Business and Biodiversity Offsets Programme (BBOP)

BBOP Pilot Project Case Study

Akyem Gold Mining Project, Eastern Region, Ghana






NEWMONT GHANA

BBOP Business and Biodiversity Offsets Programme

Forest Trends, Conservation International and the Wildlife Conservation Society provided the Secretariat for BBOP during the first phase of the programme's work (2004 – 2008).

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Available from **www.forest-trends.org/biodiversityoffsetprogram/guidelines/newmont-case-study.pdf**.

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About this document

To help developers, conservation groups, communities, governments and financial institutions that wish to consider and develop best practice related to biodiversity offsets, the Business and Biodiversity Offsets Programme (BBOP) has prepared a set of Principles, interim guidance and resource documents[1], including pilot project case studies, of which this document[2] is one. All those involved in BBOP are grateful to the companies who volunteered pilot projects in this first phase of its work.

The ability to test methods and learn from practical experience in a set of pilot projects has played an important role in the development of the BBOP principles on biodiversity offsets and supporting materials during the first phase of the programme's work (2004 – 2008). Six organisations (five companies and one city council) volunteered to undertake pilot projects during BBOP's first phase, with some joining at the outset, and some at later stages. While BBOP has offered some support and technical advice to the individual pilot projects through its Secretariat and Advisory Committee, each pilot project has been directed and managed by a team employed or contracted by the companies and city council leading the respective projects. Each of the case studies prepared by the pilot projects explains the approach taken and how close the project has come to completing the design of the biodiversity offset concerned, and sets out the developer's current thinking on the most appropriate offset. This may change as the project teams finalise their offset design and start implementation. The nature of the guidance used by the pilot projects has varied according to which drafts of the evolving BBOP Handbooks were available to them at the time. This and the individual circumstances and context of each pilot project have affected the extent to which they have used or adapted the BBOP guidance. Consequently, the case studies do not necessarily reflect the range of interim guidance currently presented in BBOP's Biodiversity Offset Design Handbook, Cost-Benefit Handbook and Implementation Handbook.

Newmont Golden Ridge Limited is still working on the design of the proposed biodiversity offset discussed in this case study. Consequently, none of the suggested or projected activities based on fieldwork to date represent a commitment on the part of Newmont Golden Ridge Limited and its potential partners to proceed with the offset as described in draft form in this document. This commitment is the subject of continuing internal discussions. The information and data relating to possible offset sites, areas and activities are presented here to communicate the initial work that has been done on a potential offset design and to illustrate one possible approach to the design of a biodiversity offset intended to comply with the BBOP principles.

BBOP is embarking on the next phase of its work, during which we hope to collaborate with more individuals and organisations around the world, to test and develop these and other approaches to biodiversity offsets more widely geographically and in more industry sectors. BBOP is a collaborative programme, and we welcome your involvement. To learn more about the programme and how to get involved please:

See: **www.forest-trends.org/biodiversityoffsetprogram/**

Contact: **bbop@forest-trends.org**

1 The BBOP Principles, interim guidance and resource documents, including a glossary, can be found at **www.forest-trends.org/biodiversityoffsetprogram/guidelines/**. To assist readers, a selection of terms with an entry in the BBOP Glossary has been highlighted thus: **BIODIVERSITY OFFSETS**. Users of the Web or CD-ROM version of this document can move their cursors over a glossary term to see the definition

2 This case study was prepared by AMEC Geomatrix, Inc. on behalf of Newmont Golden Ridge Limited.

CASE STUDY
AKYEM PILOT BBOP PROJECT
AKYEM GOLD MINING PROJECT

PROPOSED GOLD MINE
EASTERN REGION, GHANA

NEWMONT

Newmont Golden Ridge Ltd.
Accra, Ghana

AMEC Geomatrix

27 FEBRUARY 2009

CASE STUDY
AKYEM PILOT BBOP PROJECT

Akyem Gold Mining Project
Eastern Region, Ghana

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27 February 2009

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EXECUTIVE SUMMARY

Newmont Golden Ridge Limited (NGRL), a subsidiary of Newmont Mining Corporation (the Company), is proposing to develop gold reserves at the Akyem Project site in the Birim North District of the Eastern Region of Ghana, West Africa. The site is located approximately 3 kilometres west of the district capital New Abirem, 133 kilometres west of Koforidua the regional capital, and 180 kilometres northwest of Accra, the national capital. The proposed Project is currently in the planning stages.

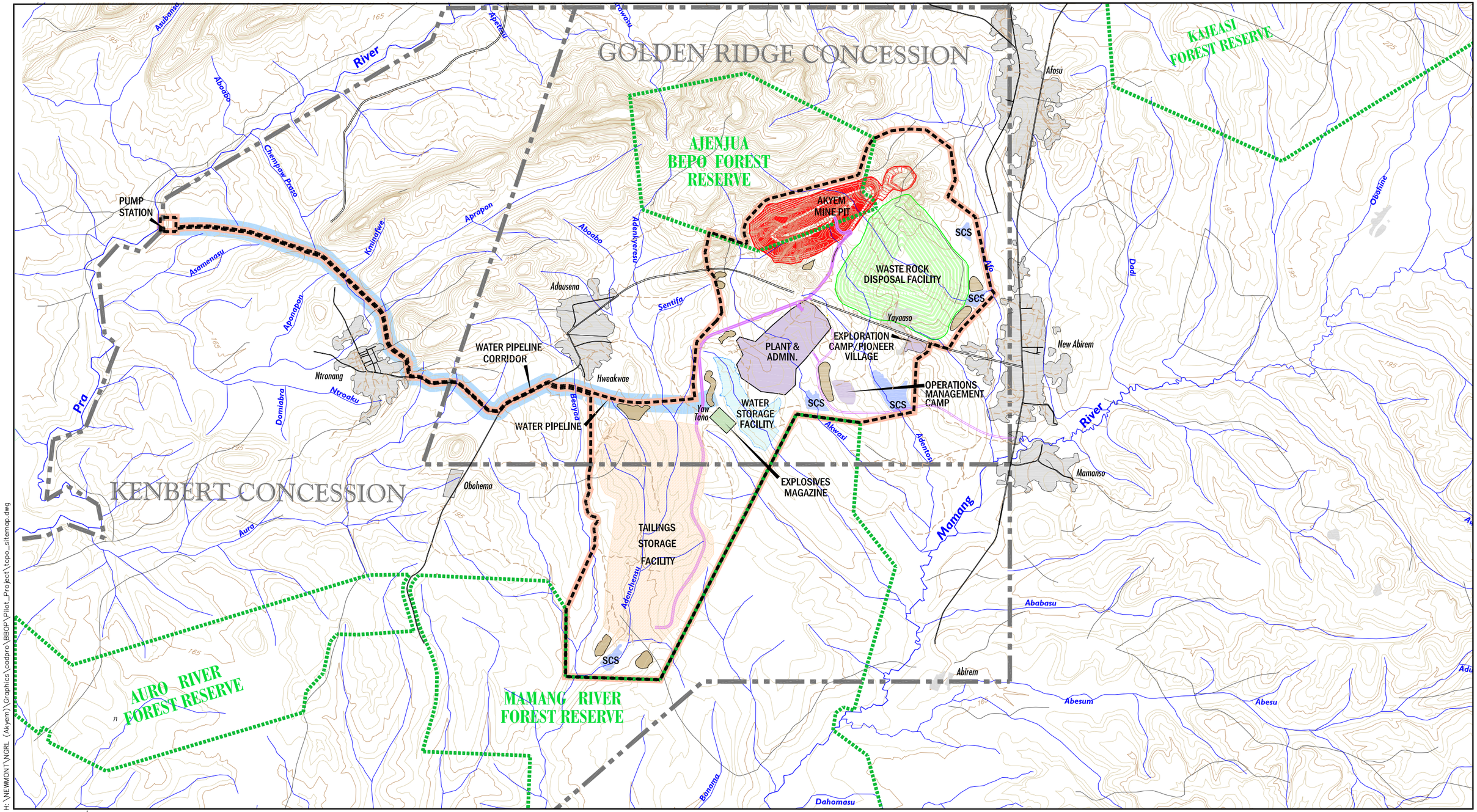
NGRL is a partner in the Business and Biodiversity Offset Programme (BBOP) which explores the concept of establishing BIODIVERSITY OFFSETS to compensate for significant residual, biodiversity impacts that can occur with development projects. Recognising that the proposed Project would affect biological resources and socioeconomic conditions in and around the Project area, NGRL volunteered the proposed Akyem Project as a pilot BBOP project. NGRL in cooperation with Conservation International – Ghana (CI-Ghana) and AMEC Geomatrix, Inc. (Geomatrix), evaluated the proposed Project relative to the biodiversity offset design processes, developed via the BBOP tools and methodologies. This Case Study report documents methods used to apply the draft BBOP tools and methodologies of the Draft Biodiversity Offset Design and Draft Community Biodiversity Offset Cost-Benefit Handbooks, to the proposed Akyem Project. BASELINE biological and social data used to prepare this report were collected between 1998 and 2008; efforts to design a biodiversity offset were initiated in 2007.

