits from the project for local people. |
| How will the artisanal miners in the area be impacted when the mine becomes operational? What will happen to their livelihoods? | Mr. Lomin Koroma | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | Various possibilities will be investigated by BMMC after the socio-economic study has been completed. The socio-economic study will also take artisanal miners into account. |
| Although studies continue in the area, people do not gain any financial benefit. | Mr. Vinneh Morris | Jenneh Brown Community | 16 September 2010 | Community meeting: Jawajei Village | BMMC understands local peoples frustrations. At this stage the company is involved in exploration drilling to see |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
|---|---|---|---|---|---|
| | | | | | if the project will go ahead or not. The socio-economic study will be conducted as part of the ESIA to identify possible community development initiatives that BMMC can initiate in partnership with local communities. |
| **5.1 Employment** | | | | | |
| What will happen to people who left their homes to seek employment at BMMC and were unsuccessful? | Mariama | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | It is not certain how many employment opportunities will become available should the proposed project go ahead. People should not change their lifestyles or leave their homes if they have no definite offer of employment from BMMC. |
| Exploration has lasted for 10 years and people have been told to stop informal mining in the area. How will employment be guaranteed?<br>What will happen to people in the area that are not employed by the mine? | Esafahmbu | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | At this stage it is not known exactly how many employment opportunities will become available should the proposed project go ahead. Information on employment numbers will be provided to stakeholders as the ESIA progresses. The presence of the mine will bring about development and increased spending power in the area, and people who provide these services eg. food, drivers, accommodation etc. to BMMC will also benefit from the mine, not only those who gain direct employment from the mine. This will have a positive impact on economic activities within the local communities which will ensure further growth. |
| I have worked as a mid-wife and would appreciate employment if a healthcare post is built. | Mr./Ms Nama Fahmbulleh | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | Thank you for offering your services. Mr Stephen Dorbor can be contacted in this regard. |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
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| BMMC has spent many years in the area. When will community members be offered employment and how will the community benefit? | Mr. Frances Boima | Jenneh Brown Community | 16 September 2010 | Community meeting: Jawajei Village | At this stage it is not known exactly how many employment opportunities will become available should the proposed project go ahead. Information on employment numbers will be provided to stakeholders as the ESIA progresses. The increased presence of BMMC in the area means the company has to buy food, fuel, use transport and possibly accommodation in the mine area. Thus people should not only concentrate on getting employment from BMMC, but also providing services to mine personnel in the area. |
| **5.2 Community Development Projects** | | | | | |
| What development initiatives is the company planning for the community? It is important that the company document what has been done for the community. | Mr. Carlton Miller | Assistant Minister for Mineral Exploration and Environmental Research, Ministry of Lands, Mines and Energy | 14 September 2010 | Government focus group meeting: Monrovia | BMMC has installed hand pumps in the villages within the mining concession area and bridges, river crossings and a road were upgraded in the area. |
| Annual company budgets need to reflect what percentage will be invested in the community. The Exploration Regulations of 2010 provides specific information for mining company community investment. | Mr. Carlton Miller | Assistant Minister for Mineral Exploration and Environmental Research, Ministry of Lands, Mines and Energy | 14 September 2010 | Government focus group meeting: Monrovia | Thank you for the comment. The ultimate objective of this work is to ensure compliance to legal requirements. |
| Will BMMC be able to provide street lights and another hand pump to Kinjor village? | Imam Mambu Sambola | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | Another hand pump will be installed at Kinjor Village. The company must guard against taking over the responsibilities of the local government, like installing street lights, but should work in |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
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| | | | | | conjunction with local leaders to provide assistance to them. |
| People require transport to the clinic, which BMMC will build at Kinjor? | Imam | Jenneh Brown Community | 16 September 2010 | Community meeting: Jawajei Village | Thank you for the comment we will investigate the opportunity. |
| **5.3 Relocation and Compensation** | | | | | |
| The possibility that two villages might be relocated as part of the mine development is a concern for the Ministry of Internal Affairs and any official information regarding this needs to be made available to the Ministry. | Mrs. Catherine N. Watson-Khosa | Grand Cape Mount County Superintendent | 15 September 2010 | Government focus group meeting: Ministry of Internal Affairs, Monrovia | The mine plan has not been completed and accurate information about the relocation of people cannot be provided with certainty at this stage. BMMC will keep the Ministry informed during the ESIA. People must not have undue expectations of compensation or build speculative houses in the hope of receiving compensation when the mine reaches their area. It often happens that a mine plan changes and people have spent their money on speculative building and they lose all their money. BMMC will manage any relocation and compensation process carefully. |
| Will Kinjor be relocated when the mine becomes operational? Residents are reluctant to make modifications to their houses because they are expecting to be relocated. | Mr. Jebbeh Mansalay | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | A resettlement program will be part of the EIA process if the mine goes ahead. Communities will be consulted regarding resettlement through meetings and committees. |
| **5.4 Education** | | | | | |
| Residents of the various communities are in need of schools and upliftment of poor living conditions. | Esafahmbu | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | The Government of Liberia is primarily responsible for ensuring that the country's mineral endowments are utilized to promote local and national development within the broader context of sustainable natural resource use. The community leaders who are |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
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| | | | | | responsible for the planning of schools and uplifting of communities must still be responsible for development. BMMC will assist as far as possible. |
| If mining goes ahead, what will happen to the children living in the communities? Will there be better schools available to them? | Mr. Varney Parsawe | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | BMMC will consider building a school in the area in the future, in partnership with the government, and communities, if the project goes ahead. |
| The community is in desperate need of a school and teacher for the children. | Imam Mambu Sambola | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | Thank you for this information. As the project proceeds and if it goes ahead, BMMC will discuss the possibility of building a school in the area with local Government and the community leaders. |
