

CHAPTER 3

ALTERNATIVES

INTRODUCTION

The Ahafo South Project is currently under construction in accordance with permits previously issued by the Ghanaian EPA for the Ntotoroso, Sefwi, and Ahafo Project (South) EISs. As such, alternatives for location of mine facilities (waste rock disposal facilities, plant site, tailing storage facility, water storage facility, haul roads, access roads, and general mine infrastructure) were previously analyzed and decisions made pursuant to those respective documents. Current operations must, therefore, comply with conditions imposed under the previous permits. Based on Ghanaian EPA review of mine plans and closure plans for these mine projects, NGGL is implementing the environmentally preferred alternative. In addition, the selected mine plan minimizes social impacts of the Project.

Design of the Ahafo South Project evolved through several iterations where options were considered for ore processing, mine pit layout, mining method, and location of various facilities. The design review resulted in modifying original mine plans developed by Centenary Gold Mining Company for the Sefwi Belt Gold Project (involving four mineral concessions) and Rank Mining Company Ltd. for the Ntotoroso Gold Project. The modification was prompted by Newmont Ghana Gold Ltd.'s purchase of these mining concessions from previous owners.

This section of the ESIA summarizes previous social and environmental impact assessments that were conducted by the Ghanaian EPA including the range of alternatives considered in those assessments and a the public participation process that was conducted during compilation of those EISs. This chapter also describes alternatives evaluated in the more recent EIS reviewed by the Ghanaian EPA for the revised mine plan prepared by NGGL for the Ahafo South Project. In addition, this section presents alternatives that are considered in this ESIA including the "No Project" alternative.

PREVIOUS ENVIRONMENTAL AND SOCIAL IMPACT ANALYSES

SEFWI BELT GOLD PROJECT

An EIS was compiled for the Sefwi Belt Gold Project and was submitted to and approved by the Ghanaian EPA in March 2000. The EIS presented a description of the proposed Project, baseline social and environmental conditions, mitigation measures, alternatives, and potential impacts of the Project. The Sefwi Belt Gold Project was a joint venture between Centenary Gold Mining Company Ltd. (a joint venture between Normandy/La Source and the Ghanaian Government) (SGS 2000a).

Public Participation

During the course of writing the EIS for the Sefwi Belt Gold Project, SGS conducted two socioeconomic surveys of the project area, the first in 1997 covering the Yamfo concession and the second in 1999 covering the entire project area and revisiting several parts of the 1997 survey in order to get a

comprehensive overview of the area. Consultants visited 60 local communities and conducted interviews with local people, including chiefs, officials, and representatives of various employment groups. Prior to interviews, the Consultants held numerous public meetings to explain the project to government officials, traditional authorities and local people. Attachment I of **Appendix E** of the Public Consultation and Disclosure Plan contains a full listing of the public meetings held during this time.

People were free to express their views and expectations about the Project (as envisioned at that time). It is notable that no major objections to the Project were voiced. Common fears expressed were that mining would result in environmental degradation and that development could result in an increase in crime and prostitution among other social changes.

In response to issues raised by local citizens and governmental officials, Centenary had actively assisted local communities in establishment of new water sources, renovation of existing water sources, support for the Kenyase town water system, installation of street lighting, assistance with building construction/renovation (schools), and disaster relief support and electrification assistance. Centenary recognizes the responsibility to contribute to socio-economic infrastructure in communities directly affected by the Project. Centenary will act in cooperation with local communities and government (SGS 2000a).

Alternatives Considered

Alternatives were examined in the Project feasibility study, including the possibility of using the heap leach technique and examining alternate site locations for proposed mine facilities. The treatment technique and location of facilities were considered to be the most appropriate and were not examined in the EIS.

The Ghanaian EPA reviewed the mine and closure plan developed by the applicant and determined that no other Project alternatives needed to be considered in the EIS and approved the EIS with mitigation measures developed by the applicants. Based on the EPA's review, the environmentally and socially superior option was selected.