This Case Study report is preliminary because the proposed Project is still in the planning stages and has only recently been approved by the Ghanaian government. Until decisions are made to advance the proposed Project, definitive statements and decisions regarding certain aspects of the BBOP process, such as STAKEHOLDER PARTICIPATION and precise boundaries of the BENCHMARK and offset areas, have not been fully developed. Consequently, this report should be viewed as a "virtual" exercise that would need to be revised and updated as additional information and data become available and decisions are made concerning the viability of the Project and stakeholders involved in the offset design.

Project Summary

The proposed Akyem Project would include development of an open pit mine (comprised of east and west pits), construction of a waste rock disposal facility, tailing storage facility, ore processing plant, water storage dam and reservoir, water transmission pipeline, sediment control structures and diversion channels, haul and access roads, and support facilities. As proposed, a portion of the waste rock in the disposal facility would be placed into the open pit during the closure and decommissioning phase of the project. **Figure ES-1** and **Table ES-1** show key project components and summarise the project.

Approximately 1,428 hectares would be directly disturbed by the project in an approximately 1,903 hectare Mining Area (mine development area and buffer zones). Concurrent reclamation would be accomplished when possible to reduce physical and biological impacts on the LANDSCAPE. Approximately 74 hectares of the surface disturbance associated with the Project would occur in the Ajenjua Bepo Forest Reserve (ABFR).


GOLDEN RIDGE CONCESSION
KENBERT CONCESSION
AJENJUA BEPO FOREST RESERVE
KAJEASI FOREST RESERVE
AURO RIVER FOREST RESERVE
MAMANG RIVER FOREST RESERVE
PUMP STATION
AKYEM MINE PIT
WASTE ROCK DISPOSAL FACILITY
SCS
PLANT & ADMIN.
EXPLORATION CAMP/PIONEER VILLAGE
OPERATIONS MANAGEMENT CAMP
WATER PIPELINE CORRIDOR
WATER PIPELINE
WATER STORAGE FACILITY
EXPLOSIVES MAGAZINE
TAILINGS STORAGE FACILITY
Adausena
Hweakwae
Ntronang
Obohema
Afosu
New Abirem
Mamanso
Abirem
Ababasu
Abesum
Abesu
Dahomasu
Aboabo River
Chempow Praso
Asamenasu
Aponapon
Ntroaku
Domiabra
Prd
Aura
Mamang
Obohine
Dpoi
Afo
Akwasi
Adentosu
Adenchensu
Adenkyeresu
Sentifo
Yaa Tana
Yayaaso
Kninakwe
Apropon
Apeasu
Atubansa
Boayaa
Banama
0
Metres
2000
1:50,000
AMEC Geomatrix
13026
Proposed Pipeline Corridor
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Soil Stockpile
Stream/Drainage
Existing Access Road
Proposed Road
Water Storage Facility
SCS Sediment Control Structure
Waste Rock Disposal Facilities
Primary Project Features
Akyem Project
Eastern Region, Ghana
FIGURE ES-1
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TABLE ES-1
Akyem Project Summary

Item	Description
Company Name	Newmont Golden Ridge Limited (NGRL), a subsidiary of Newmont Mining Corporation
Project Name	Akyem Gold Mining Project
Development Sector	Natural Resource Development (gold reserves)
Country	Ghana, West Africa
Partners	None
Principal Biodiversity Components	Upper Guinean Forest within the Moist Semi-deciduous Zone, with associated plants and animals
Scale of Impact	1,428 hectares of disturbance including 74 hectares in Ajenjua Bepo Forest Reserve; all but 162 hectares will be reclaimed. Approximately 1,331 persons in 242 households live within the project FOOTPRINT.
Offset Description	Biodiversity components subject to residual impacts following mining and reclamation (30 years) chiefly include density of large trees and IUCN Vulnerable plants. To achieve NO NET LOSS in biodiversity, an offset area of 80 HABITAT HECTARES of gain is necessary within a 250-hectare offset site located within the Mamang River Forest Reserve. In addition to conservation of habitat and species involves, the primary benefit of the offset to local communities could be the provision of medicinal plants.
Links to Newmont Information	http://www.beyondthemine.com/2007/?l=2&pid=5&parent=19&id=173 http://www.newmont.com/en/pdf/nowandbeyond/NB2005-Ghana.pdf http://newmontghana.com/images/stories/pdf/community_biodiversity_use_assessment-akyem_ci_ghana.pdf http://www.beyondthemine.com/2007/ http://www.newmont.com/en/index.asp http://www.newmontghana.com **Newmont Golden Ridge Limited. 2008.** Final Environmental Impact Statement, Akyem Project, Eastern Region, Ghana. Volume I – Text, Volume II – Annexes. November.

Table Format Source: BBOPRome2008DOC14FactSheetandCaseStudiesOutline

NGRL issued a Final Environmental Impact Statement (EIS) for the Akyem Project to the Ghana Environmental Protection Agency (EPA), dated November 2008. The EIS provided the basis for a decision by the EPA to issue an Environmental Permit for the project. Environmental and socioeconomic commitments to avoid, mitigate, and compensate for project impacts are addressed in the EIS and are consistent with proposed activities that would be implemented following the BBOP methodology and philosophy. In February 2009 the EPA issued the Environmental Permit to NGRL.

Description of Mining Area

The proposed Mining Area is located within the Upper Guinean Forest, within the Moist Semi-deciduous Zone, and is characterised by steep hills and undulating landscape with elevations ranging from 155 to over 295 metres above mean sea level. The proposed Project is located in an area on the southern boundary of the ABFR which is primarily a complex of agricultural land from which the original forest has been converted. The portion of the ABFR that would be affected by mining (74 hectares) has previously been significantly damaged or destroyed by encroachment of local subsistence farming,

intensive logging, and establishment of plantations of non-indigenous trees. Other threats to biodiversity in this area include invasion of noxious weeds and bushmeat hunting, which occurred in the area prior to NGRL's mining interests.

There are an estimated 242 (1,331 persons) households present within the Mining Area (residents). An additional 1,443 households (7,937 persons) are located outside the Mining Area but have farms within the Mining Area (non-residents). There is one settlement (Yayaaso; population 570), multiple hamlets, and a number of homesteads within the Mining Area.

Potential Project Impacts on Biodiversity

The southern end of the ABFR would be impacted through development of the open pit. Construction of the various mine facilities would remove crops, fallow fields and patches of secondary forest and remove wildlife habitat. Seven tree species of conservation concern (IUCN Vulnerable and Ghana Scarlet Star) within the Mining Area would be affected. Three species of forest antelope, one flying squirrel species, three bird species, two primate species, and two bat species (listed as Vulnerable or Near Threatened by IUCN) could be adversely affected. Construction of mine facilities would affect wetland and riparian communities in ephemeral drainages but would not adversely affect fish populations present in rivers and larger tributaries located downstream from the Mining Area.

Planned Mitigation and Compensation Measures

The EIS (NGRL 2008) identifies MITIGATION and compensation measures associated with the proposed Project to mitigate potential impacts to the environment and communities. These mitigation measures are designed to:

- Minimise impacts by limiting the degree or magnitude of the action and its resulting effects,
- Rectify the impact by repairing, rehabilitating or restoring the affected environment,
- Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action and/or
- Compensate for the impact by replacing or providing substitute resources or environments.

Potential Residual Biodiversity Impact and Offset Requirement

Using the methodologies developed as part of BBOP, it has been determined that project-related impacts would result in a residual net-loss of biodiversity and therefore the proposed Project would benefit from the design and implementation of a suitable biodiversity offset. The nearby Mamang River Forest Reserve (MRFR) was selected as the benchmark; within this area nine structural, compositional and social/cultural ATTRIBUTES of biodiversity were evaluated and weighted. At the IMPACT SITE, a loss of biodiversity equating to 320 habitat hectares, was calculated using the nine benchmark attributes. Similarly, the loss of biodiversity was calculated using the same method 30 years after the completion of reclamation and RESTORATION activities. The requirement for the biodiversity offset, or the residual loss between pre-project and post reclamation conditions (after 30 years of reclamation and RESTORATION) for the proposed Project is estimated to be 80 habitat hectares using the BBOP design methodology.

Offset Site Selection and Evaluation

Five candidate offset options for the proposed Project including: (1-3) establishing an area within one of three forest reserves (Mamang River, Auro River and Nsuensa Forest Reserves); (4) contributing to a trust fund for Globally Significant Biodiversity Areas; and (5) establishing a District Assembly Environmental Fund. Scores for 22 screening criteria were recorded for each offset option; the MRFR received the highest score.

