

4.0 ASSESSMENT OF IMPACTS

Potential impacts and issues associated with the proposed Project were determined from two primary sources:

- Terms of Reference derived through Public Stakeholder Consultation – includes issues and/or concerns that were presented by various stakeholders during a Public Scoping meeting held in November 2004 and further supplemented by many public consultation efforts expended by the Company since that time (see **Section 9.0, Consultations**).
- Consultations with Institutional Stakeholders – includes the outcomes from a series of contacts made by the Company with various relevant institutions.

The issues and concerns brought forward through these consultative efforts are considered along with the technical evaluations of impacts presented herein. Other issues beyond those expressed by the public and institutional stakeholders have been identified by the Company through its evaluation of impacts associated with the Project. This comprehensive assessment of impacts was completed to evaluate stakeholder-generated issues and concerns, satisfy statutory requirements of the Ghanaian government as well as comply with internal Company guidelines (see **Annex A-3**).

The issues and potential impacts identified through this process are generally categorized as those related to the biological, physical and human environments. Discussions and analyses of impacts provided herein follow this general theme.

4.1 IMPACTS AND ISSUES IDENTIFIED THROUGH CONSULTATIONS

As described above, identification of potential impacts and issues associated with the Project were determined through consultations with public stakeholders and government officials within various Ghanaian agencies. Brief discussions of the findings from these consultations are described below.

4.1.1 PUBLIC STAKEHOLDER SOURCES

A Public Scoping Meeting was held at Yayaaso in November 2004 to solicit input from stakeholders regarding potential issues and concerns regarding the proposed Project. Approximately 200 individuals attended that meeting to provide input to the Scoping process of the proposed Project. Prior to that event and since that time, the Company has held a series of meetings and consulted a host of groups and organisations to continue the process of soliciting and addressing concerns and potential issues from the public stakeholders. These meetings have been held with various advisory committees, communities, households, focus groups, chiefs and elders, chief farmers and international, national and local environmental, human rights, non-governmental and media organisations.

A detailed accounting of the Scoping Meeting and the various stakeholder consultations made by the Company (as well as outcomes) is included in **Section 9.0 (Consultations)**. GRRL (2004) presents the Terms of Reference that was the outcome of the Scoping process for the Project. The key issues identified during these processes include:

Biological Environment

- Loss of ecological habitat (including Forest Reserve) and increased pressure on remaining fauna,
- Protection of endangered species,
- Loss of integrity of Forest Reserve,
- Creation of a pit lake and
- Creation of wetlands.

Physical Environment

- Deterioration of air quality from increased dust levels,
- Contamination of surface and/or groundwater resources,
- Soil erosion,
- Creation of a pit lake and
- Creation of wetlands.

Human Environment

- Loss of farm holdings,
- Loss of agricultural land and lifestyles,
- Compensation process and procedures,
- Resettlement of Yayaaso, eight hamlets, and farmsteads,
- Increased noise levels,
- Increased vibrations from blasting that could damage structures,
- Disruption of socio-economic conditions,
- Respect for Traditional Authorities and traditional ways of life,
- Clear and transparent communication,
- Positive/beneficial socio-economic impacts such as increased employment, tax and improved infrastructure and
- Success of reclamation with a view to future generations.

4.1.2 GOVERNMENTAL INSTITUTION SOURCES

A number of governmental entities have been consulted between 2003 and 2008 to solicit their views regarding potential impacts and issues associated with the Project. An accounting of these consultative efforts (including outcomes) is included in **Section 9.0 (Consultations)** of this document. The following governmental organisations were contacted during the course of these consultations:

- Environmental Protection Agency,
- Ministry of Lands, Forestry and Mines,
- Ministry of Local Government, Rural Development and Environment,

- Ministry of Education / Ghana Education Service,
- Lands Commission,
- Forest Services Division,
- Land Valuation Board and
- Regional and local officials and agencies (Birim North District Assembly).

Within the last eight months, the Company has met with a number of government agencies and commissions (as well as Conservation International and Ghana Wildlife Society) to solicit their current concerns, issues and recommendations regarding the Project. These groups include:

- Forest Services Division,
- Wildlife Division,
- Inspectorate Division of Minerals Commission,
- Eastern Regional Coordinating Council,
- Water Resources Commission,
- Hydrological Services Department,
- Fisheries Department,
- Irrigation Development Authority,
- Ghana Highways Authority and
- Ghana Meteorological Agency.

Key issues and concerns expressed by these institutional sources include:

Biological Environment

- Impacts to forest habitat,
- Plans for timber removal and replacement and
- Effects on wetlands in the proposed Tailings Storage Facility area.

Physical Environment

- Impacts to water quality and quantity.

Human Environment

- Dust and noise pollution from blasting and transport activities,
- Impacts of the open mine pit on area residents,
- Long-term public safety implications and
- Safety of individuals on road rerouted around waste rock disposal facilities.

4.2 ANALYSIS OF ISSUES AND IMPACTS

In this section, issues and potential impacts identified above are evaluated to assess the direct, indirect and cumulative impacts to the environment resulting from the planned implementation of the Project.

The analysis of impacts is presented to both address particular issues expressed within the three broad categories of issues raised by stakeholders as well as those identified by the Company. Where appropriate, more detailed analyses and discussions of the impacts are presented in **Annex D** to this document which support the general conclusions presented below.

4.2.1 BIOLOGICAL ENVIRONMENT

Potential impacts of the proposed Project on the biological environment are discussed herein, including flora, fauna, wetlands and aquatic resources. These discussions further describe the following issues identified by public and institutional stakeholders listed above as well as others identified by the Company:

- Loss of ecological habitat (including Forest Reserve) and increased pressure on remaining fauna,
- Protection of endangered species,
- Loss of integrity of Forest Reserve,
- Plans for timber removal and replacement and
- Impacts to forest habitat.

FLORA

The southern end of the Ajenjua Bepo Forest Reserve, established by the Forest Services Division to manage timber resources on forest reserves in Ghana, would be impacted through development of the mine pit. As indicated in **Section 2.0** (*Project Description*), approximately 74 hectares of the proposed mine pit would be located in the Ajenjua Bepo Forest Reserve, which constitutes approximately 13 percent of the total area of the Reserve.

Construction of the mine, processing plant, waste rock and tailings disposal areas and ancillary facilities would remove crops, fallow fields and patches of secondary forest. The open pit high wall would remain devoid of vegetation and deeper parts of the pit would fill with water.

From the baseline data presented in **Section 3.0** (*Existing Environment*), seven species of conservation concern occurring within the Proposed Mining Area that would be affected include *Awiefosamina* (*Albizia ferruginea*), *Edinam* (*Entandrophragma angolese*), *Penkwa* (*E. cylindricum*), *Kusia* (*Nauclea diderrichii*), *Danta* (*Nesogordonia papaverifera*), *Keyereye* (*Pterygota macrocarpa*) and *Emire* (*Terminalia ivorensis*). These are all relatively common species but because of intensive commercial timber harvesting, these species have conservation status as Scarlet Star species (Ghana Forest Classification) and “Vulnerable” (International Union of Conservation of Nature, IUCN). One Gold Star tree species found outside of the Ajenjua Bepo Forest Reserve (*Kwaebrofre*, *Cussonia bancoensis*) would be affected, but this species is widespread and re-establishes on disturbed sites (Hawthorne 1995).

Several indirect impacts would also result through implementation of the Project. Removal of vegetation from mine-related development and ancillary facilities would have indirect impacts on vegetation locally as a result of increased human population density and

associated demands for crop production. This phenomenon is already occurring within the Study Area but would likely be intensified through development of the Project. With removal of land from production and resettlement of affected villages to adjacent areas, local population densities would increase. With construction and operation of the mine, more people would come to the area seeking jobs. Site-specific and local reductions in crop land from mine-related development would increase demand for unaffected land outside of the mine disturbance area for crop production, charcoal and other natural amenities derived from plant communities.

With increased local demand for production of food and cash crops, fallow cycles would likely shorten, reducing the productivity of land over the long term. Impacts associated with reduced amounts of arable land and increased demands for arable land as well as reduced agricultural productivity could result in long-duration impacts, experienced locally. With a decreased agricultural base as a result of the proposed Project, increased trespass on adjacent forest reserves to obtain forest products and to cultivate land for crop production could occur.

Cumulative impacts on flora would result from the proposed Project and ongoing or reasonably foreseeable future activities in the region surrounding the Proposed Mining Area. Native vegetation in forest reserves would experience cumulative impacts from ongoing legal and illegal mining, development of agricultural land in forest reserves and illegal logging in forest reserves. Planting of non-native trees would reduce the diversity of the native flora. With increased human activities that disrupt soil and vegetation, there would be increased potential for invasive weeds to become dominant and displace less aggressive native species. Construction of electrical transmission lines would result in the loss of trees within and near the corridor for these facilities.

Further discussion of these and other impacts associated with flora in the Study Area is presented in **Annex D-I**.

FAUNA

Construction of the mine and ancillary facilities would remove a portion of wildlife habitat in the Ajenjua Bepo Forest Reserve and from land that has been modified by agricultural activities outside of the forest reserve. Species with strong affinities for forest habitat (i.e., “obligate forest species”) would be directly affected by removal of vegetation in the portion of the Ajenjua Bepo Forest Reserve proposed for the mine pit; whereas species occupying habitat modified by human activities (“habitat generalists”) would be directly affected by construction of mine facilities outside of the forest reserve.

Indirect impacts on obligate forest species could result from possible increased bush meat hunting in adjacent forest reserves and alteration of habitat in forest reserves for farming. Species of conservation concern (IUCN Red List) that would have potential to be directly affected by the proposed Project and alternatives are Pel’s flying squirrel (*otra*), Maxwell’s duiker (*Otwe*), black duiker (*Oyuo*), royal antelope (*Adowa*) and Zenker’s fruit bat (*Apan*). Species protected by Schedule I of the Ghana Wildlife Regulations that would have potential to be affected include all of the hoofed animals (e.g., duikers), primates (e.g., monkeys and pottos) and raptors (hawks, owls, eagle and vultures). Protected wildlife species that could

be affected by the proposed Project have been recorded in the Ajenjua Bepo Forest Reserve and outside of the Ajenjua Bepo Forest Reserve including the Mamang River Forest Reserve.

The Project would result in a net decrease in wildlife habitat within the Ajenjua Bepo Forest Reserve because a portion of the mine pit area would not be reclaimed to the type of wildlife habitat that existed prior to mine development; water that ponds in the remaining open pit after closure could support other types of wildlife (fisheries and aquatics).

Annex D-2 includes more detailed discussion of impacts on fauna in the Study Area.