| The distance between Jawajei Village and Kinjor is too far for school children to walk. Can BMMC provide educational assistance to Jawajei? | Community member | Jawajei Community | 16 September 2010 | Community meeting: Jawajei Village | BMMC is investigating ways to support education in the area and discussions with the development superintendent have started to investigate current conditions in the area for schooling. |
| Will a junior high school be built for our community? | Mr. Fardey Dablo | Jenneh Brown Community | 16 September 2010 | Community meeting: Jawajei Village | Various community development opportunities will be discussed with local people if the project goes ahead, so that priorities can be set and a plan developed. |
| **5.5 Healthcare** | | | | | |
| Will BMMC be able to build a clinic or hospital? It takes approximately four hours to drive to the nearest clinic or hospital. | Mr. Varney Farmer | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | The Health Ministry has given approval for the healthcare post to be established. |
| **6. COMPANY CONDUCT AND POLICY** | | | | | |
| BMMC are conducting studies to identify the impact of mining activities on the environment. However, trees | Town Chief | Jenneh Brown Community | 15 September 2010 | Community Meeting: Mecca Village | Liberian law does not require that an ESIA be conducted before exploration starts. BMMC (formerly called Mano |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
|---|---|---|---|---|---|
| have already been cut down and water polluted. Why weren't studies done before exploration started? | | | | | River Resources) can now confidently say that the company wants to seriously investigate mining in the area near Kinjor and Larjor. In line with Liberian legislation, BMMC has appointed Golder Associates as an international company to conduct the ESIA. Past studies that have been conducted on the site will be taken into account in the ESIA. |
| At a meeting held in August 2007 at Jenneh Brown Village, Mano River Resources were fined $2.5 million for damaging the environment. Why is Mano conducting an ESIA while the fine hasn't been paid yet? | Town Chief | Jenneh Brown Community | 15 September 2010 | Community meeting: Mecca Village | BMMC does not have a record of such a fine and suggest the community follow this up with the government and Mano River Resources. |
| Is BMMC aware that Mano River Resources owe the people of the area money? | Mr. Jasu Kumara | Mecca Community | 15 September 2010 | Community meeting: Mecca Village | BMMC was not aware of this information and community should take the issue up with Mano River Resources |
| Why has no feedback been received from BMMC after a letter was submitted to the company in July 2009? | Josh | Mecca Community | 15 September 2010 | Community meeting: Mecca Village | We ask that you please submit the letter again to Aureus for follow up and discussion. |
| The community is in possession of a document which states that Mano River Resources will make certain commitments which include giving money to government etc. This document was signed without providing names of the signatories which has led to a lack of trust in the content. | Josh | Mecca Community | 15 September 2010 | Community meeting: Mecca Village | BMMC would be thankful to review this document in order to provide further comment. We ask that you please submit the document again to Aureus for follow up and discussion. |
| The name of the company changes frequently which causes a lot of | Josh | Mecca Community | 15 September 2010 | Community meeting: Mecca Village | Thank you for this comment. The company was previously called Mano |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
|---|---|---|---|---|---|
| confusion. | | | | | River Resources and is now called Bea Mountain Mining Corporation (BMMC). BMMC is owned by African Aura Mining (AAM), but we still refer to BMMC as this name is widely known in Liberia. |
| BMMC does not consult with communities in the mining concession area. For example: the camp/compounds and roads were built without proper consultation with people. | Josh | Mecca Community | 15 September 2010 | Community meeting: Mecca Village | Thank you for this comment. BMMC will consult with communities as necessary. |
| Is BMMC aware of the concern around the unresolved $2.5 million claim which caused disruption within the community structures? | Mr. Zana Dablo | Jenneh Brown Community | 16 September 2010 | Community meeting: Jawajei Village | BMMC has been informed by community members about this concern and the claim, but to date has not been provided with documents to support any claims. |
| The communities request that a meeting be scheduled with BMMC to discuss concerns around the $2.5 million claim. | Mr. Zana Dablo | Jenneh Brown Community | 16 September 2010 | Community meeting: Jawajei Village | Thank you for this suggestion. BMMC will arrange such a meeting. |
| Mano River Resources created many unresolved problems within communities in the area. In 2007 money for celebration of the new road was given to selected people only, which caused unhappiness with our people. Proof on this matter can be provided. | Mr. George Kiawu | Youth Leader, Dablo District. | 16 September 2010 | Community meeting: Jawajei Village | Thank you for the comment. The suggestion is for the community to arrange a meeting with Mano River Resources to discuss this matter. |
| Is it true that BMMC is contracting people to sell timber/logs? | Mr. George Kiawu | Youth Leader, Dablo District. | 16 September 2010 | Community meeting: Jawajei Village | This information is not true. BMMC does not contract people to sell timber/logs as the company is not involved in any timber harvesting business. |
| BMMC should consult with the people living in the area affected by the | Mr. George Kiawu | Youth Leader, Dablo District. | 16 September 2010 | Community meeting: Jawajei Village | BMMC is committed to ongoing consultation with communities in the |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
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| proposed project, since they are custodians of the land. BMMC must not only consult with the Superintendent of Cape Mount County. | | | | | area, so that communication s transparent and fair. As part of the ESIA, Golder Associates and Earthcons is also conducting a public consultation process to inform people about the proposed project and ESIA process, and input peoples questions and comments into the process. |
| **7. PROJECT SPECIFIC** | | | | | |
| What will the depth of the proposed mine pit be? | Mr. Carlton Miller | Assistant Minister for Mineral Exploration and Environmental Research, Ministry of Lands, Mines and Energy | 14 September 2010 | Government focus group meeting: Monrovia | The proposed mine pit will be approximately 260 – 300 meters deep. |
| What will the lifespan of the mine be? | Mr. Carlton Miller | Assistant Minister for Mineral Exploration and Environmental Research, Ministry of Lands, Mines and Energy | 14 September 2010 | Government focus group meeting: Monrovia | The lifespan of the mine will be approximately 8 years. |
| How will decommissioning of the mine be done? | Mr. James Kpadehyea | Forestry Development Authority | 14 September 2010 | Government focus group meeting: Monrovia | As part of the ESIA, a closure and rehabilitation framework will be completed. This framework will highlight the decommissioning and closure measures that will be undertaken by BMMC when the mine closes. Before closure of the mine, local people will be consulted so that their inputs are included in the decommissioning and closure plans. |
| What company does Mr Dorbor work for? | Mr. Jasu Kumara | Mecca Community | 15 September 2010 | Community meeting: Mecca Village | Mr Dorbor works for Bea Mountain Mining Corporation (BMMC), formerly |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
|---|---|---|---|---|---|
| | | | | | known as Mano River Resources. |
| In December 2005 it was indicated that mining in the concession area would commence and continue for the next 25 years. Why hasn't the mining started yet? | Josh | Mecca Community | 15 September 2010 | Community meeting: Mecca Village | BMMC has been given a Class A mining license to mine in the area and this licence is valid for 25 years. This mining license covers a wide area. However, this does not mean that the company will mine the deposit for 25 years. Before mining can commence, certain processes have to be followed, which includes the ESIA process. |