NTOTOROSO GOLD PROJECT

An EIS for the Ntotoroso Gold Project was submitted to the Ghanaian EPA in December 2000 by Rank Mining Company Ltd. (SGS 2000). This document presents a description of the proposed Project, baseline environmental and social conditions, mitigation measures, alternatives, and potential impacts of the Project. Rank Mining Company Ltd. was formed as the joint venture entity between Moydow (Ghana) Limited and Normandy Ghana Gold Ltd.

Public Participation

Rank Mining Company commissioned consultants to conduct interviews to record views and comments of the inhabitants of the proposed Ntotoroso Gold Project area. Interviews were conducted with assemblymen, heads of schools, selected heads of Government Departments, the District Coordinating Director, District Director of Agriculture, and the District Chief Executive (SGS 2000). Informal discussions were conducted with the Paramount Chief of Kenyase I and farmers from the Subika pit area.

A result of the public involvement process for Rank Mining Company's proposal is that the Project was generally welcomed by the inhabitants. The Paramount Chief (Kenyase I) indicated that he and his people could see the benefits of opening up the area for development including creation of jobs, job training, and general improvement in the socio-economic status of the area (SGS 2000). Issues raised by farmers during the public interview process included concern for different prices being paid for young and old cocoa trees; low prices for food crops; no compensation being offered for uncultivated land; use of sticks instead of PVC to cover holes (concern that sticks would rot out and leave a dangerous trap); and cash payment to farmers instead of payment by check.

In response to community concerns, Rank Mining and Normandy Ghana Gold Ltd. (Rank's partner) recognized the need to institute a community relations program. This program was designed to address compensation issues, relation and meetings with communities, contributions to community benefits, and monitoring of socio-economic conditions.

Alternatives Considered

Rank Mining and Normandy undertook an analysis of alternative methods for processing ore from the proposed Ntotoroso Gold Project. Options considered included milling ore at their operation, heap leaching the ore, or milling and processing the ore at the adjacent Sefwi Belt Gold Project operation's mill. The analysis concluded that due to the characteristics of the ore to be produced, heap leaching is not technically or economically feasible. The size of the ore body also did not lend itself to support of a mill facility; therefore, the consortium decided to process the Ntotoroso Gold Project ore at the Sefwi Belt Gold Project mill (SGS 2000).

Alternative waste rock disposal areas were considered during pre-feasibility planning. Several locations were examined; site selection was based on a combination of characteristics including absence of mineralization, appropriate geotechnical conditions, and is a reasonable distance from major settlements.

The Ghanaian EPA reviewed the alternatives to determine whether any alternative would reduce potential impacts of the proposed Project. The EPA did not identify any other Project alternatives for consideration in the EIS and approved the EIS with mitigation measures developed by the applicants.

AHAFO SOUTH GOLD PROJECT

The Ahafo South Gold Project was designed to meld the two previously approved Projects (Sefwi Belt Gold Project and Ntotoroso Gold Project) into one Project after Newmont acquired these properties. The resultant mine design was sufficiently different from the previously approved mine plans that Newmont's subsidiary – Newmont Ghana Gold Ltd. was required to submit the revised plan for review by the Ghanaian EPA. NGGL prepared and submitted the requisite EIS to the Ghanaian EPA for the Ahafo South Project in September 2004 (SGS 2004a).

Public Participation

NGGL has undertaken a comprehensive suite of consultation, disclosure activities, and stakeholder engagement exercises since acquiring the Ahafo concessions in 2002. All Project stakeholders – individuals, groups, and organizations with an interest in the Project – have been actively engaged in the consultation process. Workshops, briefings, and educational programs on the Project have been provided to local community groups; international, national, and local government agencies; and

environmental, human rights, non-governmental, and media organizations. In addition, specific engagements have involved local stakeholders during the crop and resettlement negotiations process and public hearings to discuss issues related to the environmental impact assessment. Specific duties have also been empowered to the local communities including development of a job quota system to provide equitable distribution of employment opportunities, verification of an individual's local status, determination of a family's eligibility for resettlement or relocation compensation, and conflict investigation and resolution with regard to the resettlement and compensation program. A detailed description of the public participation process is contained in the Resettlement Action Plan (PA 2005) and in **Appendix E, *Public Consultation and Disclosure Plan***.