WETLANDS

None of the wetlands identified within the Study Area that could be affected by the Project have been determined to have high ecological functions and values, warranting conservation priority. Construction of mine facilities (including the open pit, plant and administration area, Water Storage Facility, Tailings Storage Facility, Waste Rock Disposal Facility and Sediment Control Structures) in seasonally flowing drainages would remove associated wetlands in those drainages but would yield negligible impacts. The proposed Project would affect less than one hectare of wetlands.

A more detailed discussion of the direct, indirect and cumulative impacts on wetlands in the Study Area is included in **Annex D-3**.

AQUATIC RESOURCES

Construction of a tailings impoundment, Waste Rock Disposal Facility and water storage dam in ephemeral or seasonal drainages would not measurably affect fish and aquatic invertebrates associated with perennial streams in the Study Area (including the Pra and Mamang rivers). Construction of these facilities would affect faunal communities present in the ephemeral drainages these structures would occupy. Re-establishment of the natural drainage around or through the mine facilities in the affected ephemeral drainages during operations and closure would support some species of aquatic resources during periods when flow normally occurs.

Construction of the Water Storage Facility, while blocking migration below the dam, would transform limited flowing water habitat into a temporary lake environment. Many of the species found in the Study Area streams would be able to adapt to these changes in this new habitat. Habitat created through construction of this lake would exceed the area of habitat lost through development of the tailings and waste rock disposal facilities. The net effect of facility development, therefore, may be an increase in fish and aquatic invertebrate production. Likewise, the open pit lake remaining after mining would fill and would also likely result in habitat that could support fish and other aquatic organisms.

An amount of water, governed by an abstraction permit to be issued by the Water Resources Commission, would be pumped from the Pra River to the Water Storage Facility during the wet seasons (late-March to late-July, and late-September to mid-November) and routed to the processing plant for subsequent use in the mill and for other uses. Because of

the timing of when the abstraction would occur (high flow conditions), the impact of pumping would not be expected to directly affect fish and other aquatic organisms by reducing water volumes to stressful levels. Overall impacts to fish and aquatic organisms would be minimal with implementation of the proposed Project.

Further discussion of direct, indirect and cumulative impacts on aquatic resources from development of the Project is included in **Annex D-4**.

4.2.2 PHYSICAL ENVIRONMENT

Potential impacts to the physical environment in the Study Area as a result of implementation of the proposed Project are discussed in this section. These include potential impacts to air quality, geology and minerals, water resources and soil. Discussion presented below focused on the issues brought forward by stakeholder groups, described above, to address the following issues and concerns:

- Deterioration of air quality from increased dust levels,
- Contamination of surface and/or groundwater resources,
- Soil erosion, compaction and loss of fertility and
- Impacts on water quantity.

AIR QUALITY

Initial ambient air quality measurements made in the Study Area indicate that air quality in the Project Area meets relevant standards (EPA, WHO, EU, World Bank, USEPA), with the exception of increased dust periods (such as during the “Harmattan” period). Air modelling completed for the site indicates that if left unchecked, fugitive dust sources from the proposed Project could exceed 600 tonnes annually, with the primary contributing mechanisms being wind erosion of exposed areas and entrainment of dust associated with mining activities including pit development, waste rock disposal and placement of ore on the run-of-mine pad. This amount would be added to the ambient conditions present in the Study Area.

Air modelling was also completed to analyze emissions and particulate emanating from the Proposed Mining Area using the Industrial Source Complex Short Term Version 3 (ISCST3) model. Results of this modelling indicated concentrations in excess of the ambient air quality standards for both 24-hour and annual averages are apparent for areas immediately surrounding the Proposed Mining Area. For 24-hour values, PM_{10} concentrations in excess of 250 micrograms per cubic metre were predicted to occur mainly along the haul road corridors. PM_{10} concentrations were also predicted to exceed guidelines and standards near the primary mine facilities (i.e. open pit, waste rock disposal facilities and plant area). The annual average PM_{10} concentrations predicted for Afosu, New Abirem, Ahausena and other communities in the Study Area do not exceed the EPA guidelines. **Figures D5-1 and D5-2, (Annex D-5)** illustrate the results of this modelling effort. The primary sources of dust used as input to the model were truck travel on un-sealed roads, dumping rock at the Waste Rock Disposal Facility and handling ore at the primary crusher site near the processing plant.

Dust can settle on the leaves of vegetation and can interrupt or reduce photosynthesis, respiration, transpiration and allow penetration of phytotoxic gaseous pollutants in plants. These effects can lead to reduction in growth of the plant which decreases productivity and increases the vulnerability of the plant to insect or bacteriological invasion.

Gaseous emission sources associated with the proposed Project include vehicle and equipment exhaust (SO_x, NO_x, and CO) and emissions associated with operation of the gold room and onsite laboratory facility. Emissions of these gases can cause respiratory problems in humans and animals if the dosage and exposure exceed limits established by various tests and adopted by governmental institutions.

From a cumulative impact standpoint, the nature of air quality impacts from mining operations is localized, especially when dust suppression measures are put in place and made effective. As a result, even in areas where multiple mining activities occur within a limited area, air quality impacts of each individual mine typically do not overlap. The primary reason for this is that the principal air pollutant of concern for mining operations is fugitive dust. The relative size and density of fugitive dust particles are greater than the regional air quality particles. Large particle size and density leads to more rapid deposition of the suspended particles. As a result, most mining fugitive dust impacts are greatest in the immediate vicinity of each mining area and diminish rapidly with distance from the source (mine site). Because of this, no cumulative impacts to air quality from the proposed Project are expected.

Annex D-5 includes further discussion on impacts to air quality associated with the Project.

GEOLOGY AND MINERALS

Approximately 396 million metric tonnes of waste rock and 116 million metric tonnes of ore would be removed from the mine pit associated with the Project over a 15-year mine life. Available whole-rock data indicate that levels of some trace elements (i.e. arsenic, barium, cadmium, cobalt, lead, antimony, selenium, sulphur, tin, chromium and thallium) from metavolcanic and metasedimentary units of Birimian Age are present in excess of published estimates of average crustal abundance for that element which is consistent with characteristics of mineralized zones. While whole-rock concentrations for certain elements above those found in average crustal rocks do not necessarily guarantee that constituents would be released to the environment, some trace metals could be released to water in concentrations exceeding water quality standards.

Acid-base accounting analyses of Phase I (207 individual) and Phase II (16 composite) rock samples, obtained from multiple intervals in several boreholes within the Akyem deposit, as well as two composite tailings samples, indicate that sufficient neutralization capacity exists to prevent acid generation in the Waste Rock Disposal Facility, the Tailings Storage Facility and open pit area (pit lake).

Phase II specialized geochemical testing of Project waste rock using the Synthetic Precipitation Leaching Potential (SPLP) procedure provided information about the potential for leaching of trace metals by rain water. SPLP data show that there may be potential for concentrations of the following trace metals to slightly exceed regulatory standards,

especially early in the weathering process: antimony, arsenic, beryllium, cadmium, lead, mercury, manganese, molybdenum, nickel, selenium and thallium. These tests do not account for possible sequestration of trace metals by minerals that may form during weathering and thus the results may not predict actual conditions.

As a means of comparison, the Company encountered a similar suite of trace metals in rock tested at the Ahafo Project. Kinetic testing results from Ahafo input into a geochemical equilibrium model predicted antimony, manganese and sulphate (one pit only) would be present at concentrations slightly above Ghanaian drinking water standards (Geomatrix 2007a and 2007b). All other constituents were predicted to be present at concentrations below Ghanaian drinking water standards. Given the similarity in rock assemblages between the two sites, it is expected that kinetic testing of rocks associated with the Akyem Gold Mining Project, combined with geochemical modelling, would yield similar results.

Although current evidence indicates that sufficient neutralization capacity exists to prevent acid generation and it is unlikely that trace elements would be released in quantities that would exceed standards (see **Annex C-3 – Geology and Geochemistry Supplemental Information**), the Company is conducting further rock characterization tests as part of the environmental monitoring programme to confirm preliminary results (see **Section 6.0, Monitoring**). In addition, the Company is completing more detailed geochemical characterization of geologic materials, including kinetic testing and meteoric water mobility testing to expand the knowledge base that has been developed.

Annex D-6 includes more detailed discussions about potential impacts on the geology and minerals associated with the Project.

WATER RESOURCES

The Project would result in changes to surface water and groundwater quality and quantity. Changes in topography resulting from mining activities (open pit and Waste Rock Disposal Facilities) and construction of the Tailings Storage Facility, water storage dam, plant site and other associated project facilities would progressively modify watershed characteristics of some small, seasonal tributaries of the Mamang River. These modifications would include excavation of a portion of the drainage basin, filling of a portion of the drainage basins and diverting and redirecting flow upgradient of the mine facility to receiving channels located below the constructed areas. These modifications would remove streambeds and streambanks, eliminate the stream channel in portions of the site, and lengthen the flow path for existing flow to circumvent the mine site. Overland runoff volume and peak flow could be higher as a result of vegetation removal for land development. Tributary drainages that contain the proposed Project facilities are ephemeral and contain water seasonally during the rainy season.

Groundwater resources in the area may also be affected through open pit dewatering and possibly through infiltration of water through the Tailings Storage Facility and Waste Rock Disposal Facility. These potential impacts are discussed below.

Surface Water

The pump station planned for the Pra River would be constructed along the river bank and would not require damming or modifying the course of the river. The water transmission line would extend approximately 8.5 kilometres from the river to the Project's Water Storage Facility, crossing some minor tributaries of the Pra and Mamang rivers.

Potential impacts to surface water quality from mine-related facilities could result from direct disturbance to the land (increased erosion and sedimentation), exposure of rock and mineral surfaces to weathering and leaching and accidental spills of chemicals and petroleum products used for mine processing activities. During implementation of the Project, particularly the construction phase, land disturbance in tributary drainages to the Mamang River could result in some increased erosion and sedimentation. Sediment control structures and other best management practices (i.e., erosion control and retention features) would be implemented to reduce such impacts to Project area streams.

Acid-base accounting analyses of rock samples from the Akyem deposit, as well as two composite tailings samples, indicate sufficient neutralization capacity exists to prevent acid generation in the Waste Rock Disposal Facility, Tailings Storage Facility and pit lake. Limited static test data, including synthetic precipitation leaching potential (SPLP), show potential that concentrations of some trace metals may exceed regulatory standards during initial exposure of waste rock to oxygen and rainfall. In waste rock storage or pit lake facilities, the initial relatively high concentrations of trace metals predicted usually decrease markedly over time and stabilize at concentrations below standards. Kinetic testing of waste rock, currently being conducted by the Company, will provide additional data to refine predictions of the potential for leaching of trace metals as a result of exposure of waste rock to the environment.