| Is the company ready to mine or is prospecting still taking place? | Mr. Momo Farmer | Mecca Community | 15 September 2010 | Community meeting: Mecca Village | |
| Will the open pit be located where Kinjor and Larjor are situated? | Mr. Alasana Samohai | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | The location of the pit has not been finalized. Studies, which include exploration drilling, are being conducted to determine exactly where the pit should be located. |
| Will mining activities take place underground? | Mr. Varney Parsawe | Kinjor Community | 16 September 2010 | Community meeting: Kinjor Village | At this stage BMMC plans on developing an open pit mine. This means that mining will take place in a large open pit on the surface, rather than underground. |
| When will construction of the proposed mine start since several studies have been done to date? | Mr. Varney Dao | Jenneh Brown Community | 16 September 2010 | Community meeting: Jawajei Village | BMMC has to comply with Liberian legislation which requires an ESIA before authorities can make a decision on whether construction of the mine can go ahead. Construction of the mine may begin in 2012. |
| Will BMMC use the exploration holes that were drilled for mining purposes? | Town Chief (Samuel) | Jenneh Brown Community | 16 September 2010 | Community meeting: Jawajei Village | The exploration holes will not be used for mining purposes. These have merely been drilled to investigate the location of gold. The depths of the holes vary and results indicate that gold deposits are shallow. |
| How will the community be affected by the exploration holes? | Town Chief (Samuel) | Jenneh Brown Community | 16 September 2010 | Community meeting: Jawajei Village | Exploration holes that were drilled are sealed off with concrete slabs to prevent any damage or risk to the |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
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| | | | | | community or animals. Community should try to keep holes safe. |
| How long has BMMC been active in the area? | Mr. Samuel Brown | Jawajei Community | 16 September 2010 | Community meeting: Jawajei Village | BMMC, previously known as Mano River Resources, has been active in the area since 1998. |
| When will exploration within the proposed project area be completed? | Mr. Sando Lamin | Blaing Community | 16 September 2010 | Community meeting: Jawajei Village | Exploration is an ongoing process. |
| To prevent land use conflicts, it should be determined whether the mining concession area falls in an area of pre-qualified logging concessions, a conservation area or a trans-boundary conservation region. | Mr. James Kpadehyea | Forestry Development Authority | 14 September 2010 | Government focus group meeting: Monrovia | Thank you for this comment. The ESIA will take this into account. |
| **8. INFRASTRUCTURE** | | | | | |
| The road that was built has taken away farmland from the community and poses a threat to the environment. | Mr. George Kiawu | Youth Leader, Dablo District. | 16 September 2010 | Community meeting: Jawajei Village | Thank you for the comment the EIS will take this into account. |
| The company is building another road. What will the existing road be used for? | Mr. Austin Seh | DEAYELEE Mavo Development Association | 16 September 2010 | Community meeting: Jawajei Village | The existing road will still be used by light vehicles and the new road only for the transportation of heavy machinery to the proposed mine site. |
| **9. ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT** | | | | | |
| The mine should work closely with the Forestry Development Authority's EIA Department. | Mr. Morris B. Kamara | Forestry Development Authority | 14 September 2010 | Government focus group meeting: Monrovia | Thank you for the comment. The ESIA team will work closely with the EIA Department of the FDA during the ESIA. |
| The Forestry Development Authority would like to establish a collaborative framework with the mine and ESIA project team. | Mr. Morris B. Kamara | Forestry Development Authority | 14 September 2010 | Government focus group meeting: Monrovia | BMMC, Earthcons and Golder Associates will work with the FDA as the ESIA progresses so that as far as possible, the FDA is involved in the process. |
| The Forestry Development Authority's | Mr. Morris B. Kamara | Forestry | 14 September | Government focus | Thank you for the information. BMMC |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
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| GIS Department can provide maps which could be of use to the ESIA team. | | Development Authority | 2010 | group meeting: Monrovia | and Golder Associates will approach the FDA for GIS related information. |
| The Forestry Development Authority appreciates feedback from ESIA studies done in Liberia since it provides valuable information on the fauna and flora of the country. | Mr. James Kpadehyea | Forestry Development Authority | 14 September 2010 | Government focus group meeting: Monrovia | Thank you for the comment. The ESIA will include both terrestrial and aquatic ecology studies. The reports will be made available to the FDA once the ESIA is completed. |
| Please send a copy of all ESIA reports to the Forestry Development Authority. | Mr. Jaguar S. Kamara | Forestry Development Authority | 14 September 2010 | Government focus group meeting: Monrovia | A copy of the ESIA Report and accompanying specialist studies will be sent to the Forestry Development Authority. |
| Is Golder Associates aware of the trees that have been cut down and the polluted water in the area? | Mr. Varney Dablo | Jenneh Brown Community | 15 September 2010 | Community meeting: Mecca Village | AS part of the ESIA, baseline studies will be conducted, including ecological and surface water baseline studies. These studies will document the current situation regarding forest resources in the area, and surface water pollution levels. |
| Can Golder be held responsible for any environmental damage that could occurs after the ESIA studies have been concluded? | Mr. Varney Dablo | Jenneh Brown Community | 15 September 2010 | Community meeting: Mecca Village | Golder cannot be held responsible for any environmental damage that occurs on site. Golder is responsible for conducting the ESIA in an independent manner to meet Liberian legislative requirements and international standards. The ESIA will contain the mitigation/management measures that BMMC will have to undertake throughout the life of the mine, so that as far as possible, the environment is not damaged. |
| What are the impacts of mining exploration on the environment? | Mr. Mohammed Daramie | Mecca Community | 15 September 2010 | Community meeting: Mecca Village | The impacts of mining exploration will be included in the ESIA. |
| Is Golder Associates from BMMC or is it a contractor? | Community member | Mecca Community | 15 September 2010 | Community meeting: Mecca Village | Golder Associates is an independent engineering and environmental |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
|---|---|---|---|---|---|
| | | | | | consulting company. Golder is registered by the Liberian government to conduct ESIA's. Golder and Earthcons have been appointed by BMMC to conduct the ESIA. |
| BMMC indicated that mining will start in 1.5 years. Is this statement still true since Golder Associates indicated that the ESIA will take one year to complete? | Mr. Fuli Dablo | Jenneh Brown Community | 15 September 2010 | Community meeting: Mecca Village | Yes that is correct. One year of the 1.5 years will be dedicated to completing the ESIA, after which construction will begin if the project is given the go ahead. |
| Why has Golder Associates been brought to Liberia? | Mr. Varney Billie | Jenneh Brown Community | 15 September 2010 | Community meeting: Mecca Village | BMMC brought members of the ESIA team from Golder Associates to the area to conduct an ESIA for the proposed New Liberty Gold Mine. Specific environmental and social studies will be conducted as part of the ESIA. |