A 250-hectare site located on the northern and eastern margin of the MRFR was selected as the offset site. This area, near the communities of Abirem, New Abirem, and Mamanso, has been altered by farming activities within the reserve (32 hectares), timber removal, and intensive cropping to the margin of the reserve. It has the potential to provide an important corridor linking off-reserve areas, farm lands and other forest reserves such as Nsuensa and Auro River Forest Reserves. It could also serve as a refuge for animals that would be affected by the construction of the mining facilities and structures. The conservation and enhancement of this forest would also protect species of conservation concern and seed banks for species of conservation concern and provide medicinal and other plants of ethnobotanical importance for local communities. The site could also provide opportunities for ECOTOURISM which would provide revenue and employment for the local economy. With completion of the offset, the net increase in biodiversity is estimated at 93 habitat hectares.

Although not analysed in detail in this report, the use of the Ajenjua Bepo Forest Reserve is also a potential offset option. Recent studies (CI 2008) have shown that some northern portions of this forest reserve have high biodiversity values and it is of sufficient size to compensate for projected residual losses of biodiversity. Before selecting the most appropriate offset area, STAKEHOLDER PARTICIPATION and engagement will be incorporated to reflect preferences and priorities.

Potential Impacts of Proposed Offset Activities on Local Communities

Because the proposed Project has only recently received regulatory approval, biodiversity offset-specific stakeholder engagement has not been integrated into this plan, the range of management practices that would be implemented to offset biodiversity and socioeconomic impacts is tentative. The socioeconomic impacts that would result from development of the mine and ancillary facilities would be mitigated or compensated through measures addressed in the EIS (NGRL 2008) and, consequently, are not fully incorporated or addressed in the BBOP process. The only impacts for which mitigation and compensation are not addressed in the EIS are associated with development of the 250-hectare offset area in the MRFR. Under existing conditions, there are 32 hectares of crop land within the boundaries of the MFRF. Proposed management activities in the offset area to compensate for lost and degraded biodiversity values would result in the conversion of this crop land to forest communities dominated by native species. The stakeholders that would be affected by this conversion of crop land would be compensated in a manner consistent with the commitment to compensation for loss of other affected crop land described in the EIS.

Decisions and options concerning design and management of mitigation and offsets have been addressed in the impact analysis submitted to the EPA (NGRL 2008) and in this case study. These documents and supporting information will be available for public review.

BBOP PRINCIPLES

The biodiversity offset for the proposed Akyem Project has been developed, consistent with the 10 BBOP principles established by the BBOP Advisory Committee during the BBOP6 meeting in Potomac, Maryland, December 1-3, 2008. These principles address the integration of biodiversity and socio-economic conditions necessary to identify, manage, and sustain a viable offset area.

1. No Net Loss

Design and management of the offset are planned to go beyond NO NET LOSS of biodiversity by achieving a NET GAIN of biodiversity through plantings of native species and protection of forest communities from non-sustainable, extractive uses. Compensation for socioeconomic impacts associated with development of the offset would include payments for land that is taken out of production consistent with programmes committed to in the EIS for other affected cropland. Priorities in management include enhancement of native populations of plants and animals, increased efficiency in crop production, and development of additional protein sources though aquaculture and raising locally adapted animals valued by local residents (e.g., giant snails, poultry and grasscutters).

2. Additional Conservation Outcomes

Amounts of offset and mitigation biodiversity gains would exceed losses from the proposed project. The offset area would be sufficiently large to provide compensation that exceeds losses resulting from the proposed project. Because enhancement of the offset area would consist of incremental increases in biodiversity parameters, a parcel of at least 250 hectares would be required to provide the 80 habitat hectares needed for biodiversity compensation. With completion of the offset, the total net increase in biodiversity is estimated to be 13 habitat hectares.

3. Adherence to Mitigation Hierarchy

MITIGATION measures would re-establish diverse plant communities that include species of conservation concern and species with high ethnobotanical values. The local and regional viability of all plant and animal species and populations would be maintained through mitigation (reclamation) and offset management practices. The proposed offset is consistent with the MITIGATION HIERARCHY in that it has been calculated to address those RESIDUAL IMPACTS that persist after AVOIDANCE, MINIMISATION, and RESTORATION efforts. It is also possible because field work has established that the residual loss of biodiversity from the proposed project is not irreplaceable and is capable of being offset.

4. Limits to What Can be Offset

Comprehensive biodiversity studies conducted to assess impacts and define offset requirements were the primary means of assessing the IRREPLACEABILITY and VULNERABILITY of various local features of biodiversity. Based on site-specific studies and reviews of scientific literature and conservation databases, it was determined that the residual impacts on components of biodiversity in the project area were capable of being offset.

5. Landscape Context

Locations of offset options within the area surrounding the Project were evaluated based on a variety of ecological factors. The MRFR was selected because of existing high biodiversity values, proximity to the impact area and impacted population, and threats from unauthorised consumptive uses. Biodiversity gains from the 250 hectare offset area will complement and enhance the overall biodiversity of the 5,300 hectare MRFR. Because the MRFR is part of a larger series of forest reserves, these benefits may also be realised in adjacent forest reserves.

6. Stakeholder Participation

Stakeholders will be involved in determining the offset design and management when the proposed Project develops beyond the planning stages. The potential offset activities outlined here are hypothetical and will be subject to review by stakeholders identified in this case study and modification as the project proceeds through the planning stages. NGRL is committed to engaging stakeholders to share in the benefits and risks of the project and of the offset area. This is to be accomplished in full consideration of legal and customary arrangements.

7. Equity

Although comprehensive stakeholder participation has not yet been integrated into the preliminary offset design, the Akyem Project will encourage and engage stakeholders to participate in the design and management the offset with full consideration of the recognised rights of indigenous peoples and local communities. As a result, stakeholders will share the rights and responsibilities, and risks and rewards associated with both the project and the offset in a fair and balanced manner.

8. Long-Term Outcomes

Sustainability of the biodiversity gains though mitigation and establishment of an offset will depend on a strong commitment from stakeholders and NGRL to long-term management and monitoring. NGRL has a corporate policy in place to work with stakeholders to demonstrate economic and CULTURAL VALUES associated with sustainable land use in the offset area and areas mitigated through reclamation of mined lands.

9. Transparency

Decisions and options concerning design and management of mitigation and offsets have been addressed in the impact analysis submitted to the EPA and in this case study. These documents and supporting information, such as the subsequent information on the progress with the offset over time, will be available for public review.

10. Science and Traditional Knowledge

Studies of biodiversity and socioeconomic parameters in the Project area identified losses to the natural and human environments that would be compensated in the offset area. Ghanaian social scientists, ecologists, and biologists were the primary investigators in identifying potential impacts and selecting appropriate offset areas. The heavy reliance on Ghanaian expertise helped ensure that traditional knowledge and scientific data were integrated into all phases of the BBOP process.

Summary and Lessons Learned

Analysis of pre-project and post-project conditions indicates that the biodiversity ATTRIBUTES selected as proxies to represent compositional and structural features of impacted biological communities in the Project Area would largely be mitigated through post-mining reclamation. Biodiversity components subject to residual impacts following 30 years of mining and reclamation would include reductions in the density of large trees (whose density would be reduced) and IUCN Vulnerable plants. Other BENCHMARK attributes of biodiversity would experience smaller losses in HABITAT HECTARES and the benchmark attribute of patch size would realise a small net gain following reclamation. To attain no net loss in biodiversity from development of the proposed Akyem Project, it would be necessary to offset a total of 80 habitat hectares at a 250-hectare offset site located in the MRFR. The primary biodiversity offset benefit to local communities could be the sustained and regulated provision of medicinal plants and other non-timber forest products.

As a result of working through the BBOP Design methodology (BBOP 2008a), the following areas of improvement or modification were identified to more clearly explain or demonstrate the methodologies.

- It was difficult to integrate the socioeconomic components of the BBOP process with the biological components. A single streamlined BBOP guidance manual that integrates these elements would help BBOP practitioners.

- The "tools-based" methodology specified in the Handbook for designing an offset is relatively rigid. A "principles-based" approach may facilitate innovation and result in a focused and locally adapted offset that achieves the necessary CONSERVATION OUTCOMES.

- The mechanism by which the BBOP methodology accounts for socioeconomic and biodiversity gains resulting from mitigation (reclamation of mined land) or net positive socioeconomic effects of project development should be addressed more explicitly. A principles-based approach with a variety of options for applying them should be pursued in the future.

- The BBOP methodology could more explicitly provide guidance to account for the time lag between impact, successful project reclamation and establishment/development of an offset.

- The BBOP methodology could address the potential difficulties and possible solutions in finding and acquiring expanses of land available for implementing offset activities.

- A local offset was identified for proposed Akyem Project but the maximum CONSERVATION GAIN may be achieved at a regional offset site. If a regional offset site were required or selected, an existing PROTECTED AREA could be selected to maximise the conservation gains.

- If it is anticipated that a project would be subjected to analysis and development in accordance with the BBOP approach, pre-project studies (e.g., BASELINE studies) should be designed and conducted to provide quantitative measures of key biodiversity components that would be needed to comport with the BBOP methodology as well as meeting data requirements for impact assessments.