Release of these trace metals to surface water at concentrations in excess of water quality standards could affect the use of surface water in supporting aquatic life and as a drinking water source. Excessive long-term exposure to certain metals can cause harmful effects in humans including development of dietary problems, reduction in metabolism, effects on brain function, lesions of the lung, cardiovascular effects, gastrointestinal effects, effects on the liver, neurological effects and for some analytes, cancer (HDR 2000).

Water quality associated with the proposed Project can be affected by the concentration of total dissolved solids (TDS). TDS comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulfates) and some small amounts of organic matter that are dissolved in water. Projected concentrations of TDS are not expected to affect existing water uses. The kinetic testing currently underway will also provide data that will enable prediction of TDS values in surface water runoff from the mine facilities.

Groundwater

Groundwater quantity, including flow from some springs/seeps, could be affected by removal of groundwater via pumping wells for mine potable supply and open pit dewatering. Groundwater drawdown from such dewatering also would occur in the vicinity of the open pit, potentially affecting nearby village wells, depending on well completion depth and

aquifer(s) intercepted. In areas where groundwater is interconnected with surface water, groundwater drawdown could decrease flow. The magnitude and extent of groundwater drawdown is being further evaluated through installation and testing of additional monitoring wells in the open pit area to better define hydraulic characteristics of the area's groundwater systems.

Open pit dewatering would occur for a period of about 15 years, after which the lowered groundwater levels would begin to recover. It would likely take approximately 200 years for the groundwater levels to approach pre-mine conditions (Golder 2006). This prediction of recovery time of the groundwater system would be further evaluated after completion and testing of additional wells in the proposed open pit area.

After cessation of mining and dewatering, a pit lake would develop in the portion of the open pit not filled with waste rock, with the water level eventually approaching pre-mine groundwater elevations. The pit lake surface would be about 10 metres below ground surface over much of the proposed open pit area. This would result in a final pit lake depth of over 400 metres under full build-out of the mine. Groundwater modelling completed for the Ahafo project (Geomatrix 2007e) suggests that a similar time period would be required for water level recovery in those mine pits following cessation of mining. The expected quality of water that would develop in the pit lake is discussed in **Annex D-6** and **Annex D-7**.

As described under *Surface Water* above, limited static test data, including synthetic precipitation leaching potential (SPLP), show potential that concentrations of some trace metals may exceed regulatory standards during initial exposure of pit rock to oxygen and rainfall. In pit lakes, these initial relatively higher metals concentrations usually decrease substantially over time and stabilize at concentrations below standards. Kinetic testing, currently underway, will provide data which can be used to better predict the potential for leaching of trace metals as a result of mining operations.

Potential effects on humans from long-term exposure to these metals (if present at concentrations exceeded standards) are described under the *Surface Water* section above. The pathway for exposure of humans to these trace elements in groundwater would be similar to surface water sources and would also include ingestion. Exposure of aquatic life to these elements in groundwater would likely be limited to conditions where groundwater is proximal to surface water.

Chemicals and Reagents

As described in **Chapter 2 – Project Description**, operation of the processing plant will require use of various chemicals and reagents to both support gold extraction and to operate equipment at the plant site. Potential impacts on humans and the environment that could result from the transportation, storage, use and disposal of these chemicals are described below:

- Quicklime, in the presence of water, can cause develop a thermal reaction that can burn skin or other surfaces it contacts (NIOSH 2008).

- Sodium cyanide dissolves in water and in the presence of circumneutral conditions, can release hydrogen cyanide gas (NIOSH 2008). At a pH of 9.3 - 9.5, cyanide (CN⁻) and hydrogen cyanide (HCN) are in equilibrium, with equal amounts of each present. At a pH of 11, over 99 percent of the cyanide remains in solution as CN⁻, while at pH 7, over 99 percent of the cyanide will exist as HCN. Initial symptoms of cyanide poisoning to humans can occur from exposure to 20 to 40 parts per million of gaseous hydrogen cyanide, and may include headache, drowsiness, vertigo, weak and rapid pulse, deep and rapid breathing, a bright-red color in the face, nausea and vomiting. Convulsions, dilated pupils, clammy skin, a weaker and more rapid pulse and slower, shallower breathing can follow these symptoms. These symptoms can occur from sublethal exposure to cyanide, but will diminish as the body detoxifies the poison and excretes it primarily as thiocyanate and 2-amino thiazoline 4-carboxylic acid, with other minor metabolites. The LD50 for ingestion is 50-200 milligrams, or 1-3 milligrams per kilogram of body weight, calculated as hydrogen cyanide. For contact with unabraded skin, the LD50 is 100 milligrams (as hydrogen cyanide) per kilogram of body weight (ICMI 2008).

Once released into the Tailings Storage Facility, the reactivity of cyanide provides numerous pathways for its degradation and attenuation including complexation, precipitation, adsorption, oxidation to cyanate, reaction of some sulphur species to form thiocyanate, volatilization and biodegradation (ICMI 2008). Fish and aquatic invertebrates are particularly sensitive to cyanide exposure. Reported oral LD50 for birds range from 0.8 milligrams per kilogram of body weight (American racing pigeon) to 11.1 milligrams per kilogram of body weight (domestic chickens). Symptoms including panting, eye blinking, salivation and lethargy appear within one-half to five minutes after ingestion in more sensitive species, and up to 10 minutes after ingestion by more resistant species (ICMI 2008). Ingestion of WAD cyanide solutions by birds may cause delayed mortality. It appears that birds may drink water containing weak acid dissociable (WAD) cyanide that is not immediately fatal, but which breaks down in the acidic conditions in the stomach and produces sufficiently high cyanide concentrations to be toxic (see **Annex B-4**).

- Caustic soda, similar to quicklime, can cause thermal reaction upon exposure to water. Such thermal reaction can cause burns or ignite flammable substances. Effects to humans from caustic soda include: irritation of eyes, skin, and mucous membrane; pneumonitis; eye and skin burns; and temporary loss of hair (NIOSH 2008).
- Hydrochloric acid in high concentrations forms acidic mists. Both the mist and the solution have a corrosive effect on human tissue, with the potential to damage respiratory organs, eyes, skin and intestines (MSDS H3883, 2008).
- Activated carbon is not known to have harmful effects when contacted by skin or respiration. This material is used in filtering air, water and other liquids to remove contaminants (NIOSH 2008).
- Flocculent (reagents used to precipitate metals in wastewater) treatment may expose workers to corrosive chemical reagents (e.g. HCL, lime, sodium hydroxide, carbonate salts, sulfide salts, etc.) used in the process. The reagents may be in

powder or liquid form, and may pose an exposure hazard through either inhalation, dermal and/or ingestion routes. These reagents may corrode piping system components. Some chemicals used in the precipitation process are hygroscopic (water absorbing), and may develop unwanted reactions in the presence of moisture (Edwards 1999).

- Hydrogen peroxide at concentrations above approximately 70 percent can give off vapor that can detonate above 70 °C (158 °F) at normal atmospheric pressure. This can then cause a boiling-liquid-expanding-vapor explosion of the remaining liquid. Hydrogen peroxide vapors can form sensitive contact explosives with hydrocarbons such as greases. Concentrated hydrogen peroxide, if spilled on clothing (or other flammable materials), will preferentially evaporate water until the concentration reaches sufficient strength, at which point the material may spontaneously ignite. Concentrated hydrogen peroxide (>50 percent) is corrosive and can cause irritation to the eyes, mucous membranes and skin (ATSDR 2002).

Post Mine Water Resources and Cumulative Impacts

After cessation of mining and processing, the Water Storage Facility, Tailings Storage Facility, Waste Rock Disposal Facility and plant site would be reclaimed by grading the sites, replacing soil and seeding/planting resulting in drainage conditions that approach pre-mine status. Should the final closure and decommissioning plan include provisions to retain the Water Storage Facility, maintenance of the infrastructure supporting the structure would be necessary to maintain its integrity.

Cumulative impacts to water resources from development of the Akyem Gold Mining Project could include potential release of trace metals (e.g., aluminum (Al), antimony (Sb), arsenic (As), beryllium (Be), cadmium (Cd), lead (Pb), mercury (Hg), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se), thallium (Tl)), total dissolved solids and suspended sediment in the water resources at levels which are not expected to exceed water quality standards. No other major land disturbing activity has been identified as occurring or proposed to occur in the drainage basins that would be affected by the Project.

Contribution of trace metal release, total dissolved solids and/or suspended sediment to water resources resulting from the Project would be additive to other sources in the watershed, including farming and agricultural practices. As such, the cumulative effects of the proposed Akyem Gold Mining Project when combined with other activities in the affected drainage basins would likely increase the load of constituents in water resources but would not cause a change in concentration from the existing condition.

Annex D-7 provides a more detailed discussion of the direct, indirect and cumulative impacts to water resources through implementation of the Project.

SOIL RESOURCES

The Project would result in impacts on soil resources throughout the Proposed Mining Area as well as resettlement areas. Potential direct impacts to the physical, chemical and biological properties of the soil resource in the Proposed Mining Area include reduced

fertility, loss of soil structure, reduced infiltration, reduced water holding capacity, increased erosion and reduced productivity relative to pre-mine conditions. Most of these impacts would occur as a result of soil handling activities including vegetation clearing and grubbing, compacting, soil salvage and stockpiling, and soil redistribution during reclamation. Additional impacts could result from combining salvaged soil from all series without segregation. The resultant blending of soil conditions may improve some soil types for agricultural uses while degrading others. Many impacts that would result from soil salvage, storage and replacement are unavoidable, although their severity and duration are subject to mitigation.

The degree and duration of soil impacts realized through implementation of the Project are largely dependant on soil handling methods employed during salvage, stockpiling and redistribution activities and the management practices employed during implementation of reclamation. Expected impacts are based on experience with soil handling operations and impacts to soil resources, an understanding of tropical soil, review of the soil resources in the Study Area as determined by survey (Geomatrix and SRI 2008) and consideration of the proposed activities associated with the Project.

Soil Salvage Depths and Volumes

Soil types in the Proposed Mining Area are characterized as having surficial materials (topsoil) that are better suited to plant growth than subsurface materials (subsoil). Relative to subsoil, the surface soil horizons have higher nutrient content, higher pH (less acidic), higher organic carbon content, and exhibit better tilth. In addition to being less suitable with regards to these properties, subsoil horizons of several soil series contain plinthite that could harden irreversibly upon drying and impede root growth. Selectively salvaging topsoil and suitable subsoil horizons and stockpiling them prior to commencement of other mining related operations would preserve many of the characteristics that make this material a suitable growth medium.