| What proof is available that Golder Associates will do proper work on the ESIA? | Mr. Varney Billie | Jenneh Brown Community | 15 September 2010 | Community meeting: Mecca Village | Golder Associates is a reputable international company that has conducted ESIAs for the last 50 years across the world. Golder is approved by the Liberian Government to work as an independent environmental consultancy and has partnered with Earthcons. Earthcons are a Liberian environmental consulting company and are approved by the Liberian Government. |
| Is the Government aware of Golder Associates and the work that will be done? | Community member | Mecca Community | 15 September 2010 | Community meeting: Mecca Village | Several meetings have been held with Government departments to introduce the Golder Associates ESIA team. Meetings were held with the Superintendent for Grand Cape Mount County, the Forestry Development Authority, the Environmental Protection Agency and the Ministry of Lands, |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
|---|---|---|---|---|---|
| | | | | | Mines and Energy. Golder is approved by the Liberian Government to work as an independent environmental consultancy on this EIA in Liberia |
| BMMC should provide the community with a letter to confirm the appointment of Golder Associates to conduct studies in the mining concession area. | Town Chief | Mecca Community | 15 September 2010 | Community meeting: Mecca Village | Thank you for the comment. |
| BMMC should inform the Environmental Protection Agency Director in a formal letter of its intention to mine in a certain area.<br>BMMC should state that an international company will be used to conduct the ESIA. A profile of Golder Associates and the relevant CVs will be required. | Mr. Ben Karmorh | Environmental Protection Agency | 17 September 2010 | Government focus group meeting: Monrovia | Thank you for the information. |
| Upon receipt of a formal letter, the Environmental Protection Agency will respond with the necessary forms and a list of environmental consulting companies in Liberia that Golder can collaborate with. | Mr. Johansen Voker | Environmental Protection Agency | 17 September 2010 | Government focus group meeting: Monrovia | |
| **9.1 Specialist studies** | | | | | |
| Does this ESIA only cover the area near Larjor or will other areas also be part of the studies? | Mr. Walter McCarthy | Ministry of Lands, Mines and Energy | 14 September 2010 | Government focus group meeting: Monrovia | This ESIA will cover what is called the local study area, where the proposed mine will be located near Larjor. At a higher level the ESIA will also take into account the regional study area. |
| When will the ESIA process be completed? | Mr. Carlton Miller | Assistant Minister for Mineral Exploration and Environmental | 14 September 2010 | Government focus group meeting: Monrovia | The ESIA will take approximately one year to complete because of baseline monitoring during the wet and dry seasons. At this stage it is thus |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
|---|---|---|---|---|---|
| | | Research, Ministry of Lands, Mines and Energy | | | envisaged that the ESIA will be completed during the 3rd - 4th Quarter of 2012. |
| Will ESIA studies cover areas other than the proposed project area? | Mr. Thomas Brown | Blain Community | 16 September 2010 | Community meeting: Jawajei Village | The ESIA specialist studies will focus on the area where the proposed mine will be located. I&AP's will be identified during the ESIA process and will take the areas of impact into account. |
| People recently came to our community and took photographs of gravesites. Why did they do this? | Mr. Adu Daldo | Jawajei Community | 16 September 2010 | Community meeting: Jawajei Village | Specialists that are conducting a cultural heritage study as part of the ESIA have to visit the area and document cultural sites such as gravesites. Photographs were taken to ensure the gravesites are documented. |
| **9.2 Public Consultation** | | | | | |
| Public consultation is critical to environmental management and should form an integral part of the ESIA. | Mr. Morris B. Kamara | Forestry Development Authority | 14 September 2010 | Government focus group meeting: Monrovia | BMMC, Earthcons and Golder Associates support the views of the Forestry Development Authority. The ESIA team will aim to involve and keep stakeholders informed throughout the ESIA process, by means of thorough and transparent public consultation. |
| The Forestry Development Authority is working with other mines in Liberia to develop offset areas in concession areas. Certain sections of the mining concession area need to be allocated for protection. | Mr. Morris B. Kamara | Forestry Development Authority | 14 September 2010 | Government focus group meeting: Monrovia | Thank you for this comment. As he ESIA progresses, BMMC and Golder will consult with the FDA regarding potential offset areas. The ecology study will also take biodiversity offsets into account. |
| Initial consultation about the proposed project and ESIA is appreciated and should continue. | Mr. James Kpadehyea | Forestry Development Authority | 14 September 2010 | Government focus group meeting: Monrovia | Thank you for this positive comment. The public consultation process will continue throughout the ESIA. |
| An official of the office of the Superintendent of Grand Cape Mount County should in future be | Mrs. Catherine N. Watson-Khosa | Grand Cape Mount County Superintendent | 15 September 2010 | Government focus group meeting: Ministry of Internal | Thank you for the recommendation. This will be done for future consultation. |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
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| represented at ESIA public consultation meetings. | | | | Affairs, Monrovia | |
| We appreciate that Golder Associates is providing the community with information about the project and we are certain that another meeting will take place. The community is thankful that Mr Dorbor meets with us regularly to discuss progress and mining. | Town Chief | Jenneh Brown Community | 15 September 2010 | Community meeting: Mecca Village | Thank you for your comment. |
| Were community members informed that BMMC was granted a mining license? | Mr. Momo Farmer | Mecca Community | 15 September 2010 | Community meeting: Mecca Village | BMMC is eager to meet with the communities and discuss the mining license in order to understand the communities' grievances. This will be managed through the ESIA and RAP community consulting process |
| Please ensure that community meetings are also held with other towns and not only in Jawajei. | Mr. Thomas Brown | Blain Community | 16 September 2010 | Community meeting: Jawajei Village | This request will be considered when future ESIA public consultation meetings are scheduled. |
| Constant engagement with stakeholders is necessary and a requirement for the ESIA. | Mr. Johansen Voker | Environmental Protection Agency | 17 September 2010 | Government focus group meeting: Monrovia | Thank you for your valid comment. Public consultation with relevant stakeholders will take lace throughout the ESIA. |
| **10. OTHER** | | | | | |
| Is Bea Mountain Mining Corporation (BMMC) the correct name for the company responsible for this project? | Mr. Walter McCarthy | Ministry of Lands, Mines and Energy | 14 September 2010 | Government focus group meeting: Monrovia | Yes, BMMC is the correct name and is widely known in Liberia. BMMC is owned by African Aura Mining (AAM). |
| What is the nature of the legal transfer that took place between Bea Mountain Mining Corporation and African Aura Mining? | Mr. Carlton Miller | Assistant Minister for Mineral Exploration and Environmental Research, Ministry of Lands, Mines and Energy | 14 September 2010 | Government focus group meeting: Monrovia | This information will be provided in upcoming consultation sessions. |
| The Ministry of Internal Affairs has | Mrs. Catherine N. | Grand Cape Mount | 15 September | Government focus | Thank you for this comment. |