Primary issues associated with the Ahafo South Project have been identified through the public involvement process which provided interested and affected parties opportunity to identify issues and concerns and receive Project related information. The Scoping Report and Terms of Reference (SGS 2004a) identified the following issues during the scoping process:

- Land tenure and crop compensation;
- Employment opportunities;
- Process and communication;
- Expectations and benefits;
- Social responsibility;
- Development and need for infrastructure;
- Social disruption;
- Environmental impacts;
- Assessment of Alternatives; and
- Legal and policy.

Alternatives Considered

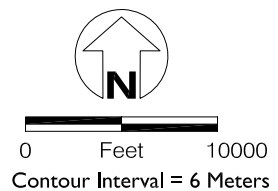
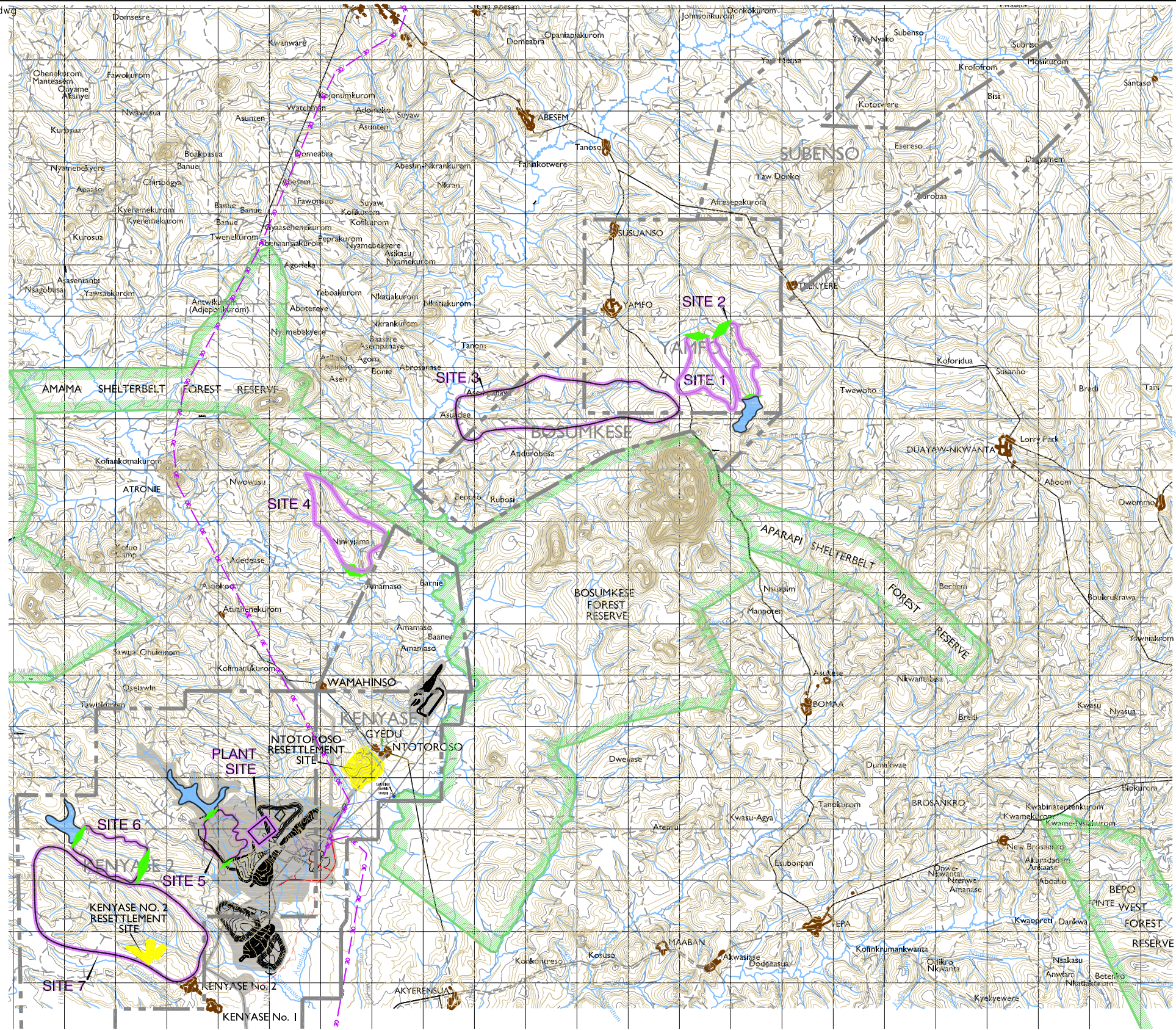
The September 2004 Environmental Impact Statement (EIS) for the Ahafo Project (South), prepared by SGS Environment (2004a), describes alternatives considered during early stages of Project planning (see Section 4.2 and Appendix II.6 of the September 2004 EIS) including:

- No development of the Project;
- Alignment of access road into the Project area from the south and analysis of a by-pass;
- Mine pit locations;
- Make-up water source including analysis of use of groundwater, pumping water from Tano River, and construction of a dam to capture water;
- Water storage reservoir location – position of dam;
- Location of a treatment plant;
- Tailing storage facility locations; and
- Waste rock disposal facility locations including pit backfill.

As indicated in the alternatives listed above, geographic location options for the tailing and water storage facilities, and processing plant were developed and evaluated. Locations of these sites are shown on **Figure 3-1** and described in **Table 3-1**.

Site No.	Facility	Location	Approximate Area	Rationale for Elimination
1	TSF	Abutu stream valley	3.3 km ²	Unsuitable topography; heavily farmed; would have required greater surface area to contain estimated volume of tailing; significant loss of farmland and major displacement of people; upstream from village of Susuanso.
	WSD	Amoeabene stream valley	3.3 km ²	
2	TSF/WSD	Amoeabene stream valley	3.3 km ²	Limited drainage area from which to capture adequate water for processing facility requiring an additional source of water to meet project demands; upstream from village of Susuanso
3	TSF/WSD	Mankwasu stream valley	NA	Unsuitable topography; would have required extensive area to contain estimated volume of tailing; heavily forested; low run-off coefficient; insufficient water to meet processing plant requirements; moderate to heavily farmed; inadequate buffer zone between confluence with Tano River; too distant from processing plant.
4	TSF/WSD	Amama stream valley	5.1 km ²	Unsuitable topography would have required three separate dams to attain area needed to contain estimated volume of water and tailing; heavily farmed for cocoa; very close to Amama Shelterbelt Forest Reserve and may have attracted wildlife to TSF during dry season; upstream from a GWSC pumping station for Ntotoroso and Wamahinso; too distant from processing plant and mineralized areas.
6	TSF/WSD	Densu stream valley	3.6 km ² TSF 1.0 km ² WSD	Unsuitable topography would not provide volume of water necessary for processing plant operations; heavily farmed for cocoa; displacement of high number of farmers.
7	TSF/WSD	Subika/Samanusa stream valley	NA	Immediately upstream from major settlements of Kenyase 1 and 2

Source: SGS 2004a



- Water Storage Reservoir
- Alternative Tailings Site
- Water Storage Dam
- Lease Boundary
- Forest Reserve Boundary
- Proposed Mine Disturbance
- Urban Area

Alternative Tailings and Water Reservoir
 Ahafo South Project
 Brong Ahafo Region, Ghana
 FIGURE 3-1

Of the alternative locations for these facilities evaluated by NGGL, the location in the Subri Valley was selected supported by the following rationale:

- Topography of the selected site was most suitable of all sites considered;
- Site occupies the least amount of surface area compared to all other sites;
- Site provided most reliable source of water for the project;
- Site topography supported a natural spillway location for the dam;
- Farming was limited in the valley floor area due to presence of elephant grass as well as flood-prone areas;
- Not settlements are present in the valley floor area;
- Site is approximately 7.5 km from confluence with Tan River – risk of impacting river is reduced;
- No large settlements exist downstream of the dam location;
- The Subri River enters the Tano River downstream of the pumping station located at Akyerensua; therefore, the tailing storage facility cannot impact this pumping;
- A greater portion of the Subri River basin would remain unaffected by the Project (76 percent of the total basin);
- Site is located as remotely as possible from major population centers;
- Plant site topography combined with tailing storage area would allow pipeline leaks or mishaps to be captured by the tailing storage facility; and
- Site is close to main area of mineralization.