The approximate volume of soil available for salvage within the Proposed Mining Area was calculated using the average depths (centimetres) and extent of distribution (hectares) presented in Section 3.0. The evaluation of the soil survey data reveals that an average of 74 centimetres of material, including 15 centimetres of topsoil and 59 centimetres of suitable subsoil, are available for salvage within the Proposed Mining Area. Sufficient quantities of suitable plant growth materials in the Proposed Mining Area would be adequate to satisfy the closure and decommissioning reclamation requirements. Portions of the mine pit, access roads, and facilities not decommissioned would not require soil replacement, further adding to the excess of soil volume available for use in reclamation elsewhere.

While salvage depths would be series and site specific, it is not anticipated that soil from the various series would be segregated and stockpiled separately. Segregation by series would only be undertaken if necessary to preserve soil properties for selective placement in the reclaimed landscape. Topsoil and subsoil would be separately salvaged and stockpiled to the extent practicable to ensure the properties of each are maintained. Soil volumes in excess of those required to achieve post-closure reclamation quantities could be salvaged to allow for additional replacement depth in areas requiring greater cover.

Effects of Soil Handling

Soil salvage and redistribution affect soil structure. As soil is handled, peds (natural soil aggregates) are crushed and larger natural pore spaces are eliminated. After soil is redistributed, large temporary pore spaces are created. These pores do not exhibit the same interconnectivity as that found in undisturbed soil and the structure providing them is less stable. Many of the pores that occur in the short-term following redistribution would shrink as soil settles over time.

Soil compaction from compaction often occurs coincident with destruction of soil structure. Some compaction of soil would occur during grubbing and clearing activities prior to salvage and again during redistribution of topsoil. Compaction leads to an increase in bulk density, root inhibition and reduced infiltration. These impacts could lead to reduced plant productivity, increased runoff, and erosion. Further compounding this effect is the presence of low-activity clay in the soil, which is common in the Proposed Mining Area. This soil has slight capacity to shrink and swell that would otherwise act to resist and reverse compaction. Effects of compaction are further increased through reduction in organic matter content and drying at high temperatures.

Active microbes would continue to oxidize organic carbon and release nutrients into the soil even after salvage. Oxidation, combined with partial blending of topsoil with subsoil that could occur during salvage operations, would reduce the organic matter content of salvaged topsoil relative to pre-mine conditions. As the soil is replaced on the regraded surface for reclamation, the soil would again be aerated and subjected to increases in temperature that would increase the rate of biological activity and further reduce organic matter content. Establishment of plants to immobilize nutrients released during these processes would limit leaching of nutrients from the soil.

A reduction in organic matter and nutrients resulting from soil handling operations would influence other soil properties. When organic matter is depleted, soil structure weakens and crusting following rainfall or saturation could become more common. Crusts forming on the soil surface inhibit shoot sprouting and decrease infiltration rates. Decreased infiltration rates and weaker structure could also result in increased runoff and erosion. A decline in topsoil organic matter would also lead to a reduction in cation exchange capacity (the ability of the soil to retain nutrients) and exchangeable bases (nutrients) and eventually to further acidification.

Immediately following replacement, soil not protected from intense rainfall events would be subject to water erosion. Erosion potential is further exacerbated by previously described impacts to soil structure and other characteristics reducing infiltration rates. Soil replaced on steep slopes (e.g., embankments and the waste rock disposal facility) would be especially vulnerable to water erosion. Continued operation of sediment control structures and runoff collection ditches would result in capture of soil that moves from the site during the closure and decommissioning period. Soil capture in sediment collection facilities would be returned to reclamation areas.

Potential Effects of Non-Segregated Soil Salvage

Topsoil characteristics have an effect on the plant species that may be grown and the capability for agricultural production. In the pre-mine condition, suitability for agricultural production varies between soil series. In a similar manner, topsoil and subsoil of the series exhibits variable suitability for use in reclamation. As proposed, soil salvage operations would not segregate soil by series.

Effects of non-segregated salvage and resultant blending of soil would be most notable for topsoil due to the dependence on this surficial material for agricultural production. Blending moderately suitable soil with less nutrient-rich soil, combined with nutrient loss through handling, would affect the overall nutrient content of soil in reclamation. Blending soil with low coarse fragment content with high coarse fragment soil could result in a greater distribution of coarse fragments in the reclaimed area, potentially affecting suitability of the soil for certain uses. As indicated in **Section 8.0** (*Closure and Decommissioning*), the Company would evaluate topsoil replacement to arrive at a design that accounts for soil replacement that may vary according to location and soil type. The *Land Rehabilitation Plan (Annex G)* would also be refined within six months of commencement of operations and periodically updated to ensure the Company's revegetation programme goal of establishing a productive vegetative cover based on applicable land use plans and designated post-mining land uses is met.

Potential Effects of Planned Salvage and Replacement Depths

Post-mine landscapes and pre-mine soil depth conditions would likely vary resulting in slight alteration of topsoil and subsoil function. To maximise reclamation effectiveness, the rehabilitation plan would address several key areas to meet the Company's revegetation programme goals.

- Replaced waste rock in mine pits and waste rock disposal facilities: Topsoil redistributed over coarse waste rock or fractured bedrock would result in coarse fragment-dominated material nearer the surface than occurred in the pre-mine condition. Where erosion or anthropogenic influences result in removal of replaced soil, this rock could become exposed and render the soil unsuitable for cultivation. If the high coarse fragment material occurs within the rooting-zone, roots may be inhibited and plant available water may be reduced.
- Spoil materials: In areas where soil is redistributed over spoil material such as oxidized materials (e.g., saprolite) textures, rooting depths and stratification may be similar to pre-mine conditions. Comparison of pre-mine with post-mine conditions would be dependent on specific chemical and physical makeup of spoil material with rooting depth, permeability, and nutrient availability likely being the most affected properties. Where spoil material has high clay content or lateritic (including plinthite) materials, permeability may be reduced and rooting depth may be limited at the soil/spoil interface if compaction occurs during spoil grading. Soil replacement resulting in covering this material before it is allowed to dry and harden would preserve the permeability characteristics of the material.

- **Tailings Storage Facility:** The suitability of the Tailings Storage Facility to support agricultural uses or other plant growth would be dependant on the thickness of the material replaced and the texture, drainage, and chemical properties of the underlying material. If textures are sandy, these materials may allow for greater root penetration, but may be less able to hold nutrients than the pre-mine subsoil. Tailings are often saturated materials that require some drying prior to soil replacement. Such wet conditions would be comparable to the conditions in natural valley bottoms, but may occur across a larger area. Tests of tailings that would be located in the root zone would indicate whether conditions are suitable for agricultural uses and what soil amendments would be needed to address identified conditions.

Increased Agriculture Activities Outside the Proposed Mining Area

Farming operations and other agricultural activities would be relocated to nearby areas in advance of mining operations. Relocated and new agricultural operations could impact soil in areas adjacent to the Proposed Mining Area as previously uncultivated areas and fallow are cultivated and planted, use of existing cultivated areas intensifies and fallow cycles shorten. The expected impact could be similar to the current effects of agriculture on soil in the area, which include reduced nutrient and organic matter content, destruction of soil structure, increased erosion, petroplinthite formation, and acidification among others. If agricultural uses are intensified, these affects may become more severe or occur more rapidly and as a result agricultural production may not be sustainable. The magnitude and duration of possible effects cannot be estimated without determining precise conditions of available resources in the area and details of these operations.

Annex D-8 provides additional discussion of the direct, indirect and cumulative impacts to soil resources through implementation of the Project.

4.2.3 HUMAN ENVIRONMENT

Potential impacts to the human environment identified by public and government stakeholders are described herein. Specific issues or concerns identified above are further described and analyzed herein:

- Loss of farm holdings,
- Loss of agricultural land and lifestyles,
- Compensation process and procedures,
- Resettlement of Yayaaso, hamlets, and farmsteads,
- Increased noise levels,
- Increased vibrations from blasting that could damage structures,
- Disruption of socio-economic conditions,
- Respect for Traditional Authorities and traditional ways of life,
- Clear and transparent communication,
- Positive/beneficial socio-economic impacts such as increased employment, tax, and improved infrastructure,
- Success of reclamation with a view to future generations,
- Impacts of the open mine pit on area residents,
- Long-term public safety implications and
- Safety of individuals on road rerouted around waste rock disposal facilities.

In addition to these, issues and potential impacts identified by the Company are also discussed below.

LOSS OF LAND, COMPENSATION AND RESETTLEMENT

Implementation of the proposed Project would result in loss of 1,752 hectares currently used by farmers in the area for cultivation of food, cash crops and fallow; some portions of this total area are either unused or occupied by forests. Approximately 2,734 farms in the Proposed Mining Area would also be lost during mine development and operation. There are 1,331 persons (242 households) living and farming within the Proposed Mining Area (residents). An additional, 7,937 persons (1,443 households) live outside the Proposed Mining Area but have farms within the Proposed Mining Area (non-residents). The Proposed Mining Area supports 242 households on an average farm size of 0.9 hectares.

Development of the Project would necessitate physically displacing an estimated 1,331 persons from the settlement of Yayaaso, multiple hamlets and numerous scattered farmsteads who live in the Proposed Mining Area. These residents would be resettled and compensated in accordance with International Finance Corporation Performance Standard 5 (*Land Acquisition and Involuntary Resettlement*). The well-being of these individuals, households and communities would be affected by an uncertainty regarding their future, unfulfilled expectations for individual and family lifestyle improvements and alteration and/or breakdown of social bonds and support mechanisms. An additional 7,937 people would be economically displaced because their farms would be required for mine development. Other risks of resettlement include conflict, homelessness, food security, impact to host community, environmental impact and increased social pathologies.

Resettlement of residents of Yayaaso and affected hamlet residents along with re-establishing farm fields elsewhere would reduce the overall amount of available agricultural land and may increase pressure on the forest reserves as sources of agricultural land. Some relocated residents may become “settlers” on host land and may be at some disadvantage depending on the specific nature of new tenure arrangements negotiated as part of the resettlement and compensation packages.

NOISE AND VIBRATION

Noise

The level of noise generated by the proposed Project would vary during construction, operational and reclamation phases. Short-term noise levels during construction and reclamation activities are predicted to be 55 decibels (dBA) at 0.5 kilometres from the Proposed Mining Area. During the site clearance portion of the Project, the Company is proposing a threshold sound level of 55 dBA or less between 0600 and 2200 hours and 48 dBA or less between 2200 and 0600 hours as measured 0.5 kilometres from the Proposed Mining Area. It is expected all construction and reclamation activities would be completed during day-light hours.