- Offset selection in BBOP guidance should address the consideration of degraded areas as well as areas with existing high biodiversity values. It is difficult to manage for and measure small incremental increases in biodiversity in areas with existing high levels of biodiversity. Gains in biodiversity in a degraded area may be greater than gains realised in areas that initially have higher biodiversity. There does not appear to be a scientific basis for focusing offset activities on areas with existing high biodiversity values as compared to focusing biodiversity management emphasis on degraded areas.

- Analyses of environmental impact in the EIS and in the BBOP process should be consistent.

General comments regarding our application of the Cost-Benefit Handbook (BBOP 2008b) to the proposed Akyem Project include:

- The information gathered during the biological portion of the study is not readily transferable to the cost-benefit analysis.

- The cost-benefit analysis does not work well for projects that are still in the planning stages and have not yet been approved, either by stakeholders, the government or company directors.

- The cost-benefit analysis does not appear to allow biodiversity benefits of the proposed Project to be considered, nor do provisions to account for the benefits of reclaimed/restored land and its uses appear to be addressed in the Cost-Benefit Handbook.

1.0 INTRODUCTION

Newmont Golden Ridge Limited (NGRL or the "Company"), a subsidiary of Newmont Mining Corporation (Newmont), is proposing to develop gold reserves at the Akyem Project (the "Project") site in the Birim North District of the Eastern Region of Ghana, West Africa. The Project is located approximately 3 kilometres west of the district capital New Abirem, 133 kilometres west of Koforidua, the regional capital, and 180 kilometres northwest of Accra, the national capital (**Figure 1, Appendix A**). The proposed development lies within an area belonging to the Akyem Kotoku Paramountcy.

In recognition that the Project would affect biological resources and socioeconomic conditions in and around the Project Area, NGRL volunteered to become a partner in the Business and Biodiversity Offset Programme (BBOP) to explore biodiversity offset concepts to compensate for residual, unavoidable impacts that would be caused by the proposed Project. The Company and NGRL are members of the broader BBOP Advisory Committee composed of representatives of non-governmental organisations (e.g., Forest Trends, Conservation International (CI), others), academics, biologists, impact specialists, etc. committed to conservation of biodiversity and the exploration of biodiversity offset concepts, principles, methodologies, and the development of pilot projects to apply and test outcomes from BBOP.

NGRL volunteered the proposed Akyem Project into the portfolio of BBOP pilot projects located in various countries around the world. The goal of the pilot projects is to apply the current (2008) BBOP methodologies under development and offer suggestions for refinement based on the developer's experience.

In this report, the Akyem Project Area (or Study Area) generally includes the Ajenjua Bepo Forest Reserve to the north, the area between the Pra River to the west and New Abirem on the east, and the northern portion of the Mamang River Forest Reserve to the south. The Mining Area referred to herein includes land within the Project Area that will be required for mine development and includes disturbed areas, buffer zones and land required for construction of resettlement villages (refer to **Figure ES-1**).

This report describes the proposed project, existing biodiversity and socioeconomic conditions in the Project Area, potential impacts on biodiversity from developing the Project, and an analysis of offsets to compensate for unavoidable impacts associated with the Project. Biodiversity and socioeconomic information for the Akyem Project Area (Project Area) used in developing this pilot offset programme is included in Geomatrix Consultants (2007a,b,c and 2008), Conservation International (2007 and 2008), Conservation International – Ghana (2005, 2006, and 2008a,b) and SGS (1998 and 2004a,b,c). Other data and information used to prepare this report are contained in the Final Environmental Impact Statement (EIS) for the Akyem Project, dated November 2008 (NGRL 2008).

This Case Study report was prepared in general conformance with several draft BBOP documents including the Draft Biodiversity Offset Design Handbook (Design Handbook, BBOP 2008a) and the Draft Community Biodiversity Offset Cost-Benefit Handbook (Cost-Benefit Handbook, BBOP 2008b). The organisation of this report is generally consistent with guidance NGRL received from the Secretariat in October 2008 (*Guidance on the Preparation of BBOP Pilot Project Case Studies – October 2008*).

This Case Study report integrates the biological or conservation aspects of the biodiversity offset process with the compensation or LIVELIHOOD aspects of the offset process. To that end, the assessment endeavored to blend both Design activities and Cost-Benefit activities into the same sections of this report. In doing so, the Pilot applied the implementation "tools" provided in the Design and Cost-Benefit Handbooks were applied to create the various tables presented in **Appendices B** and **C**. Many of these tables include notations which reference specific BBOP tools. Figures referenced in this report are contained in **Appendix A** and photographs presented herein were taken while completing several baseline studies during 2007-08.

The biodiversity offset for the proposed Akyem Project was evaluated in consideration of the 10 BBOP principles established by the BBOP Advisory Committee during the BBOP6 meeting in Potomac, Maryland, December 1-3, 2008. These principles address the integration of biodiversity and socio-economic conditions necessary to identify, manage, and sustain a viable offset area.

2.0 PROJECT CONTEXT

This section outlines the existing biological and human environment at the proposed Project site; additional descriptions are provided in **Section 5.0**, below, and in NGRL (2008). Stakeholders associated with the Project, including local governmental authorities, local communities, traditional authorities, focused groups, regulatory agencies, non-governmental agencies, private sector entities and academic institutions, are identified in **Section 5.0**.

2.1 BIOLOGICAL ENVIRONMENT

The proposed Mining Area is located within the Upper Guinean Forest, extending from Guinea to Cameroon. The Mining Area lies within the Moist Semi-deciduous Zone of forest and is characterised by steep hills and undulating landscape with elevations ranging from 155 to over 295 metres above mean sea level. The proposed Project is located on the southern boundary of the 569 hectare Ajenjua Bepo Forest Reserve (ABFR). Land outside of the ABFR consists of crop land, plantations of non-native trees, and small, isolated patches of secondary forest (**Figure 2**, **Appendix A**). The portion of the ABFR that would be affected by mining has previously been degraded by encroachment of local subsistence farmers, intensive logging, and establishment of plantations of non-indigenous trees. Other threats to biodiversity in this area include invasion of noxious weeds and bushmeat hunting which were occurring in the area prior to NGRL's mining interests.

2.2 HUMAN ENVIRONMENT

The proposed Project is located in the Birim North District, which has a population of 123,579 (2000 population census). The district has a lower population density (99 persons per square kilometre) than the average for the Eastern Region of 109 persons per square kilometre, reflecting the prevalence of relatively small settlements in the district. There is one settlement (Yayaaso; population 570), multiple hamlets, and a number of homesteads within the Mining Area. As of March 2008, NGRL had identified 2,734 farms within the Mining Area. There are 242 (1,331 persons) households located within the Mining Area (residents) and an additional 1,443 households (7,937 persons) located outside the Mining Area but have farms within the Mining Area (non-residents).

3.0 PROJECT SUMMARY

The proposed Akyem Project would include development of an open pit mine (comprised of east and west pits), construction of a waste rock disposal facility, tailing storage facility, ore processing plant, water storage dam and reservoir, water transmission pipeline, sediment control structures and diversion channels, haul and access roads, and support facilities (**Figures 2** and **3, Appendix A**). As proposed, a portion of the waste rock in the disposal facility would be placed into the open pit during the closure and decommissioning phase of the project. Based on current reserve estimates, NGRL proposes to process approximately 8.8 million tonnes of ore annually (on average) to ultimately extract 7.7 million ounces of gold over a projected 15-year life-of-mine.

Approximately 1,903 hectares would be required for mine development and buffer zones (i.e., Mining Area); additional acreage would be required to accommodate a resettlement village which location has not yet been chosen. Of this amount, approximately 1,428 hectares would be actually disturbed by the project. Concurrent reclamation would be accomplished when possible to reduce physical and biological impacts on the landscape. Approximately 74 hectares of the surface disturbance associated with the Project would occur in the Ajenjua Bepo Forest Reserve (ABFR).

The Mining Area (**Figure 3**, **Appendix A**) is located in portions of NGRL's Kenbert and Golden Ridge Concessions. The concessions demonstrate ownership and royalty considerations. The project layout (**Figure 3**) is defined and must conform to the Environmental Permit issued by the EPA. Any expansion to mining activities that may be warranted would be subject to additional environmental review and permitting by the EPA.

The Project would involve relocation and resettlement of one settlement (Yayaaso), multiple hamlets and a number of farmsteads with individual residences. In total, 2,734 farms (average farm size < 0.4 hectare) within the Mining Area would be directly impacted through loss of farmland and require compensation and LIVELIHOOD replacement. Households located within the Mining Area total 242 and would also require resettlement.

Construction of the Project would require up to 30 months to complete with employment during construction peaking at approximately 3,300 workers. The short-term employment mix of construction contract workers at any one time could include up to 1,155 skilled, semi-skilled and unskilled workers from within the affected communities. Company policy dictates that unskilled labour would be recruited from within the area of mine development and construction contractors would be required to source unskilled labour locally. Once mining operations commence, employment associated with the Project is estimated at 3,200 permanent Ghanaian workers (employees and contractors) with 25 to 30 percent of the workforce coming from the local communities based on a similar mine size at Ahafo Mine in the Brong Ahafo Region of Ghana. Contractors would augment this workforce to provide laboratory, vehicle and equipment maintenance, catering and transport services.