The Project mine and reclamation plan that was developed after consideration of these alternatives was reviewed by the Ghanaian EPA and a permit was issued on April 25, 2004. Based on the Ghanaian EPA review, NGGL is implementing the most environmentally and socially acceptable plan for the Ahafo South Project.

ONGOING ENVIRONMENTAL STUDIES

NGGL has initiated several environmental studies and technical investigations designed to confirm and validate existing baseline data and expected operational impacts of the Ahafo South Project. These studies will be useful in later mine-life years to better understand social implications and opportunities related to post-closure conditions and potential land uses. Specifically, these studies include:

- **Pit Lake Study** (Golder Associates, Inc.) – This study will identify whether pit lakes would form after mining and identify water quality expected in pit lakes such that post-closure uses can be defined.

- **Geochemical Analyses** (Newmont) – Kinetic testing of waste rock to confirm results of static testing regarding potential for acid generating rock. These tests will confirm appropriate closure and reclamation techniques which facilitate post-mined land use objectives.
- **Aquifer Characteristics** (Golder Associates, Inc.) – This study will provide an analysis of the groundwater conditions in the mine pit and tailing impoundment areas for purposes of predicting effects to groundwater (quantity and quality). These tests will confirm appropriate closure and reclamation techniques which facilitate post-mined land use objectives.
- **Soil Survey** (Contractor to be determined) – This study will augment soil information collected to date in the Project area and will be used to determine condition of soil currently being used for crop production. The survey results will also determine the amount and quality of suitable soil available in the area to support post-reclamation agriculture practices.

The reclamation and closure plan is summarized in Chapter 2 – *Project Description* of this document. Based on review of available baseline data, a number of reclamation or closure alternatives have been identified. These closure alternatives will be evaluated by NGGL once ongoing studies are completed in the Project area and potential effects on resources have been fully analyzed.

PROJECT ALTERNATIVES

Alternatives designed to eliminate or reduce potential impacts resulting from Ahafo South Project have been developed and are described in this section of the ESIA. With the exception of the No Project Alternative, these alternatives focus on closure and reclamation options that are available to NGGL should environmental conditions warrant implementation of one or more of these closure options.

Social and environmental impacts of each of these alternatives (including the No Project Alternative) is included in Chapter 4 – *Affected Environment and Human/Environmental Impacts*.

NO PROJECT ALTERNATIVE

Implementation of the No Project Alternative would include cessation of construction activity currently underway at the Ahafo South Project site. Planned development of the Project would not occur and NGGL would initiate and complete restoration of land disturbed by current construction at the site.

All aspects of the Project including job creation, job training, and other components of the mine development would be suspended.

CLOSURE ALTERNATIVES

PIT LAKE MANAGEMENT

These alternatives will be evaluated should results of current studies indicate that poor quality water would reside in the mine pits after cessation of operations. The need for these alternatives is to provide positive measures that would limit or eliminate direct exposure of humans and animals to the pit lakes. If water quality is acceptable, an opportunity to develop a source of irrigation water and/or an aquaculture facility should be considered as an alternative.

A. Partial Backfill

Partial backfill of mine pits would be designed to place inert or non-reactive rock in mined-out pits to a level above the water table. Backfill placement to this level would eliminate direct contact for humans and wildlife to water in the pit. The amount of material that would be rehandled to complete partial backfill is dependent on the water table elevation associated with each mine pit and feasibility of backfill operations.

B. Pumping and Water Treatment

Where conditions allow, water levels in mined-out pits could be maintained by pumping from sumps in the pits and treating the water to meet effluent standards. Operation of a water treatment plant would occur until water quality in the pit meets applicable standards. Pumping water that inflows to the pit and water treatment could be conducted in concert with partial backfill of mined-out pits to reduce the amount of water requiring treatment to maintain pit lake levels.