| COMMENTS, ISSUES AND SUGGESTIONS RAISED | COMMENTATOR | ORGANISATION | DATE | SOURCE | RESPONSE |
|---|---|---|---|---|---|
| addressed the concern of illegal miners in Gblaing. | Watson-Khosa | County Superintendent | 2010 | group meeting: Ministry of Internal Affairs, Monrovia | |
| Why have there been there so many roadblocks in the area? | Town Chief | Jenneh Brown Community | 15 September 2010 | Community meeting: Mecca Village | It is the understanding of BMMC that road blocks were set up by the community because of grievances with BMMC. |
| Will the ESIA studies being conducted for the proposed project also assist to stop people from hunting animals? | Mr. Frances Baley | Kinjor Village | 16 September 2010 | Community meeting: Jawajei Village | The ESIA studies themselves cannot stop people from hunting. The ESIA team will conduct studies to understand the impact of the proposed project on the environment and people. It is the responsibility of the government to ensure the environment is protected and not that of the ESIA study or Golder. |
| Will the community receive royalties from the mine? | Mr. Fardey Dablo | Jenneh Brown Community | 16 September 2010 | Community meeting: Jawajei Village | Thank you for the question the mine will follow its agreement with government. |
| How many people in Larjor have died since Mano River Resources arrived in the area? | Mr. Samuel Brown | Jawajei Community | 16 September 2010 | Community meeting: Jawajei Village | Golder do not know the answer to this question and suggest the community take it up with Mano River Resources. |