At the conclusion of mining, the open pit (comprised of the east and west pits) would be approximately 900 metres wide, 2,560 metres long and 480 metres deep with a FOOTPRINT area of approximately 139 hectares. NGRL proposes to place waste rock into the smaller eastern lobe of the open pit concurrent

with the latter stages of active mining and reclaim approximately 19 hectares of land in this portion of the open pit. This would reduce the overall pit length to 1,920 metres.

Placement of waste rock in a portion of the western and larger open pit has been identified as a key closure and decommissioning objective by NGRL based on the following criteria and considerations: (1) proximity of local population to the open pit area to ensure overall safety, (2) importance of agriculturally productive land in proximity to local populations and (3) minimisation of the visual impacts to residents of communities located east of the mine pit. Placement of waste rock in the open pit would be completed only if the action would result in a stable land configuration that minimises long-term environmental impacts, does not compromise proposed post mine land uses, the quality of water in the reclaimed mine area meets standards for beneficial use, and the reclaimed land is physically safe for people to access and does not pose a human health risk. Such decisions would be made in consultation with the Ghana Environmental Protection Agency (EPA).

Assuming environmental conditions and safety issues are not compromised; approximately 130 million metric tonnes of waste rock would be transported following mining from the Waste Rock Disposal Facility and placed into a portion of the larger western open pit in accordance with the Closure and Decommissioning Plan, resulting in reclamation of an additional 51 hectares of land. Total open pit area being reclaimed would be 70 hectares (19 hectares for the east open pit and 51 hectares for a portion of the west open pit). The resultant open pit would be an oval-shaped feature approximately 960 metres along its axis, covering an area of approximately 69 hectares. Other features associated with the Project would be abandoned and reclaimed in accordance with a Closure and Decommissioning Plan, to be prepared by NGRL within two (2) years of cessation of mining and approved by EPA. The primary feature that would remain following reclamation activities would be an open pit lake, covering approximately 69 hectares. NGRL believes that the water source in the pit could be developed into an asset if creative thought is applied to how such a source of water can be used in a post-mine environment. Discussions have been initiated with relevant institutional stakeholders to identify viable options for productively using this water source.

3.1 PRIMARY ISSUES AND POTENTIAL IMPACTS

The primary issues associated with the proposed Project were identified through three principal means: (1) the public consultation process which provided interested and affected parties opportunities to identify issues and concerns and receive Project-related information; (2) consultations with a variety of government institutions; and (3) analyses completed by technical specialists. The outcome of the public consultation process was preparation of a Scoping Report and Terms of Reference. The Terms of Reference, along with the outcomes of consultations held with government officials resulted in identification of several primary potential issues associated with the proposed Project. The expressed views resulting from the consultation process are described in the EIS (NGRL 2008) and are summarised below:

3.1.1 Biological Environment

- Loss of habitat (including some in the Ajenjua Bepo Forest Reserve) and increased pressure on remaining fauna,
- Protection of species of conservation concern,

- Loss of integrity of Ajenjua Bepo Forest Reserve,
- Formation of a pit lake,
- Impacts to forest habitat and
- Plans for timber removal and replacement.

3.1.2 Physical Environment

- Deterioration of air quality from increased dust levels,
- Contamination of surface and/or groundwater resources,
- Formation of a pit lake,
- Soil erosion and
- Impacts to water quality and quantity.

3.1.3 Human Environment

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

Guided by these expressed potential issues and impacts resulting from the consultation process described above and in NGRL (2008), technical specialists conducted an evaluation using scientific data collected at the Study Area and reported in the scientific literature to assess the direct, indirect and CUMULATIVE IMPACTS associated with the Project. These assessments provided the basis from which measures to mitigate the impacts were identified.

3.2 MITIGATION MEASURES

In response to issues and potential impacts identified above, NGRL designed a variety of mitigation measures to:

- Minimise impacts by limiting the degree or magnitude of the action and its resulting effects,
- Rectify the impact by repairing, rehabilitating or restoring the affected environment,

- Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action and
- Compensate for the impact by replacing or providing substitute resources or environments.

NGRL's general philosophy with regard to mitigation of impacts to the biological, physical and human environments is grounded in its commitment to conduct this Project in a manner that is transparent and in accordance with Ghanaian rules and regulations and is compliant with NGRL's internal standards and policies. The Company abides by stringent internal policies that affect the Company's behaviour with respect to its environmental, social and health and safety responsibilities at the various locations that the Company operates around the world. The Company has established management, audit and reporting procedures to ensure the manner individual projects are developed, operated and decommissioned is in compliance with internal policies and accepted international practice.

Numerous mitigation programmes and monitoring systems are in-place at the Company's existing Ahafo Mine that have proven the Company's willingness to honour its commitments to individuals, communities and the environment. Examples of the mitigation programmes and monitoring that are ongoing at Ahafo Mine include:

- Monitoring of air resources, climate, surface water, groundwater, aquatic resources and revegetation success,
- Concurrent reclamation of disturbed surface areas that are no longer needed for ongoing operations,
- Construction and maintenance of sediment control structures to control sedimentation,
- Installation of plastic-lined ditches that host reagent pipelines to provide secondary containment in the event a leak occurs,
- Operation of a nursery at which various floral species are evaluated and propagated for use in ongoing reclamation of disturbed areas,
- Periodic external assessments of the Land Acquisition and Compensation Programme, Resettlement Action Plan, Livelihood Enhancement and Community Empowerment Programme and Vulnerables Programme and,
- Regular independent assessment of Management System standards and procedures with reports issued outlining areas for improvement.

The Company intends to exercise the same level of care and attention to detail with respect to mitigating its impacts at Akyem and implement improvements in areas, where practicable. Details regarding planned mitigations for the Project are found in **Section 5.3**, below.

4.0 BUSINESS CASE FOR A BIODIVERSITY OFFSET

NGRL is committed to environmental stewardship and to building and maintaining relationships with communities in areas where they operate. They are dedicated to develop, operate and close mines in a manner that improves the lives of the people in the surrounding communities, in a safe and environmentally responsible manner. By maintaining high standards for protecting human health and the environment, and working in cooperation with our host communities, NGRL endeavors to create sustainable, long-term economic and social opportunities.

As part of its corporate environmental and social responsibility framework, Newmont Mining Corporation is developing corporate-level strategies on biodiversity, one component of which involves researching biodiversity offsets as tools for conservation. NGRL recognises that utilising biodiversity best management practices can support companies in securing their license to operate, improve relations with local people and the international community, and help secure access to land and capital. NGRL also recognises the concerns expressed by stakeholders related to biodiversity impacts associated with forest reserve components of the Akyem Project and is committed to engaging with appropriate local, regional, national, and international stakeholders to determine appropriate mitigation mechanisms relative to the potential impacts of the Project.

Conservation International (CI), a partner in NGRL's biodiversity offset programme, prepared an analysis of international regulatory and legal requirements for biodiversity offsets. This analysis is presented in their report titled "*Defining and Refining Regulatory or Legal Requirements for Biodiversity Offsets*" (CI-Ghana 2008a).

Ghana has laws and regulations pertaining to mining and environmental protection, which were reviewed by CI-Ghana (2008a). Although biodiversity offsets are not specifically addressed in Ghana laws and regulation, Ghanaian policy is to conserve the country's biological diversity while ensuring that the biological resources provide lasting social, economic and environmental benefits to the population through their efficient and equitable use.

The Company is cognisant of the importance of managing the environment in the planning and construction of their two mine developments in Ghana, the Ahafo Mine (Newmont Ghana Gold Limited) and the proposed Akyem Mine (NGRL). Deforestation has been ongoing in Ghana for many decades independent of mine exploration. One of the main activities the Company conducts in the early stages of these projects before mining begins is propagation of trees in nurseries in preparation for reforestation and ultimate reclamation when the mines close. The Company has established three nurseries and has successfully propagated more than 90 species of trees. In addition to planting trees on-site, the Company supplies seedlings of native trees from their nurseries to reforestation projects of the government and non-governmental organisations. Since 1998, the Company has donated 112,820 seedlings for reforestation in Ghana.

NGRL demonstrated their commitment to a biodiversity offset for the Akyem Project in their November 2008 EIS submitted to the EPA (NGRL 2008). NGRL committed to enhancing the biodiversity of a target area to offset impacts to biodiversity located in Ajenjua Bepo Forest Reserve

resulting from Project development. This enhancement, at a minimum, would address loss of timber resources, plants of conservation concern, native fauna and habitat, and plants for medicinal and cultural uses. NGRL, is committed to development of the proposed project consistent with the principles of BBOP focused on delivering positive, sustainable, CONSERVATION OUTCOMES.