During the operational phase of the Project, mine-related activities are expected to occur 24-hours a day. Noise levels that exceed the 48 dBA (nighttime) and 55 dBA (daytime) residential noise guidelines would not be expected to occur at dwellings greater than about 0.6 kilometres from the plant site (assuming no intervening terrain – i.e., hills or upland areas that are present between the noise source and the receptor), greater than about 1.2 kilometres from the Waste Rock Disposal Facility (assuming no intervening terrain), or greater than about 0.4 kilometres from excavation activities in the open pit.

Long-term, continuous noise levels from all mine pit activities were estimated at nearby communities at levels of 46 dBA or lower, indicating little potential for adverse noise impacts in the more populated portions of the Study Area. Blasting noise levels at locations further than 0.5 kilometres from the rim of the open pit are estimated to be 120 dBC (peak) or less. The World Health Organisation recommends persons should not be exposed to a peak sound pressure level (unweighted instantaneous level) greater than 140 dB for adults and 120 dB for children (WHO 1999).

Vibration

Effects of vibration vary depending on strength of the vibration, distance to the receptor and duration. These likely effects can include structural damage ranging from creation of or expansion of existing cracks in walls, ceilings or foundations of buildings.

Vibration induced by blasting would be minimised because controlled blasting technology would be applied. Also, all private buildings and infrastructure within 500 metres of the planned ultimate pit rim would be relocated. Although blasting noise, air over pressure, and vibration near the mine pit may be noticeable and temporarily disrupt residential activities, relocation of dwellings within 500 metres of the mine pit rim to locations farther from the pit would ensure that no health or safety issues occur.

The prediction of ground vibration levels from blasting that would be experienced in the villages surrounding the proposed mine requires information regarding the blast design, as well as the type of geological strata that exists between the pit and the villages. The most critical blast design element is the charge weight of explosives per delay. The manner in which ground vibrations travel through the geological strata are, ideally, obtained by conducting small test blasts. Blast tests have not been conducted within the Proposed Mining Area.

The best empirical data regarding blast vibration impacts in the area were collected in conjunction with development of the Company's Ahafo mine in the Brong Ahafo Region. The blast design at the two mines would be similar, as is the geology.

The nearest community to the mine pit is Afosu; portions of community are within 1,250 metres of proposed pit. This distance is similar to the distance from the Ahafo Mine Pit that project's vibration measurement location SKBMP2. Of over 70 blasts monitored at location SKBMP2, the ground vibration levels ranged from 0.0 to 2.2 millimetres per second. Two blasts produced ground vibration levels of 2.2 millimetres per second, while all others produced velocities of less than 2.0 millimetres per second. All measured levels are well below the Ghanaian standard of 5 millimetres per second.

It is unknown what vibration impact that blasting associated with proposed mine pit development would have on individual structures closer than the 1,250 metre analysis presented above.

Ground vibration levels could range up to 2.2 millimetres per second near Afosu (the nearest community to the open pit) based on studies conducted at other mining operations in Ghana. This level of vibration is below the Ghanaian standard of 5 millimetres per second. Vibration velocities due to blasting would be higher closer to the mine pit; the standard may be exceeded at certain individual residences or hamlets proximal to the open pit. Noise and vibration would, at a minimum, pose a nuisance to residents, particularly those who live closer to the proposed open pit; residents of Afosu would remain at this location and may experience nuisance vibration.

Annex D-9 includes additional discussion pertaining to noise and vibration impacts associated with the Project.

ACCESS AND TRANSPORTATION

Traffic and congestion on local roads would increase as Project development progresses. The condition of existing roads would likely deteriorate with increased amounts of traffic from Project development. Some trucks would be transporting reagents required for operation of the processing plant including sodium cyanide, lime, caustic, hydrochloric acid, activated carbon and flocculent. Spills or incorrect use of such reagents could result in injuries to workers on site and workers and residents along transportation routes.

On a broader scale, current plans are to transport reagents (and other materials required for the Project) from Tema Port, located some 180 kilometres from the Proposed Mining Area. Portions of this route experience relatively heavy traffic and congestion. Spills or accidents that may occur while transporting reagents from Tema Port could have an impact on human health and the environment, depending on where and when the spill occurs.

VISUAL RESOURCES

Changes in landscape because of development of the Project were compared with the characteristic landscape to determine the degree of contrast in form, line, colour and texture. The primary visual impact of the proposed Project would be large scale modification of landforms. Angular, blocky forms and horizontal lines would create major contrasts with the natural rolling hills of the Study Area. The waste rock disposal facilities would introduce a visual impact of geometric shapes into a landscape of rolling hills. The facilities would cover approximately 246 hectares with the facility rising over 200 metres above the existing terrain (as viewed from the east) until placement of waste rock in the open pit occurs which would reduce the height of the feature by 116 metres. Although the open pit would be an expansive feature, no more than 50 metres of highwall would be visible unless the viewer was standing at the edge of the open pit.

Land clearing and construction of the Waste Rock Disposal Facility and excavation of the open pit would expose soil and rock material. The open pit highwall colours of yellow to reddish brown would contrast with the existing green hues of the natural vegetation,

especially during clear periods of bright sunlight. However, the long distance of the view would reduce the contrast to the landscape. One kilometre is generally the extent at which human-made features are visible in clear conditions; features beyond this distance are not discernable and visual impacts become minimal. Contrasts in colour and/or shape are further mitigated by the natural occurrence of humid atmospheric haze.

The Proposed Mining Area can be viewed from several different locations. Most of the visual impact would occur along the public road between New Abirem and Afosu. The Waste Rock Disposal Facility would be visible to the west from the road. Potential viewers would primarily be local residents of Afosu, New Abirem, Mamanso and Ahausena as well as the residents of Yayaaso (depending on the location of the resettlement village) and other highway travellers. Simulated views of the Proposed Mining Area using the same two viewpoints presented in **Section 3.0 (Existing Environment)** are shown on **Figures 4-1 and 4-2**. **Figure 4-1** illustrates views of the Proposed Mining Area from New Abirem (Viewpoint 1) for three phases of development – (1) pre-mine, (2) after mining is completed and (3) following placement of waste rock in the western open pit in accordance with the Closure and Decommissioning Plan. Likewise, **Figure 4-2** shows simulated views of development from Viewpoint 2 at Afosu.

As urban development grows and encroaches in the Study Area as a result of the Project (either directly or through related services), visual resources would likely change from a rural native landscape to a more urban landscape. Initial visual disturbances due to the Project itself would, in time, become less discernable as local residents become accustomed to the changed viewshed.

HERITAGE AND ARCHAEOLOGICAL RESOURCES

Sacred sites and cemeteries are important in terms of linkage with ancestors. Disruption of such sites and relocation of graves would occur as a result of Project development. Preliminary findings of the 2008 supplemental Heritage Resources Survey (Geomatrix 2008d) indicate a total of 46 heritages sites are present in the Study Area. Of these, 18 were attributed by the survey team as Community Sacred Sites (sites which serve the community and are overseen by the stool chief, linguist and / or elders); 12 were Individual Sacred Sites (sites which are located in an individual's home or land and overseen by that individual); six were Royal Cemeteries; and 10 were Public Cemeteries.

Of the 46 heritage sites, 15 sites were determined to be within the Proposed Mining Area where planned development of pits, waste rock disposal facilities and other proposed mine features may impact some or all of the sites. The shrine located in Ayesu Zigah hamlet is well known and revered throughout Ghana. This hamlet would be resettled and the shrine would be relocated as part of that process. The Community Sacred Sites and the other Individual Sacred Sites would be relocated as would the two cemeteries located in Yayaaso.

Three "Community Sacred Sites" and 10 individual household shrines are located within the Proposed Mining Area. Sacred sites and cemeteries are important in terms of linkage with ancestors. Graves located in the Yayaaso Royal Cemetery and the Yayaaso Public Cemetery would also need to be relocated. Potential impacts associated with the relocation of sacred sites and graves include:



Viewpoint 1 looking west from New Abirem - Pre-Mining



Viewpoint 1 looking west from New Abirem - Post-Mining



Viewpoint 1 looking west from New Abirem - Post-Backfill

See Figure 3-13 for Viewpoint Locations

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Viewpoint 1
View of Proposed Mining Area from New Abirem
Akyem Gold Mining Project
Eastern Region, Ghana
FIGURE 4-1



Viewpoint 2 looking southwest from Afosu - Pre-Mining



Viewpoint 2 looking southwest from Afosu - Post-Mining



Viewpoint 2 looking southwest from Afosu - Post-Backfill

See Figure 3-13 for Viewpoint Locations

- Destruction of sacred sites and removal of graves could lead to a loss of infrastructure around which to conduct religious activities.
- Disruption of these sites may affect social stability and increase potential for social tension within the community.
- Disruption of these sites could displace the ideology around ancestors and forms of authority endorsed by the ancestors, thereby undermining the position of elders within the family and community.
- Based on ancestral beliefs, negative events within communities could easily be rationalized as anger wrought on communities for the developer's inappropriate or disrespectful actions – particularly in regard to sacred sites and graves.

As indicated in **Section 3.0 (Existing Environment)**, nine archaeologically significant sites were identified in the Proposed Mining Area. Six of these sites were determined to be within or reasonably close to areas of proposed disturbance associated with the Project. Planned development of the mine pit and waste rock disposal facilities would likely impact or damage these sites. The sites identified may require additional study before the land can be disturbed to ensure that artefacts have been removed and catalogued prior to being archived. This Level II investigation (more detailed characterization) and implementation of a plan for removal of identified artefacts will be initiated at least 2 months prior to ground disturbing activities in the Proposed Mining Area.

Annex D-10 includes additional discussion regarding direct and indirect impacts associated with heritage resources within the Proposed Mining Area. No cumulative impacts are anticipated.

COMMUNITY HEALTH AND SAFETY

Development of a Water Storage Facility and Tailings Storage Facility may lead to increased malaria vectors. Development of the Project may also lead to increased incidences of HIV/AIDs. This disease is known to follow transport corridors and where there is an influx of migrant workers and people seeking work in an area.

Improved housing and sanitation quality and access to clean water would result from the construction of the resettlement village which would have a positive impact on the health of the households that are resettled. Also, because the Company would operate a medical clinic and would offer its employees substantial training opportunities regarding such topics as personal healthcare, it is expected that some improvement in the overall health of the employees and their families may result through implementation of the Project.

Because of the location of the proposed Waste Rock Disposal Facility, safety issues related to road rerouting are not relevant. This scenario will not require a reroute of the primary thoroughfare through the Proposed Mining Area; the resultant safety condition will be no different than the baseline situation at the site.

Long-term safety concerns associated with the Project will primarily be related to the presence of a relatively large open pit that will fill with water. Safety hazards connected to the pit and pit lake would be possible drownings of people accessing the lake by choice or by accident and trip and fall consequences resulting because of the presence of relatively steep pit walls.