# APPENDIX G

## Background Information Document and Comment Sheet

## PUBLIC CONSULTATION PROCESS

During the ESIA process there will be a number of opportunities for communities, and other potentially interested and affected stakeholders to participate, and comment on the proposed project and ESIA process.

**Your participation in the ESIA will help to identify concerns that are important to the community, for assessment in the ESIA studies.**

All stakeholder comments will be recorded and made publicly available in a Comment and Response Report (CRR) for people to verify that they have been recorded correctly.

Special efforts will be made to involve, in addition to government and traditional authorities and community leaders, potentially directly affected people, women, the youth, as well as local, regional and national educational and religious organisations, research institutions, NGOs and other key stakeholders

After the project announcement, the second phase of the ESIA is the development of the Terms of Reference (ToR), also called the scoping phase. This will be done from September to November 2010. The draft ToR report , referred to as the scoping report ,will be made available at various public places, and at public meetings to discuss the report and obtain comments and suggestions from the public.

Between December 2010 and June 2011, after completion of the Scoping/ToR, detailed specialist studies will be undertaken. The aim of these specialist studies will be to identify and assess potential positive and negative impacts associated with the proposed project, so that BMMC can manage the project accordingly. The draft ESIA report will be made available to the public for comment in mid-2011.

Interested and affected parties (I&APs) will be notified of the availability of reports, public /community meetings and dates and venues, through personal contact, written invitations and/or site notices. This is to ensure that I&APs have adequate information to understand the potential environmental and socio-economic impacts of the project , and opportunities to comment on the findings of the ESIA .

Once a decision has been made regarding the ESIA and whether the project will go ahead or not, stakeholders will be informed by letters and site notices.

## TECHNICAL STUDIES

The following technical studies will be conducted by specialists from Golder, as part of the ESIA:

Soils, ecology, surface water, groundwater, air quality, visuals, noise, socio-economic and cultural heritage.

## CONTACT DETAILS

Public comment is important for the ESIA process. To provide any comments or request any additional information please contact:


**ESIA PUBLIC CONSULTATION OFFICE (West Africa)**
Ms Alet Fell
*Golder Associates (Ghana) Ltd*
KEK Insurance Building, 41-41 Senchi Street,
Airport Residential, Accra, Ghana
*Tel: +233 (0)302 779 124*
*e-mail: afell@golder.com*

**LOCAL CONTACTS OFFICE**
Mr Stephen Dorbor
*Bea Mountain Mining Corporation/African Aura Mining, Mano House, Cnr. 18th Street & Tubman Boulevard, Sinkor, Monrovia, Liberia*
*Tel: +231 (0)652 0876 or +231 (0) 647 7007*
*e-mail: stephen.dorbor@african-aura.com*


### Your comment is important

**Your comment on any aspect of the proposed project, ESIA and public consultation process will assist the ESIA team and help the authorities make an informed decision about the project.**

All ESIA documents will also be available on the **www.golder.com/public** website.

BACKGROUND INFORMATION

A world of capabilities delivered locally

September 2010

# INVITATION TO COMMENT

# ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR BEA MOUNTAIN MINING CORPORATION'S PROPOSED NEW LIBERTY GOLD MINE, LIBERIA

# BACKGROUND INFORMATION DOCUMENT

***Due date for comment: Friday 15 October 2010***

african aura mining inc

Golder Associates

## INTRODUCTION

The purpose of this Background Information Document is to provide stakeholders with information and an opportunity to comment on the Environmental and Social Impact Assessment (ESIA) for Bea Mountain Mining Corporation's proposed New Liberty Gold Mine (NLGM) Project in Liberia, West Africa.

According to Section 37 of the Environment Protection Agency Act of Liberia, Bea Mountain Mining Corporation (BMMC) is required to undertake an ESIA for the proposed project. Based on the findings of the ESIA, the Environmental Protection Agency (EPA) will make a decision on whether the project may go ahead or not. The ESIA will be undertaken to meet Liberian legislative requirements, as well as international standards and guidelines like the Equator Principles and IFC Performance Standards.

BMMC has appointed an independent consulting company, Golder Associates (Ghana) Ltd, based in Accra, Ghana, to undertake the ESIA, with assistance provided by local Liberian consultants.

## BACKGROUND

BMMC, a company registered in Liberia, is a wholly owned subsidiary of African Aura Mining Inc. (AAM), which is a gold and iron ore development company with projects in a number of countries in West Africa, for example, Liberia and Cameroon. AAM was established in 2009. In Liberia, BMMC hold a Class A mining license issued by the Liberian Ministry of Land, Mines and Energy to mine the NLGM deposit for a period of 25 years. New Liberty is one of a series of gold deposits located within BMMC's 457 square kilometer mining license area.

## PROJECT DESCRIPTION

The NLGM Project involves the development of an opencast gold mine, that is, where the gold is mined from the surface and there are no underground operations.

The proposed project is currently in the exploration stage, which means that BMMC is trying to find out the location and quality of the gold ore, and whether the project is feasible.