5.0 BIODIVERSITY OFFSET DESIGN PROCESS

The BBOP Design Handbook (BBOP 2008a) and the Cost-Benefit Handbook (BBOP 2008b) present a structured, integrated approach based on the mitigation hierarchy to avoid, minimise, and compensate for residual biodiversity and socioeconomic impacts of proposed projects that affect biodiversity and community uses of biodiversity. The Design Handbook presents a systematic process for offset planners to use in designing a biodiversity offset programme from conception through site selection and development. The Cost-Benefit Handbook presents methodologies that direct analyses to ensure that biodiversity offsets compensate communities for RESIDUAL IMPACTS on biodiversity based livelihoods and amenities. These methodologies also assess whether biodiversity offsets deliver required conservation (biodiversity) gains without adversely affecting communities.

5.1 BIODIVERSITY COMPONENTS

This section addresses the biodiversity design for the Akyem Pilot Project. Presented below are discussions that:

- Define the Project elements and site boundaries,
- Identify affected communities and potential stakeholders,
- Summarise available BASELINE ecological data on flora, fauna and aquatic resources,
- Discuss the current community use and enjoyment of biodiversity and
- Identify key biodiversity components.

5.1.1 Principal Project Elements and Site Boundaries

The first step in the biodiversity offset design process is defining principal project elements (**Table B-1, Appendix B** and **Table C-1, Appendix C**) and delimiting site boundaries (**Figure 3**). The values in **Table B-1** are used throughout the various steps of the BBOP process to quantify the Project's residual impacts following avoidance, minimisation, and mitigation actions. The hectares of pre-project cover types were determined through overlaying the footprint of proposed disturbance over a cover type map (**Figure 4, Appendix A**) constructed through the interpretation of aerial imagery, with coordinated on the ground verification (Geomatrix 2008a). Biodiversity CONDITION classes were assigned based on comparison to a reference area ("BENCHMARK site"), which represents maximum biodiversity functions and values. The biodiversity condition classes are different from than the Forest Condition Classes designated for Forest Reserves in the EIS (NGRL 2008). Under pristine conditions, the Mining Area was composed of flora and fauna associated with the Moist Semi-deciduous Zone of the Upper Guinean Forest. Currently, no primary forest exists in the Mining Area, but secondary forest exists in forest reserves and as scattered patches preserved as sacred groves or as fallow areas among crop fields and plantations. Three biodiversity condition classes in the Mining Area were assigned:

- All secondary forest in the Mining Area has been assigned a biodiversity Condition Class of I, representing the highest biodiversity values.
- Plantations of cocoa, citrus, oil palm, teak, and non-indigenous timber species are biodiversity Condition Class II, representing low biodiversity.

- Cropland, the mine pit, and unreclaimed facility sites are biodiversity Condition Class III, considered to have no biodiversity values.

5.1.2 Affected Communities

Within the Mining Area, there is one principal COMMUNITY and numerous hamlets and farmsteads. **Table C-2** identifies the communities affected by the Project; **Figures 3** and **5** show communities, hamlets and farmsteads relative to primary Project components.

The primary settlement in the Mining Area is Yayaaso (**Figure 3**). The settlement is regarded as a settler community because the inhabitants are predominantly non-Akyem. The estimated population in 2000 was 570 occupying 100 houses. Using the 2000 Census figures, the International SOS Health Survey published in May 2006 (International SOS 2006) estimated Yayaaso's population in 2006 at 700 persons. Two Social Impact Assessments were prepared for NGRL (CIVA 2005 and GGRL 2008). The initial SIA (CIVA 2005) noted that Yayaaso was a very poor community with a striking feature of the settlement being the poor construction of most of the dwellings. The settlement was served by a piped water supply. A 120 cubic-metre tank, forming part of the water system, was located at Yayaaso and also provided water to Afosu, New Abirem and Mamanso. The community has two public water standpipes, one borehole and one hand-dug well. The community had one public pit latrine and one dumping site neither of which was actively managed.

The Yayaaso community had limited access to electricity and had one operating streetlight. Although the community had a health volunteer, there was no health facility in the village and the people traveled to New Abirem (2 kilometres away) to seek medical attention. The people of Yayaaso were mainly farmers engaged in the cultivation of cocoa, oil palm, citrus, maize, cassava, plantain and cocoyam. Production of cocoa ranged between ½ bag and 30 bags from farms between 0.2 to 6 hectares in size. Food crop farms ranged from between 0.2 to 1.2 hectares; the two most important food crops were cassava and plantain. The settlement had four masons, two carpenters, two mechanics, two electricians, four seamstresses and two tailors. There were four stores, seven drinking spots, and two hair salons in Yayaaso. Of greatest economic value in the community was the presence of two oil palm processing facilities and three maize mills. The settlement of Yayaaso had a primary school and two churches - Pentecost and Mosama, both charismatic Christian religions.

Hamlets, located within the Mining Area (**Figure 5**), housed approximately 631 people based on the 2005 Social Impact Assessment (CIVA 2005). There were also individual farmsteads located in the Mining Area. The buildings in these smaller residential areas were structurally poor and were generally of wattle-and-daub construction with rammed-earth floors and thatched or bamboo roofing with a few buildings having corrugated iron roofs. There were no public facilities or services in these hamlets, and economic activity was limited to agricultural pursuits. Most of the residents of these hamlets raised cash crops of cocoa, oil palm and citrus and grew a variety of food crops including cassava, pineapple, cocoyam, plantain, maize, ginger and vegetables. Residents in the Mining Area belonged to one or more

identifiable communities or social groups, including religious and cultural groups and youth development associations.

Stakeholders are persons or groups who are affected by or can affect the outcome of a project. Geomatrix, in conjunction with the Akyem Project Community Relations staff, prepared a Stakeholder Participation Plan Table, (**Table B-2**) including local communities, local government agencies, traditional authorities, social groups, national government agencies, non-governmental organisations, and representatives of the private sector.

Local communities living within, adjacent to or near the Mining Area were highlighted in the plan for particular attention in the development of a stakeholder engagement strategy for the offset design process. For the purposes of this document, the community of Abirem (**Figure 3**) is considered analogous to Old Abirem. Development projects can impact local communities in a variety of ways, but for the purposes of offset design it is important to focus attention on biodiversity related impacts that will affect local stakeholders and not to become distracted by other broader community impacts which fall outside the sphere of biodiversity offsets and should be included in other corporate responsibility programmes. Those impacts are fully disclosed in the EIS (NGRL 2008).

5.1.3 Biodiversity Components

The proposed Mining Area is mostly a complex of agricultural land from which the original forest has been removed. The structure and composition of habitats in the Mining Area have been fragmented by human activities and primarily support wildlife species adapted to high levels of human activities ("habitat generalists"). Obligate forest species are generally restricted to the forest reserves areas, which tend to support higher levels of biodiversity including the majority of observed species of conservation concern.

FLORA

Natural vegetation in the Mining Area consists mostly of secondary forest in the forest reserves and small patches of secondary forest outside of the reserves, which are periodically cleared as part of the fallow/cropping cycles of agroforestry in Ghana (Geomatrix 2008a). Typically, native forest communities are characterised by a three-story canopy structure with emergent tall trees often exceeding 50 metres in height, with the uppermost canopy having a mixture of evergreen and deciduous species (Hawthorne and Abu-Juam 1995). Existing patches of forest in the ABFR are 35 to 40 metres high. Within the ABFR, plantations of the exotic timber species *Cedrela odorata* and *Gmelina arborea*, were established over the period 1975 through 1983. A relatively diverse understory of shrubs and forbs has established in these plantations.

In Ghana, a biodiversity measurement system (Star Rating System) has been developed that rates individual plant species on their conservation priorities, with most consideration given to rarity and risk of extinction. Of the approximately 3,600 plant species in Ghana, most, with the exception of some weedy species, have been given "star ratings" (**Table 1**). The star ratings for composite species in plant communities are incorporated into a weighted model whose output is a "genetic heat index" (GHI) for a given community (Hawthorne and Abu-Juam 1995). The GHI reflects the concentration of rare species in plant communities, rather than the number of species per unit area and allows for the identification of genetic hotspots, thus allowing prioritisation of conservation areas.

TABLE 1
Star Ratings for Ghanaian Plant Species

Star Rating	Description
Black	Highly significant in context of global biodiversity; Rare globally and not widespread in Ghana.
Gold	Significant in context of global biodiversity; fairly rare globally and/or nationally.
Blue	Mainly of national biodiversity interest; e.g. globally widespread, nationally rare; or globally rare but of no concern in Ghana due to commonness.
Scarlet	Common and widespread commercial species with potential seriously threatened by overexploitation.
Red	Common and widespread commercial species; under significant pressure from exploitation.
Pink	Common and widespread commercial species; not currently under significant pressure from exploitation.
Green	Species common and widespread in tropical Africa; no conservation concern.
Other	Unknown, or non-forest species e.g. ornamentals or savannah plants.