SOCIOECONOMICS

Development of the Project would necessitate physically displacing an estimated 242 households from the settlement of Yayaaso, multiple hamlets and scattered farmsteads present in the Proposed Mining Area. These residents would be resettled and compensated in accordance with provisions of the Minerals and Mining Act (2006) and International Finance Corporation Performance Standard 5 (*Involuntary Resettlement*). An additional 1,443 households would be economically displaced as their farms would be located in the mine development area. Social impacts associated with resettlement are discussed under *Loss of Land, Compensation, and Resettlement*, above.

Construction and operation of the Project would impact the socioeconomic conditions in Ghana, Birim North District, Study Area, and the Proposed Mining Area creating new wealth by royalty distribution and new job opportunities. Implementation of the proposed Project would also include unavoidable loss of agricultural and Ajenjua Bepo Forest Reserve land, and displacement of households.

Specific impacts and potential mitigation measures are identified with additional detailed information available in the Social Impact Analysis (SIA) prepared by CIVA (2005) and the update to that SIA (GRRRL 2008). The SIA analyses are issue-based, addressing issues which were generated both via the examination of available documentation and from the SIA and associated field work, including qualitative interviews with local residents, focus groups with local interest groups and key stakeholders, and interviews with local authorities and relevant organisations. In addition, information and specialist-obtained knowledge (from EIA and SIA team members, OICI, rePlan, Newfields, and SOS International) accumulated through completion of similar work in Ghana, the Study Area and elsewhere have contributed to this impact assessment. **Annex D-II** includes a broader discussion of the findings from the SIAs and interviews; the following are synopses of that information.

Loss of Land

Social impacts associated with loss of land due to Project development of resettlement of residents within the Proposed Mining Area are discussed under *Loss of Land, Compensation, and Resettlement*, above. Re-establishing farm fields and relocating Yayaaso and affected hamlet and farmstead residents would reduce the amount of available land and increase pressure on the forest reserves as sources of agricultural land. Productivity on existing land would need to increase in order to avoid undermining local food security.

Most people living in the affected settlements (both directly affected – Yayaaso and hamlets, and indirectly affected – the remainder of the Study Area settlements) receive little cash income and are therefore almost completely reliant on subsistence agriculture for survival. The limitation of access to existing fields and other natural resources as a result of mine

development would directly impact those relying on food production within the Proposed Mining Area irrespective of the type of land-use rights held by the land user. The threat to food security, and thereby to people's survival, would begin when land is expropriated and continue until reclamation is complete and land made available to residents or until such time as alternative agricultural land, of equal productivity, is accessible to affected land users.

Local residents would be affected by temporary, and in some cases permanent, elimination of resources growing wild in the Proposed Mining Area. Access to land and resources by people currently living and farming in areas that become host sites for resettlement would also be affected.

Elimination of agricultural fields and subsistence produce would place increased pressure on women to fulfil their expected role within the household, while simultaneously reducing their ability to do so through reduced access to agricultural land (CIVA 2005).

Loss of Land Tenure

Land tenure for populations directly affected by resettlement on the Project is tenuous – given that land was allocated to them through the generosity of the stool chief. However, gaining access to new land places these people at the discretion of the stool chief – even if negotiations for land are done through the Company. These residents would become “settlers” on host land and may be at some disadvantage depending on the specific nature of new tenure arrangements negotiated as part of the resettlement and compensation packages. Those not owning land, but sharecropping or tenant farmers, are at additional risk and need particular attention during compensation negotiation.

Many landowners and users from established settlements have historical attachments to ancestral land dating back to the beginning of settlement in the area (up to 300 years ago). For these residents, the land is seen as a birthright and future inheritance that partially secures survival. People's identity and sense of belonging is often expressed in relationship to ownership of land in the area. Loss of these ties to ancestral land could impact people's sense of self and identity (CIVA 2005).

Detailed information on the additional land use impacts are presented in the SIAs (CIVA 2005 and GRRL 2008).

Loss of Forest Reserve Land

Development of the open-pit mine would permanently remove 74 hectares of existing ethno-botanical resources (wild food products, medicinal plants, firewood) from the Ajenjua Bepo Forest Reserve. In allowing use of part of the Ajenjua Bepo Forest Reserve, the national government is recognizing the transfer of value from one national asset into another. Extraction of gold for export would transfer the Ajenjua Bepo Forest Reserve's natural value into an economic one.

Some survey respondents highlighted the Ajenjua Bepo Forest Reserve as their inheritance – something connecting them to their ancestors. For these individuals the loss of land within the Reserve would have an emotional impact. Although most residents did not express any particular attachment to the forest, its visible presence as part of the natural landscape would be lost, and this loss may affect people's sense of place and identity.

Resettlement

Social impacts associated with resettlement are discussed under *Loss of Land, Compensation, and Resettlement*, above. Yayaaso is the only settlement within the Proposed Mining Area. Multiple hamlets and numerous farmsteads are located within the Proposed Mining Area. There are an estimated 1,331 persons (242 households) within the Proposed Mining Area that would be physically displaced by the Project.

There are currently 12 kiosks, two drinking spots, one chop bar, one distilling shed, and four carpentry shops in the Proposed Mining Area that would be displaced. The following public and private facilities would be displaced by the Project and have been identified for compensation and/or relocation:

- Two oil palm processing facilities,
- Two corn mills,
- One marketing shed,
- Primary school serving 100 students from Yayaaso and several hamlets,
- Water tower at Yayaaso and
- Two churches - Pentecost and Mosama.

Residents of Yayaaso and the various hamlets are among the most impoverished in the Study Area, and are further marginalized in regard to long-standing land ownership and traditional attachments to the land. Yayaaso has been settled for nearly 100 years, and the hamlets for at least 75 years. Although these residents are often perceived as “settlers” on Ahausena land, they have established attachments to their settlements and fields over this period.

Resettlement involves moving a community or household to an alternate site developed by the Company; *relocation* provides monetary compensation to an affected household to move to a location of their choice; *compensation* provides money for crops and/or structures destroyed at an agreed upon rate between the Company and affected person(s) and in-kind support to enable establishment of alternative livelihood and long term food security. The Company does not plan to provide cash specifically targeted at short term food security. The Company would implement a programme designed to identify, monitor and support, as necessary, those that need assistance.

The World Bank identifies the following risks of resettlement for affected communities:

- **Conflict:** This can happen within established communities as existing social structures are disrupted and undermined through resettling, but can also happen between resettlement communities and neighbouring ones. Yayaaso would be an example of potential for conflict during a resettlement. The settlement's residents

are poor, and considered as “settlers” by others in the Study Area. At resettlement these people would suddenly have improved housing and infrastructure, potentially causing envy and conflict with other Study Area settlements.

- **Homelessness:** Relocation is often given as an alternative to resettlement. Experience suggests that people make short-term decisions with their cash and often end up without either the money or the security of a home and therefore become vulnerable. Considering the “settler” perception that people have of Yayaaso residents and the sense of impermanence of the hamlets, the possibility of people opting for relocation would seem high. Under these circumstances people would be provided complete information on which to base decisions.
- **Food security:** For people living a predominantly subsistence lifestyle, moving off the land makes food security an important risk. Both Yayaaso and affected hamlets are almost exclusively subsistence agriculture based. Survival is dependant not only upon crops planted each season but also on the produce of trees (e.g. oil palm and citrus) that need time to be reestablished. The timing of resettlement according to planting and harvesting seasons would assist in securing adequate food supplies – although it is critical that the developer plans to have supplementary food accessible to ensure food security.
- **Impact on host communities:** Land used for resettlement is usually within or adjacent to existing communities – creating social impacts that go beyond the resettled communities. Changes to existing social structures that may result from the presence of a new neighbouring group are impacts that need to be recognized and mitigated in the same way as those experienced by the directly affected communities.
- **Environmental impact:** Establishing a new settlement, with the necessary infrastructure and buildings may mean new environmental impacts on the host area. These need to be recognized cumulatively taking account of neighbouring communities and available resources.
- **Increase in social pathologies** – alcoholism, crime, prostitution: Changes in social structures and known lifestyles often have correlating emotional and psychological consequences. Additional emphasis should be given these impacts in the resettled community and measures to address them should be discussed during resettlement planning stages.

Given the extent of the impact of involuntary resettlement of communities and considering international best practice, the Company has commissioned a Resettlement Action Plan, which aims to mitigate impacts through a comprehensive plan for resettlement and compensation that would be identified and implemented in a participatory manner. Detailed discussions of resettlement and compensation would be described in the Resettlement Action Plan.

Population Movement

As a result of development of the Project, the resident population in the Proposed Mining Area would drop to zero as a result of resettlement and relocation, and it is foreseen that the current residents of the Proposed Mining Area would become part of adjacent resettlement communities.

An in-migration of construction and operations workers would be anticipated to compete with local residents for employment. Local residents may find themselves dealing with social problems such as prostitution, teen pregnancy, drugs, drunkenness, and increased crime. Prostitution is recognized as an unavoidable consequence of a large influx of wealth, which, aside from the health implications discussed below, tends to create conflict between spouses, sometimes with breakdowns in marriage and disruption of families and children.

Potential impacts would include inflation of local food and accommodation costs; a decrease in the availability of food and accommodations; an additional burden on an already inadequate infrastructure, especially sanitation and solid waste disposal; and further stress on marginal water resources, health care facilities, and schools. Currently (before authorization is obtained to develop the Project), local salaried professionals such as teachers and medical workers report that housing costs have increased beyond their ability to pay (CIVA 2005).

Outsiders who fail to find employment may resort to criminal activities. In addition, there is increasing Galamsay (illegal, artisanal mining) activity in the region – about five kilometres northeast of Afosu a settlement has grown from 10 people to over 1,000 in a number of years. While not an impact of the Project *per se*, the presence of Galamsay could have an effect on local settlements. As the settlements around the Proposed Mining Area swell with the influx of job seekers and expand the services they supply and products they sell, they would likely attract the Galamsay, many of whom are armed and have been described as aggressive.

One of the concerns expressed by health workers at the New Abirem Centre was the enormous increase of accommodation costs as a result of the presence of the Project. Rates for accommodations have risen from GH¢1 to GH¢2/month (\$0.97 - \$1.94 USD) for a single room to GH¢5 (\$4.85 USD). This monthly rate, combined with a typical 3 month deposit up-front, makes it difficult for non-mine employees to afford rental accommodation (GRRL 2008).

Social System

The Study Area currently is an agriculturally-based rural society. Social systems and structures have evolved in the Study Area over generations and have responded dynamically to the changing social environment. Any development of the scale of the proposed Project would mean social change, particularly as residents in the Project Area would be resettled and the population of the Study Area would experience a change from an agricultural to an industrial environment.