Other options include consideration of using treated water for potable water supply to hamlets and villages in the Project area or discharge to the Tano River to augment flow. These opportunities can be evaluated throughout the life of the Project when monitoring data would provide a more precise indication of post-closure water conditions in the mine area.

C. Fencing/Berm Installation

This option could be used as a stand-alone measure or in conjunction with other water management options. Fencing and/or berm installation could be effective in reducing contact between animals/humans and the pit lake. Such a measure would likely require security to ensure that the fence is maintained and that conditions of the pit lake are effectively communicated to people.

D. Development of Irrigation Source and/or Aquaculture Facility

Should water quality in the pit lake stabilize to a condition where limitations on use of the water could be removed, opportunities to use the water to support food production (aquaculture), potable water supply, or other uses could be developed.

WASTE ROCK DISPOSAL FACILITIES

Results of additional testing to be completed on waste rock (kinetic testing) associated with the Ahafo South Project will be used to predict the quality of water that will emanate from the base of waste rock disposal facilities as a result of precipitation leaching through the pile. Should predicted water quality indicate that effluent from the base of waste rock disposal facilities exceed applicable quality standards, closure options that could be considered include construction of a cap that would limit the amount of precipitation infiltrating into the waste rock disposal facilities and/or collection of seepage from the toe ponds and treatment of the seepage to meet water quality standards.

Consideration will also be given to modification of the waste rock disposal site slopes to increase the amount of surface area that could be farmed or cultivated in the post-closure period. This alternative would also evaluate the need to increase the amount of soil salvaged during construction of the facility in order to maximize the soil replacement depth at reclamation. Increasing soil replacement depth could

enhance the value of the land for crop production. Reducing slopes of waste rock dumps would, however, increase the disturbance footprint of these facilities.

A. Reduce Slopes to Maximize Post-Mining Land Use for Subsistence Farming

Topography surrounding the Ahafo South Project site is relatively flat. Construction of waste rock disposal facilities for each mine pit would result in elimination of existing farm or cropland sites and displacement of residences to other locations. Post-mining land use is likely to include subsistence farming uses. As such, consideration of reducing side slopes of waste rock disposal piles to increase the area that could be used for farming or cropland should be considered. This option would need to consider whether reduction in slope of the facility would impact existing farm or cropland areas.

B. Maximize Soil Replacement Depth

Maximizing soil replacement depth on waste rock disposal facilities could result in enhancing the post-mining land use for cropland or agricultural production. Increased soil depth would result in an increased rooting depth and moisture holding capacity of the soil horizon.

C. Construct Capping System to Reduce Infiltration

Placement of a specific cap design on the waste rock disposal facilities may reduce the amount of precipitation that could migrate through the rock pile and thereby reducing the amount of water that may require collection and treatment at the toe of each disposal facility. Cap designs that store and release water would be effective in reducing the amount of water that infiltrates through the waste rock pile.

D. Water Treatment Facility Operation to Treat Effluent

Precipitation that eventually infiltrates the waste rock disposal facilities would be collected in toe ponds and analyzed for a suite of trace metals. If water quality of this effluent does not meet applicable standards, the water would be treated to meet standards prior to discharge.

TAILING STORAGE FACILITY

Effluent draining from the tailing storage facility underdrain collection system may exceed water quality standards. Depending on the closure period, options that consider maintaining a water treatment facility may need to be evaluated. Using the reclaimed tailing storage facility as farm land in the post-closure period may also warrant consideration.

A. Water Treatment

Draindown from the tailing disposal facility would be collected as necessary (if quality does not meet applicable standards) and treated through operation of a water treatment plant. Water treatment would continue until draindown ceases or meets applicable standards.

B. Post-Closure Use as Farm Land

Reclamation options for the tailing storage facility include placement of soil in sufficient depths to support subsistence farming on the site. Soil replacement depths would need to consider mobility of any residual constituents that may remain in the tailing material during closure operations.