Source: Hawthorne and Abu-Juam (1995)

Studies by SGS (1998 and 2004) and CI-Ghana (2005 and 2006) were conducted in the ABRR that included areas that would not be directly disturbed by mining activities. These studies recorded 434 species of which three were Black Star (*Monocyclantha vignei*, *Berlinia occidentalis*, and *Albertesia cuneata)* and five were Gold Star (*Cola boxiana*, *Baissea multiflora*, *Cussonia bancoensis*, *Albertesia scandens*, and *Antiaris toxicaria*). Of these species, *Monocyclantha vignei* and *Cola boxiana* are listed by the International Union for Conservation of Nature (IUCN) as "Endangered" and *Berlinia occidentalis* and *Cussonia bancoensis*, are listed as "Vulnerable". One of these species, *Cussonia bancoensis*, was recorded in the area to be directly affected by mine development.

The IUCN RED LIST identified seven species of trees found in and adjacent to the Mining Area as Vulnerable and of conservation concern at the international level. These Vulnerable tree species are valuable for timber and subject to over harvesting. They are present in the ABFR and as overstory shade trees in some cocoa plantations outside of the ABFR, in the mine disturbance footprint. These species are common, widespread timber trees in Ghana, under pressure because of their economic value (i.e., Scarlet Star rating). The Gold Star tree species, *Cussonia bancoensis,* recorded outside of the

ABFR, is not common in Ghana, but occurs in all forest zones and regenerates freely in many areas. Most plants in the Mining Area are Green Star species, common and widespread in tropical Africa and of no conservation concern.

Land altered by agricultural activities, outside of forest reserves, consists of a mosaic of plant communities that reflect various stages of cropping and fallow (Geomatrix 2008a). The cropping system begins with clearing and burning of fallow thickets and secondary forest regrowth. The newly opened fields are then planted with a mix of production. Fields typically contain a diverse range of crops. Common cash crops are cocoa, citrus, and oil palm and the most common food crops include cassava, maize, cocoyam, and plantain.

Scattered tall trees that emerge from the cropped areas include *Ceiba pentandra* and *Triplochiton sceroxylon*. As crop fields become less productive, they are abandoned and allowed to revegetate with both native and introduced species. Typically, land remains fallow for three or more years depending on the demand for arable land. If land lies fallow for 10 or more years, it becomes secondary forest. According to Nye and Stephens (1962), five to 10 years of fallow are required to restore nutrients to the soil. Foggie (1962) believes that 20 years or more are required to restore nutrients to the soil. If land is devoted solely to food cropping, Foggie (1962) believes that 13 percent, at most, should be devoted to that purpose each year and the remaining 87 percent should be fallow.

FAUNA

Like the flora, the fauna of the Mining Area has been extensively affected by alteration and fragmentation of habitat resulting from fire, logging, human settlement, and agricultural activities. Bush meat hunting has also reduced numbers and geographic distribution of many mammalian and avian species, especially those associated with forest communities.

Biodiversity studies in the Mining Area reported 24 species of large mammals (Geomatrix 2008b). Large mammal occurrence in the Mining Area is low with rare encounters. The most widespread species is the grasscutter. Interviews and observations concerning large mammals have not indicated use of recorded large mammal species as totems. There is strong evidence of dependence on large mammal species for what is commonly referred to as bushmeat in communities in the Mining Area, which could be a major contributory factor to their low population densities.

Several of large mammal species have national or international conservation status under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which deals with species involved in international trade. The IUCN evaluates species based on their level of

EXTINCTION risk; and the Ghana Wildlife Conservation Regulations (GWC), First Schedule and Second Schedule, control the use of wildlife as bushmeat or for other consumptive purposes.

Mammal species of conservation concern (IUCN Red List) reported from the Project Area include the Near Threatened Maxwell's duiker, black duiker, royal antelope, and Pel's anomalure; and the Vulnerable Zenker's fruit bat. These species are associated primarily with forest habitats but forage in agricultural land and in fallow regrowth. Primate species protected by CITES are the Bosman's potto and bushbaby. Interviews with local residents suggest that several monkey species may be present within or near the proposed Project area; however, biological surveys conducted by CI (2008), SGS (1998 and 2004) and Ghana Wildlife Society (2007) did not confirm the presence of any species of monkey.

Eighteen species of small mammals were reported from baseline biodiversity studies including seven species of shrew, four species of squirrel, eight species of mouse and two species of rat (Geomatrix 2008b). The most common small mammals are the soft-furred mouse, fire-footed rope squirrel, and the zebra mouse. No small mammals reported for the Mining Area are of conservation concern based on IUCN, CITES, or GWC criteria.

Twenty-three species of bats (nine species of insect-eating bats and 14 species of fruit bats) have been documented for the Mining Area (Geomatrix 2008b). Most fruit bats forage and roost in habitats both inside and outside of ABFR. Plantations of non-indigenous *Cedrela odorata* and *Gmelina arborea,* planted in the ABFR, provide seasonally abundant food for some species of fruit bats. The Zenker's fruit bat, round-leaf bat, and horseshoe bat are classified as Near Threatened by IUCN. No bats reported for the Mining Area are regulated under CITES. All fruit bats in the Mining Area are protected under the GWC regulations.

Biodiversity studies conducted over the period 1998 through 2007 in and near the Mining Area identified 258 species of birds of which 23 species were found exclusively in the forest habitats (Geomatrix 2008b). Birds most commonly associated with the ABFR (e.g., turacos, hornbills, trogons, owls, parrots, and most woodpeckers) often have specific habitat or breeding requirements provided by forest habitats. Some forest species require cavities in large trees for nesting, which are mostly available in forest stands in later stages of ecological succession. Eight species in the Project Area are regulated under CITES, 25 species are protected under GWC regulations, and three species are listed by IUCN as species of conservation concern (Vulnerable or Near Threatened).

Biodiversity studies in the Mining Area recorded 19 species of frogs and toads, 21 species of lizards and skinks, 19 species of snakes, and two species of tortoise and terrapin (Geomatrix 2008b). The green mamba and black cobra are common

venomous snakes in and out of forest habitats. The hinged tortoise is classified Vulnerable by IUCN. The Nile monitor, hinged tortoise, chameleon, royal python, and African python are regulated under CITES and the hinged tortoise and Nile monitor are protected under GWC regulations.

Surveys by the Ghana Wildlife Society (GWS 2007) and others identified 162 species of butterflies in the Mining Area, biodiversity typical of moist, deciduous forests. IUCN lists one species for Ghana, the African giant swallowtail which was not found in the Mining Area. Although not identified by IUCN or CITES as of conservation concern, several rare and forest interior species of butterflies were identified.

AQUATIC RESOURCES - FISH

A comprehensive fish and aquatic resource study was completed in the Study Area in 2007 and 2008 (Blay 2008a and 2008b, as reported in Geomatrix 2008d) that focused on updating studies completed previously by SGS (2004c). Fish sampling occurred on the Pra and Mamang rivers and several tributaries, which lie outside of the proposed mine disturbance area. Study Area streams and rivers support an abundant and diverse fish fauna that has adapted to the conditions and seasonal variation of the rivers and streams that are typical for this area (Blay 2008a and 2008b).

Fish sampling for the 2007-08 aquatic study was the most comprehensive conducted for this area to date. A total of 7,947 fish were "caught" during these baseline studies; 1,591 during the wet season sampling and 6,356 during the dry season sampling. In previous studies, SGS (2004) caught 218 fish at four study sites on Study Area rivers and streams.

During the two sampling events (October/November 2007 and January 2008), 34 fish species representing 13 families were identified within the Study Area. In previous studies, SGS (2004) identified 22 fish species from 9 families in the Study Area. In general, the Pra River sites had the highest number of fish species. The fewest species were found in the smallest of the tributaries and at sites that were closest to the headwaters of the rivers. Three families of fishes numerically dominated the fish caught across all study sites. These were the Alestidae (African tetras), Cyprinidae (minnows and carp), and Cichlidae (wide and diverse family of fishes). The most diverse families of fish were the Alestidae (seven species), Cichlidae (six species), and Cyprinidae (six species). Members of the Alestidae and Cyprinidae families dominated the number of fish caught at all the sites sampled, representing from about 65 to 100 percent of the catch at all sites.

None of the fish species identified during the baseline studies are listed as species of special concern or have special conservation status under IUCN, CITES, or Ghana regulations.

AQUATIC RESOURCES - BENTHIC INVERTEBRATES

Benthic invertebrates were collected from 11 study sites in the Pra River Basin in October/November 2007 (wet season) and January 2008 (dry season) to provide baseline information about the occurrence, composition, and diversity of benthic invertebrate species. Thirty-three (33) benthic invertebrate species belonging to 11 orders and 21 families were identified in the Pra River Basin streams. The results indicate that, relative to the other streams in the Pra River Basin, benthic invertebrate diversity was greatest in the Pra River. The Abesu Stream station had the lowest diversity of any station sampled. The two most dominant groups in the Pra River Basin are the Diptera (order – the true flies and midges) and the Oligochaeta (subclass – segmented annelid worms).