The influence of the Project on the various intra- and inter-settlement social systems and structures would likely be experienced in a number of ways. Kinship relationships as well as economic and social sharing of resources are common, providing support (emotional and practical) between residents of the Study Area. It is vital that people (vulnerable population groups in particular) are not left worse off as a result of the Project.

Changes in well-being are often difficult to identify because they cannot easily be measured. People's uncertainty regarding the future; unfulfilled expectations for individual and family lifestyle improvements; and alteration and/or breakdown of social bonds and support mechanisms could impact the well-being of affected individuals, households, and communities. The extent of the impact may vary from person to person depending on the support structures they have access to. In addition, impacts of resettlement could compound emotional stress and contribute to reduced well-being among affected individuals and their families. Decreased emotional well-being could also lead to alcohol abuse and increased incidences of family violence.

Challenges to Traditional Authority

The Paramount Chief at Akyem Oda is the head of the Kotoku Traditional Area. Below him are the various divisional chiefs who exercise traditional authority over the chiefs, sub-chiefs and headmen administering the communities and stool lands within the Paramountcy. At the community level the chiefs, sub-chiefs, and headmen, in consultation with their elders, typically resolve issues and conflict and are in most cases the symbol of unity and custodians of the customs and traditional practices of the community.

With the influx of people from other areas of the country and from other cultures, this traditional role could come under threat. The transition from agrarian economy to a more industrial, urban economy could also lead to an undermining of the role of these traditional rulers.

Ethnic Diversity

Mine development would likely create an influx of people to the area in search of work and spin-off opportunities. In-migrants would bring ethnic and racial diversity to the area and facilitate an expanded world-view that local people, most of whom rarely travel, would otherwise not experience. Diversification of ethnicity would be positive and inter-tribal marriages would create an opportunity for national unity and tolerance (CIVA 2005).

The influx of "different" people may also increase levels of conflict through misunderstandings or tribal and community loyalties, which may feel threatened. This would create the positive diversity referred to above, but could also create tension both around perceptions of outsiders accessing jobs and around the short-term presence of contractors in the area. Short-term contracts have, across numerous international projects, often correlated to contractors with no need or desire to integrate into local society, and this lack of a sense of belonging, in conjunction with the reality of contractors being single men far from home and family, may result in unaccountable social behaviour with little regard for the consequences of inappropriate actions.

Vulnerable Populations

Within the Study Area, the most marginalized groups are those whose access to land and food produced thereon depends on other people. This group includes sharecroppers and tenant farmers. Women for whom access is dependant upon a husband or male family member owning land may also be classified as vulnerable. In addition, where men would be

lost to the family's agricultural activities because of mine employment, food security could be threatened, increasing vulnerability of this group. If salaries are spent on food (thereby replacing lost productivity) food security would then be guaranteed. A last group vulnerable to loss of land is the youth who would not gain compensation for loss but would also not have future access to land that is their inheritance.

Malaria

Malaria is the most frequently occurring disease in the Study Area (CIVA 2005). The development of a water storage facility may lead to increased malaria vectors in the area, thereby increasing the risk of infection within local communities and Project accommodation villages.

Malaria requires institutional capacity (and some financial input) to undertake preventative programs. There are various studies by malaria specialists from the South African Institute of Medical Research, as well as environmental economists from the NGO Africa Fights Malaria, to ascertain the impacts of malaria on heavy industry and mining in Mozambique and Zambia. All these studies conclude that the disease has an impact on productivity in the form of downtime, treatment costs, and costs of preventing the spread of malaria (CIVA 2005).

HIV/AIDS

HIV/AIDS are seen as critical issues in Africa with disastrous consequences. The disease follows transport corridors and spreads rapidly in mining areas where there is an influx of migrant workers. The incidence of HIV/AIDS could increase as a result of in-migration of workers seeking employment. At present the HIV/AIDS infection rate in Ghana is approximately 3 percent, making it one of the lowest rates in Africa. The New Abirem Health Centre reported that the incidence of HIV is not high (although the stigma attached to HIV/AIDS would contribute to non-disclosure thus probably reducing diagnosed cases) but sexually transmitted diseases are prevalent.

Detailed discussions of the additional impacts on social systems and the population are included in the SIAs (CIVA 2005 and GRRL 2008).

Economics

Ghana is a member of the Heavily Indebted Poor Countries program. A Foreign Direct Investment project such as the Project is recognized as a way of reducing the country's debt, increasing the Gross Domestic Product, and potentially reducing the levels of poverty in the country.

The Project would function as a "basic industry" in Ghana, the Birim North District, and Study Area economy. "Basic industries" are those business and government activities, which bring outside income into an area economy. Through salaries and purchases with non-local monies in local economies, provides a foundation for economic development at the national, district, and Study Area levels.

Gold recover at the mine site is predicted to be in excess of 7.7 million ounces over the 17-year life-of-mine. At the national level, the Project would have a direct impact through the payment of royalties and taxes related to gold production and Company profits, and an indirect positive impact through additional income taxes on the increase in direct and indirect employment; increased incomes and profits of local businesses and major suppliers; and the purchase of goods and services manufactured and supplied in Ghana.

Taxes and Royalties

The Investment Agreement between the Company and the government of Ghana defines and fixes the effective tax and royalty burden the Project would carry during construction and operation. In Ghana, mining companies pay royalties to the central government for the extraction of minerals from territorial land. For the Company, the royalty payment 3 percent of gross sales with an additional 0.6 percent royalty of gross sales attributed for mining within the forest reserve. The Company would pay this royalty quarterly to the Internal Revenue Service as stipulated in the Company Investment Agreement.

Employment Opportunities

Labour for construction of the Project, based on the Ahafo experience, is estimated to average 1,750 workers and to peak at 3,300 workers over the 30-month construction period. Five hundred employees will work for NGGL directly. The short-term employment mix of contract workers at any one time is expected to include:

- 500 skilled from primarily outside of the Study Area,
- 250 semi-skilled from within the Study Area and
- 500 unskilled – from within the Study Area.

In addition, approximately 130 employees would be required for security purposes and 80 percent (104 workers) of these would be selected from residents currently living within the Study Area.

The anticipated workforce, once mining operations begin, would range between 2,800 and 3,300 workers. Between 1,300 and 1,500 of those workers would be employed directly by NGGL for administrative, technical, and mining jobs. Between 1,500 and 1,800 would be contract labour hired to provide laboratory, vehicle and equipment maintenance, catering, and transport services. Both NGGL and contractors would hire between 25 and 35 percent of their labour from the local communities, resulting in between 700 and 1,155 jobs for local residents during operations. The employment mix would include approximately 100 expatriates. **Annex D-II** includes additional information regarding the expected mix and breadth of the work force for the operations phase of the Project.

Expatriate numbers would reduce as the Project progresses and Ghanaian staff would replace expatriate supervisors and managers. In an environment where only 12 percent of residents in the Study Area report having access to formal employment these new jobs would bring significant benefit to the area. In addition, the number of job opportunities would significantly decrease the household dependency ratios.

Although the local communities expect that the Project employs its entire required workforce (skilled and unskilled labour) from the affected communities, some technical skills required for the operation cannot be obtained from the communities. Therefore, it is foreseen that the Project would aim to employ 100 percent of the unskilled labour from the affected communities while aiming to maximize skilled labour employment. By way of comparison, the Ahafo project has committed to employing 30 percent of the total permanent workforce from the local communities.

Ghanaian Labour Law sets a minimum employment age of 15 years and prohibits night work and certain types of hazardous labour for those younger than 18; however, child labour is a serious problem in the informal sector. Many parents in the District engage their school-going age children in the family farming enterprises, as well as other businesses. This is due to poverty that precludes some families from hiring labourers. It is also common to see children selling goods on the streets at the expense of their education. The Project would ensure a minimum age for employment within the Project of 18 years in accordance with both Ghanaian and International labour laws.

Indirect Employment

The normal job creation multiplier for local service industries in the gold mining industry ranges from 3 to 6 indirect jobs for each direct NGGL employee (SGS 2000). Other sources state this multiplier effect could be as high as 10 indirect jobs resulting from each direct job (Chamber of Mines of South Africa 2005).

The construction phase of the Project is expected to create a sustained average of 1,750 new jobs, of which 500 workers would be permanent NGGL employees. Given the range of 3 to 6 indirect jobs (including the contractor created jobs) created for every new direct job, an implied range of between 250 to 1,750 additional indirect jobs could be created.

The operational phase of the Project is expected to require a mix of staff ranging from 2,800 to 3,300 employees. Between 1,300 and 1,500 workers will be employed directly by NGGL. Indirect employment (calculated on Company employees only) may range from 2,400 to 7,200 additional new indirect jobs.

Purchases of Goods and Services

In addition to direct employment opportunities with the Company and its contractors, several hundred new jobs would be created to service the needs of local mine employees and their families. Currently there is limited local and perhaps national capacity, to supply the Company's needs. The Company policy to procure locally can improve the income levels, increase entrepreneurial capacity, and broaden potential markets, all of which enables the local economy to reduce long term dependence on the mine. If the Company has to import most supplies from outside the area, it could create conflict over benefits leaving the area.

It is difficult to estimate the dollar amount of procurement for goods and services that would actually occur with the exception of electrical power from the VRA. Average expenditures per year for electrical power required for oxide and primary ore processing

range from approximately \$18.6 to \$21.3 million (USD). Payments would be received by VRA and are sensitive to the final conditions of the Power Purchase Agreement Contract negotiated between the Company and VRA.

Other procurement opportunities would depend on goods and services available in the Study Area, the district, and in Ghana.

Potential for Inflation

CIVA 2005 notes that increased opportunities create economic risks at the local level. Inflated housing and food costs may create increased hardship for local people especially for civil servants working in the area. Of particular concern is the impact that high rentals are already having on teachers and health workers who are either deployed to the area or enticed by the hope of jobs. However, high living costs threaten to undermine the ability and desirability of staff to work in the area – and as a spin-off, threatens access of local residents to health care and education. This is of particular concern during the construction phase – before Proposed Mining Area accommodations would be completed to relieve the demand on the local housing supply.

Sustainable Development

Economic expansion in the Study Area would occur at relatively rapid rate considering the low starting point. Mining is a finite activity, depending on the extent of the reserve, and the danger of the extraordinary burst of economic growth that results from a project of this nature into a predominantly subsistence agricultural economy is that it may not be sustainable in the future, resulting in a boom and bust effect which may leave residents worse off than before.