The following main components of the proposed mining operation will be considered in the ESIA:
- Opencast mine pits, illustrated in the Figure 2 photograph
- A waste rock dump
- Access roads
- An ore processing plant , where the gold will be extracted from the rock
- A tailings storage facility for storing waste material from the ore processing plant
- Electricity infrastructure
- A staff accommodation camp
- Water supply dams and infrastructure
- Maintenance facilities, offices, a laboratory and stores.

## Project Location

The project is located in the Grand Cape Mount County of Liberia, about 100 km north-west of the capital, Monrovia (See Figure 1). Sinje is a large town located to the south of the project area and villages in the vicinity of the proposed mine site include Kinjor, Larjor and Jawajei.

Current land use activities in the area include mainly subsistence farming, logging of timber and artisanal gold mining.


FIGURE 1: MAP OF LIBERIA SHOWING THE LOCATION OF THE NLGM SITE

## SCHEDULING

If the project goes ahead, BMMC hopes to start construction of the mine in the second half of 2011. Construction will last twelve to eighteen months and the estimated life of the mine will be seven to eight years.

## EMPLOYMENT

During the construction and operational phase of the project, employment opportunities will be created for local people. As the ESIA process is undertaken, stakeholders will be provided with more information on employment.

FIGURE 2: AN EXAMPLE OF WHAT AN OPENCAST MINE PIT COULD LOOK LIKE

## THE ESIA PROCESS

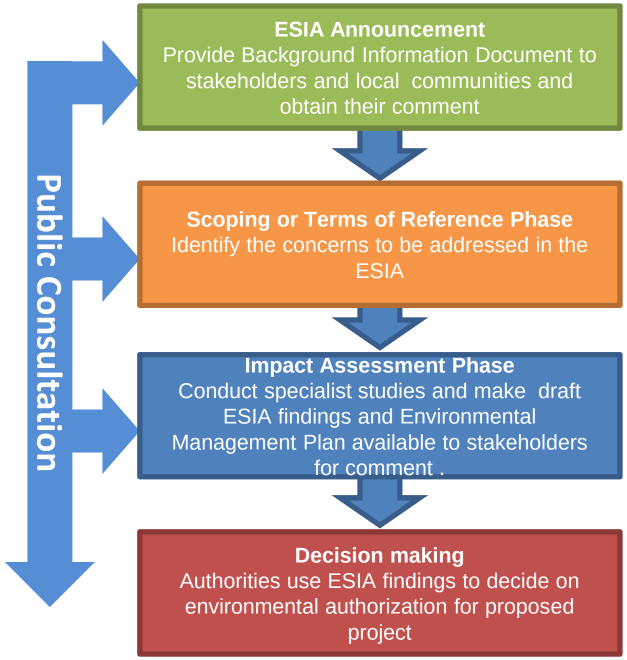
An ESIA evaluates the potential positive and negative impacts of a project and develops measures to reduce the negative impacts and enhance the positive impacts. During the ESIA, various specialist studies will be done to identify and assess potential impacts on the environment , from a biophysical and social perspective.

In line with Liberian legislation the ESIA process will consist of the following two phases:

- **Scoping/Terms of Reference (ToR) Phase** – this phase develops the framework and proposed methodology for the assessment of environmental and social impacts. The Scoping or ToR phase includes a presentation of the project description, proposed ESIA process, the public consultation process, and provides an opportunity to identify concerns to be addressed in the ESIA.

- **Impact Assessment Phase**–detailed specialist studies will be undertaken to assess potential positive and negative impacts. A Draft ESIA report, containing the findings of the specialist studies will be made available to stakeholders for comment. The ESIA is then finalized and submitted to the Liberian Government for a decision on the ESIA (the decision making phase).

The proposed ESIA will be completed within about 10 months (by about June 2011). The figure below presents an overview of the ESIA process.



09 September 2010

**Golder Associates (Ghana) Ltd**
**ESIA Public Consultation Office (West Africa)**
Alet Fell
KEK Insurance Building, 41-41 Senchi Street
Airport Residential, Accra, Ghana
**Tel** +233 302 779 124/9910
+233 24 958 0716
**Email** afell@golder.com

**Or**
**Local Contact**
Stephen Dorbor, In-Country Project Contact
**Tel** 231 652 0876 or 231 647 7007
**Email** stephen.dorbor@african-aura.com

Dear Sir / Madam

**INVITATION TO COMMENT ON THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR BEA MOUNTAIN MINING CORPORATION'S PROPOSED NEW LIBERTY GOLD MINE, LIBERIA**

Bea Mountain Mining Corporation (BMMC) is proposing to construct an opencast gold mine at its New Liberty Gold Mine (NLGM) site in the Grand Cape Mount County of Liberia. According to Section 37 of the Environment Protection Agency Act of Liberia, BMMC is required to undertake an environmental and social impact assessment (ESIA) for the proposed project.

The proposed project will have the following components: opencast mine pits, waste rock dumps, access roads, an ore processing plant, tailings storage facility, electricity infrastructure, staff accommodation camp, water supply dams and infrastructure and maintenance facilities, offices, a laboratory and stores.