Cumulative Effects

The impacts to land use would continue as additional people move to the area to find employment and require accommodation and community services. With full operational development of the concession, the Project would not require any additional land; however, demand for permanent housing and replacement agricultural fields may continue for many years.

Implementation of the proposed Project would set a precedent for mining in forest reserves (a small number of exploration permits are currently being exercised) and this is an impact of cumulative concern at the national and international level.

The social and economic pressures of population growth would continue as additional people move to the area to find employment and require accommodations and community services. With full operational development of the concession, employment and the economic/training improvement benefits streaming from that would continue providing a longer timeframe to create the base for economic security, sustainable development, and social adjustment after closure.

POPULATION INFLUX AND SOCIAL AMENITIES

The rapid influx of people in search of jobs associated with Project development may lead to social and economic pressures on the existing residents and change the social and political dynamics in the Study Area. An in-migration of construction and operations workers is anticipated to compete with local residents for employment. Potential impacts could include:

- Inflation of local food and accommodation costs,
- Inflated housing and food costs may create increased hardship for local people,
- A decrease in the availability of food and accommodations,
- Additional burden on sanitation and solid waste disposal and
- Stress on domestic water resources, health care facilities, and schools.

As a result of development of the Project, the resident population in the Proposed Mining Area would become part of adjacent resettlement communities. CIVA (2005) notes that increased opportunities create economic risks at the local level. Inflated housing and food costs may create increased hardship for local people especially for civil servants working in the area. This is of particular concern during the construction phase – before Proposed Mining Area accommodations would be completed to relieve the demand on the local housing supply.

The proposed Project would result in some degree of social change, particularly as residents in the Proposed Mining Area would be resettled and the population of the Study Area would experience a change from an agricultural to an industrial setting. This change could affect feelings of well-being.

The Paramount Chief at Akyem Oda is the head of the Kotoku Traditional Area. Below him are the various divisional chiefs who exercise traditional authority over the chiefs, sub-chiefs and headmen administering the communities and stool lands within the Paramountcy. With the influx of people from other areas of the country and from other cultures, this traditional role could come under threat.

In-migrants would bring ethnic and racial diversity to the area and facilitate an expanded world-view that local people would otherwise not experience. Diversification of ethnicity would be positive and inter-tribal marriages would create an opportunity for national unity and tolerance (CIVA 2005).

Within the Study Area, the most marginalized or vulnerable groups are those whose access to land and food produced thereon currently depends on other people. These groups include sharecroppers and tenant farmers. Women, for whom access is dependent upon a husband or male family member owning land, may also be classified as vulnerable. In addition, where men would be lost to the family's agricultural activities because of mine employment, food security could be threatened, increasing vulnerability of this group. If salaries are spent on food (thereby replacing lost productivity) food security would then be guaranteed. Youth, who would not gain compensation for loss of land but would not have future access to land that is their inheritance, would also be considered a vulnerable group.

ECONOMY

The Project would function as a “basic industry” in Ghana, the Birim North District, and Study Area economy. “Basic industries” are those business and government activities, which bring outside income into an area economy. The primary socioeconomic impacts associated with the Project would be positive in that residents of the Study Area and the region would be offered employment opportunities during construction and operation. Royalties and taxes would be realized by the Ghanaian government from gold production.

Project construction is expected to result in peak employment of approximately 3,300 workers. The construction phase of the Project is expected to create a sustained average (during the 30 month construction period) of 1,750 new jobs, of which approximately 500 workers would be permanent Company employees. Given the range of 3 to 6 indirect jobs (including the contractor created jobs) created for every new job, an implied range of 250 to 1,750 additional indirect jobs could be created.

Approximately 130 employees would be required for security purposes and approximately 80 percent (104 workers) of these would be selected from residents currently living within the Study Area.

Once mining operations begin, the anticipated workforce would range from 2,800 to 3,300 workers. Between 1,300 and 1,500 of those workers would be employed directly by the Company for administrative, technical, and mining jobs. Between 1,500 and 1,800 would be contract labour hired to provide laboratory, vehicle and equipment maintenance, catering, and transport services. The Company and its contractors would hire between 25 and 35 percent of their labour from the local communities, resulting in 700 to 1,155 jobs for local residents during operations. The Company policy is to recruit 100 percent of unskilled labour from within the Study Area and between 25 and 35 percent of all Company and contractor employees will come from local communities. Indirect employment (calculated on Company employees only) may range from 2,400 to 7,200 additional new jobs, including unskilled jobs such as cleaners and food service workers as well as skilled sales and communication workers.

Gold production at the mine site is predicted to be approximately 7.7 million ounces over the 15-year life-of-mine. At the national level, payment of royalties and taxes related to gold production and Company profits, the additional income tax on the increase in direct and indirect employment, increased incomes and profits of local businesses and major suppliers and purchase of goods and services manufactured and supplied in Ghana would be realized.

The social and economic pressures of population growth would continue as additional people move to the area to find employment and require accommodations and community services. With full operational development of the concession, employment and the economic/training improvement benefits would continue providing a longer timeframe to create the base for economic security, sustainable development, and social adjustment after closure.

Detailed discussions concerning impacts to additional economic activities are contained in the SIA documents (CIVA 2005 and GRRL 2008b). Additional discussions relating to direct, indirect and cumulative impacts to socioeconomic resources in the Study Area because of Project development are included in **Annex D-II**.

OCCUPATIONAL HEALTH AND SAFETY

A variety of hazards to humans are associated with implementation of the Project that may impact the health, well being and safety of both Company employees and contractors. These effects could include bodily harm from exposure to machinery, chemicals, noise, dust and traffic and short- and long-term health effects from acute and / or chronic exposures to certain chemicals and reagents that are used in the gold recovery process.

SOLID, LIQUID AND HAZARDOUS WASTES

The Company will generate and/or transport several types of solid, liquid and hazardous waste in developing the Project and during subsequent operations. Impacts could result to the environment and to human health should these wastes not be transported, handled and disposed of properly. Potential impacts that may result from the transport or use of various general waste types generated at the site include:

- **Used Oil and Lubricants** – These wastes include motor oil, gear oil, hydraulic fluid and brake fluid. The primary impacts from these wastes would result from spills or disposal practices that allow for unmitigated releases to the environment, particularly to area soils, groundwater and surface water resources. Such releases could pose health threats to residents in the Mining and Study areas through direct contact, ingestion or inhalation of deleterious organic compounds.
- **Diesel Fuel** – Impacts from transport and use of diesel fuel, the primary fuel to be utilized during the Project, would be similar to that described above for used oil and lubricants. Spills that may occur from transport of diesel from tanker truck accidents and at the fueling stations from overfilling or other accidents may enter the environment and be held in the soil profile. If the soil is sufficiently saturated with fuel, downward and surface movement can occur, potentially jeopardizing the quality of groundwater and surface water resources. Such impacts could pose a threat to both the environment and human health by impacting village water bores and surface water fetch points.
- **Oily Water** -- Impacts from oily water that is generated as a result of rainfall occurring in fuel storage tank secondary containment areas and as a result of cleaning operations at maintenance shops and vehicle washing facilities would be similar to that described for used oil, lubricants and diesel fuel, above.

- **Containers / Drums** -- Most materials will be transported using standard shipping containers, which will be trucked to the appropriate areas for emptying and distribution. Spills could occur during transport or off-loading of these materials, some of which may contain deleterious substances that may be harmful to the environment or human health. The pathway of movement of such substances to human and environmental receptors could be through direct contact, ingestion or inhalation, if the materials are volatile.
- **Sewage** -- Sewage waste streams originate as effluent from bathroom facilities, laundry facilities and kitchen operations. These materials, if left unchecked, would represent a threat to human health through direct contact, ingestion and inhalation, resulting in symptoms in humans such as diarrhea, urinary tract infections, respiratory illness and pneumonia, and other illnesses. In certain cases, the impacts from the bacteria associated with such wastes can be life threatening.
- **Solid Waste** -- Solid waste will consist of bulk non-hazardous and hazardous waste. Most construction waste generated during the initial phase of the Project would be considered non-hazardous and would pose little, if any risk to public health or the environment, because of its intrinsically inert nature. Other non-hazardous wastes would include putrescible waste (i.e., food scraps) and rubbish such as domestic waste would be generated in the offices, kitchen, camp and eating areas. These wastes, if left unmanaged, can represent hosts for various types of bacteria that can enter the food chain for humans and pose a health threat as well as a aromatic nuisance as decay occurs. Symptoms can include diarrhea, urinary tract infections, respiratory illness and pneumonia, and other illnesses that can progressively lead to severe ailments that can be life-threatening. Other non-hazardous waste includes inert industrial waste will be generated throughout the mine and includes such materials as piping off-cuts, drained containers (i.e., with no residual liquids), scrap metal, paper, wood, concrete and textiles. These wastes likewise pose minimal environmental or human health risks.

Hazardous wastes of various types can pose a threat to human health and the environment to varying degrees, depending on the chemical composition of the waste and its toxicity and ignitability characteristics. Health impacts to humans can result through direct contact, ingestion and inhalation to such wastes and can be contracted at various points along the migration of the waste from source to receptor. The breadth and degree of health impacts can vary from minor to life-threatening, depending on the exposure pathway, the dosage received and duration of contact. Likewise, environmental receptors (including surface water, groundwater, air resources, and soil) can become impacted through a release of hazardous wastes and become sources and pathways of contaminant movement in the environment, ultimately compromising the integrity and utility of these resources.

- **Explosives** -- Several explosive products and diesel fuel will be stored in the designated Explosives Magazine in the Proposed Mining Area. Risks associated with explosives include the potential for spillage of ammonium nitrate and emulsion with the consequent release of the compounds to the environment and mishandling that may create a human health hazard through premature detonation. Diesel stored in a tank at the Explosives Magazine may pose an impact through accidental release or spillage, as described under *Diesel Fuel*, above.
- **General Chemicals** – Potential impacts associated with general chemicals to be used by the Company in implementing the Project are generally associated with human health risks and releases of various compounds to the environment through accidental excursions or spillage. The plant will use a wide range of containerized and uncontainerized chemicals that may pose threats to residents, workers, and the environment commensurate with the toxicity and abundance of specific chemicals. Health impacts may range from minor illnesses to more major conditions requiring medical attention. Environmental impacts may include degradation of the quality of surface water and groundwater, as receptors of possible contaminant releases, as well as degradation of surficial and subsurface soils located proximal to the release point.
- **Medical Waste** -- Biologically hazardous waste may pose a health threat to both site workers and the public, depending on the type and amount of waste released in the event of unchecked usage and/or disposal. Used sharps and syringes may pose a danger of bacterial and viral infections to health workers and unsuspecting members of the public who may access such equipment. Health impacts may range from relative minor to more significant incidents that may require medical attention.