The NLGM ESIA will be undertaken by Golder Associates (Ghana) Ltd, based in Accra, Ghana. The enclosed Background Information Document (BID) provides more information on the proposed project and the ESIA process, and your comments are invited. Due date to submit comments for the BID is **Friday 15 October, 2010.**

**How to comment?**

- Complete the comment sheet enclosed
- Write a letter, email, fax or telephone the ESIA public consultation office
- Telephone your local contact
- Attend a public open house meeting at a later date in the ESIA process

If you wish to participate in this ESIA and to receive further information as the ESIA progresses, please complete the enclosed Comment and Registration Sheet and return it to the Public Consultation Office by the **15th October 2010.**

**Your participation would be appreciated**

Please call me at Tel: +233 302 779 124/910 or email: afell@golder.com should you require any further information at this stage. We look forward to your participation in the NLGM ESIA process.

Sincerely

AFell

Alet Fell
Golder Associates (Ghana) Ltd

| **INVITATION TO COMMENT ON THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR BEA MOUNTAIN MINING CORPORATION'S PROPOSED NEW LIBERTY GOLD MINE, LIBERIA**<br><br>**COMMENT SHEET**<br><br>**Accompanying Background Information Document, September 2010** | **Golder Associates (Ghana) Ltd**<br>**ESIA Public Consultation Office and return address for comment**<br>Alet Fell<br>KEK Insurance Building, 41-41 Senchi Street<br>Airport Residential, Accra, Ghana<br>**Tel** +233 302 779 124<br>+233 24 958 0716<br>**Email** afell@golder.com<br><br>**Or**<br><br>**Local Contacts Office**<br>Stephen Dorbor, BMMC In-Country Project Contact<br>**Tel** +231 652 0876 or 2+31 647 7007<br>**Email** stephen.dorbor@african-aura.com |
|---|---|

***Please complete by Friday, 15 October 2010, and return to the ESIA Public Consultation Office or local Bea Mountain Mining Corporation (BMMC) contact.***

| | | | |
|---|---|---|---|
| **TITLE** | | **FIRST NAME** | |
| **TOWN / VILLAGE** | | **SURNAME** | |
| **ORGANIZATION** | | | |
| **If available, POSTAL ADDRESS** | | | |
| | | **If available, POSTAL CODE** | |
| | | **TELEPHONE** | |
| **EMAIL** | | **FAX** | |

**COMMENTS** (please use separate sheets if you wish)

I suggest that the following issues of concern/suggestions be investigated in the ESIA process:

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My comment on the ESIA process and / or public consultation process is:

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Other comments:

……………………………………………………………………………………………………………………
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Please add the following of my colleagues/friends to the mailing list for this ESIA process:

……………………………………………………………………………………………………………………
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Signature……………………………………………………… Date…………………………………………………………

**THANK YOU FOR YOUR CONTRIBUTION**

# APPENDIX H

## Distribution of Announcement Documents

# ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR BEA MOUNTAIN MINING CORPORATION'S PROPOSED NEW LIBERTY GOLD MINE, LIBERIA

**Background Information Document, Announcement Letter and Comment Sheet distribution in English at Public Meetings and Focus Group Meetings – September 2010**

| Place | Organisation | Number of BIDs distributed | Number of announcement letters distributed | Number of comment sheets distributed |
|---|---|---|---|---|
| Offices of the Ministry of Lands, Mines and Energy, Monrovia | Ministry of Lands, Mines and Energy, Liberia | 20 | 20 | 20 |
| Offices of the Forestry Development Authority, Monrovia | Forestry Development Authority, Liberia | 30 | 30 | 30 |
| EarthCons Offices, Monrovia | EarthCons Environmental Consulting | 5 | 5 | 5 |
| Ministry of Internal Affairs, Monrovia | Ministry of Internal Affairs (Superintendent of Cape Mount County), Liberia | 10 | 10 | 10 |
| Mecca Village, Grand Cape Mount County, Liberia | Community Public Meeting | 30 | 30 | 30 |
| Kinjor Village, Grand Cape Mount County, Liberia | Community Public Meeting | 30 | 30 | 30 |
| Jawajei Village, Grand Cape Mount County, Liberia | Community Public Meeting | 30 | 30 | 30 |
| Radio Cape Mount 102.4 | Radio Cape Mount 102.4 | 20 | 20 | 20 |
| Offices of the Environmental Protection Agency, Monrovia | Environmental Protection Agency (EPA), Liberia | 15 | 15 | 15 |

# APPENDIX I

## Limitations of this Document

# DOCUMENT LIMITATIONS

This Document has been provided by Golder Associates Africa Pty Ltd ("Golder") subject to the following limitations:

i) This Document has been prepared for the particular purpose outlined in Golder's proposal and no responsibility is accepted for the use of this Document, in whole or in part, in other contexts or for any other purpose.

ii) The scope and the period of Golder's Services are as described in Golder's proposal, and are subject to restrictions and limitations. Golder did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Document. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Golder in regards to it.

iii) Conditions may exist which were undetectable given the limited nature of the enquiry Golder was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required.

iv) In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. Golder's opinions are based upon information that existed at the time of the production of the Document. It is understood that the Services provided allowed Golder to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

v) Any assessments made in this Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Document.

vi) Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Golder for incomplete or inaccurate data supplied by others.

vii) The Client acknowledges that Golder may have retained sub-consultants affiliated with Golder to provide Services for the benefit of Golder. Golder will be fully responsible to the Client for the Services and work done by all of its sub-consultants and subcontractors. The Client agrees that it will only assert claims against and seek to recover losses, damages or other liabilities from Golder and not Golder's affiliated companies. To the maximum extent allowed by law, the Client acknowledges and agrees it will not have any legal recourse, and waives any expense, loss, claim, demand, or cause of action, against Golder's affiliated companies, and their employees, officers and directors.

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**GOLDER ASSOCIATES AFRICA (PTY) LTD**

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.


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