Dipterans and oligochaetes compose anywhere from about 24 to almost 100 percent of the benthic invertebrates species in the streams sampled. The dipterans consisted primarily of the chironomids (midges), which occur in soft-bottomed habitats such as those found in the streams that were sampled. Similarly, the oligochaete worms are also associated with soft-bottomed habitats. The predominance of the dipterans and oligochaetes in the benthic community is consistent with the substrates occurring in the streams that were sampled.

BIODIVERSITY USE

CI-Ghana (2006) evaluated current community use and enjoyment of biodiversity in the Mining Area. **Table C-3** presents a summary of the direct (consumptive), non-consumptive and cultural biodiversity uses and values which are presently available to local residents and which would theoretically continue to be available if the Project were not developed. The following describes how CI-Ghana (2006) presents these biodiversity uses and values from the local resident perspective.

- Consumptive Uses/Access to the ABFR. Non-timber forest products (NTFPs) contribute to all aspects of rural life providing food, fodder, fuel, medicine, building materials, household items and intangible benefits such as cultural symbols, ritual artifacts and sacred sites. People from all the communities in the Mining Area use the ABFR, although those people who live closest probably use the forest more than others. Residents of Yayaaso and the hamlets in the Mining Area and residents of Afosu, New Abirem, Aduasena, and Hweakwae are the most likely consumers of non-timber forest products. The major non-timber forest products used in the Akyem Project Area are described below:

- ✓ Medicinal herbs and plants: CI-Ghana (2006) reports that about 22 percent of the biodiversity of the area was used by the communities for their herbal medicine. About 91 percent of the respondents indicated that they had used herbal medicine at least once. NTFPs in the ABFR included chewing sponge from *Acacia kamerunensis,* kola nut from *Bese* (*Cola nitida),* and wrapping leaves from species in the family Maranthaceae. Studies in the ABFR have found that 24 percent of flora potentially provides herbal medicine.

  Seventy (70) percent of the respondents to the CI survey (CI-Ghana 2006) considered herbal medicine to be very important, 25 percent rated it as important, and five percent indicated that herbal medicine was not important. Additionally, traditional medicine practitioners said that they were concerned that the proposed Project would cause a rapid loss of herbal plants but were excited about the creation of NGRL's Akyem nursery which had the stock to replace medicinal herbs and plants.

- ✓ Charcoal making: About 12 percent of the biological resources used by respondents to the CI survey (CI-Ghana 2006) were used to provide energy, i.e., firewood and to make charcoal for cooking, mostly from hardwood species with *Esakoko* (*Celtis zenkeri),* the preferred species. Although wood products are commonly used by local communities from forest species, it is illegal to take wood from the forest reserve.

- ✓ Hunting: CI-Ghana (2006) notes that the main traditional sources of protein in the Akyem communities were bushmeat, fresh water fish and vegetables. The bushmeat trade, which used to be one of the most lucrative economic activities in the area had collapsed due to the rapid destruction of the forests and years of over hunting.

- Cultural activities: CI-Ghana (2006) reports that all of the communities in and near the Mining Area used the available biodiversity resources in carrying out cultural practices, festivals and other traditional rituals, including the totem of the Chief of Afosu, the Gray Parrot. In addition, Geomatrix has identified two cemeteries and 13 community or individual shrines within the Mining Area (Geomatrix 2008c).

KEY BIODIVERSITY COMPONENTS

Based on field surveys of the Mining Area, biodiversity components on and around the IMPACT SITE, of particular significance to conservation, were identified and are presented in the KEY BIODIVERSITY COMPONENTS matrix (**Table B-3**). The matrix reflects biodiversity at three levels (species, habitats, and ECOSYSTEM SERVICES) and indicates whether these components are of conservation significance and if they have utilitarian values for local communities (e.g., non-timber forest products and amenities).

5.2 POTENTIAL PROJECT IMPACTS ON BIODIVERSITY

This section presents several potential impacts to the flora, fauna and aquatic resources in the Mining Area. Potential impacts to the community are also presented.

5.2.1 Potential Impacts to Biological Environment

FLORA

The southern end of the ABFR, established by the Forestry Services Division to manage timber resources on forest reserves in Ghana, would be impacted through development of the open pit. Approximately 74 hectares of the proposed open pit would be located in the ABFR, which constitutes approximately 13 percent of the total area of the forest 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 open pit would fill with water when mining ceases.

Seven tree species of conservation concern within the Mining Area that would be affected include *Albizia ferruginea*, *Entandrophragma angolense*, *E. cylindricum*, *Nauclea diderrichii*, *Nesogordonia papaverifera*, *Pterygota macrocarpa* and *Terminalia ivorensis* (**Table B-3**). 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" (IUCN). One Gold Star tree species found outside of the ABFR, *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 effect currently is occurring within the Mining 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 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.

FAUNA

Construction of the mine and ancillary facilities would remove a portion of wildlife habitat in the ABFR 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 ABFR proposed for the open 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, Maxwell's duiker, black duiker, royal antelope and Zenker's fruit bat (**Table B-3**). Species protected by Schedule I of the GWC that would have potential to be affected include all of the hoofed animals (e.g., duikers), primates (e.g., bushbaby and potto), and raptors (hawks, owls, eagle, and vultures). Three species of birds listed as species of conservation concern by IUCN could be affected by the project.

The Project would result in a net decrease in wildlife habitat within the ABFR because a portion of the open 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 (fish and other aquatic organisms).

None of the wetlands identified within the Mining Area (associated with ephemeral streams) 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 narrow strips of associated wetlands in those drainages but would yield negligible impacts. Wetlands comprise less than one percent of the Mining Area (two hectares) and the proposed project would affect less than one hectare of wetlands.

AQUATIC RESOURCES

Construction of the Tailings Storage Facility, Waste Rock Disposal Facility and Water Storage Facility (**Figure 3**) sited in ephemeral or seasonal drainages would not measurably affect fish and aquatic invertebrates associated with perennial streams in the Project Area (including the Pra and Mamang rivers). Construction of these facilities would affect terrestrial faunal communities present in the ephemeral drainages. 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 would transform limited flowing water habitat into a temporary lake environment. Many of the species found in the Project Area streams would be able to adapt to these changes in this new habitat. Habitat (in terms of area and quality, measured in HABITAT HECTARES) created through construction of this lake would exceed that 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. Diverting water from the Pra River during periods of high stream flow for mine processing would not affect fish or aquatic invertebrates.

5.2.2 Potential Impacts to the Community

Table C-4 presents a summary of potential impacts from the Project to local residents use and enjoyment of biodiversity elements in the ABFR and the Mining Area. The primary impact would be land clearing and the loss of homes and farms within the Mining Area. Several settlements would lose archaeological and cultural sites in Mining Area.

5.3 PLANNED MITIGATION AND COMPENSATION MEASURES FOR THE AKYEM PROJECT

5.3.1 Mitigation and Offset Measures

Following the identification of potential impacts to biodiversity, it was determined that expected reductions in biodiversity components, as measured using BBOP tools and methodologies, would require an offset to mitigate for losses following AVOIDANCE, MINIMISATION, REHABILITATION, and RESTORATION (i.e., "RESIDUAL IMPACTS"). Residual impacts remaining after mitigation become the focus of the offset. The BBOP matrix, "Impact Assessment and MITIGATION HIERARCHY" (**Table B-4**) is a worksheet used to assess the likely impact of Project activities and how best they can be mitigated by avoidance, minimisation, and offset development. The matrix also indicates whether the offset should be IN-KIND (LIKE-FOR-LIKE) or OUT-OF-KIND (traded up).

Table 2, extracted from the EIS (NGRL 2008), further summarises proposed mitigations to the biologic environment for the Project.

TABLE 2 Summary of Proposed Mitigations Biological Environment Akyem Project	
General Issue or Impact Identified by Public Stakeholder, Government Stakeholder or Company	**Proposed Mitigation(s)**
Loss of ecological habitat (including portion of Ajenjua Bepo Forest Reserve) and increased pressure on remaining fauna Loss of integrity of Ajenjua Bepo Forest Reserve Impacts to forest habitat	• Implement reforestation programme developed in concert with agencies • Company using Akyem Project as pilot project in evaluating biodiversity offsets in conjunction with non-governmental organisations. • Implement a closure and decommissioning plan that would include provisions for re-establishing habitat throughout disturbed areas. • Implement community education programmes to develop alternative means to secure bushmeat, forums for reducing pressure on fauna and establishing farms to raise bushmeat and snails. • Administrative controls including policies that prohibit employees and contractors from engaging in hunting activities on all mine properties have been implemented.
Protection of endangered species	• Company to develop and implement a Critical Species Management Plan including avoidance of nesting and brood-rearing periods for raptors and other species of high conservation priority, implement an ENDEMIC plant species propagation programme and sponsor educational opportunities for individuals to reduce stress on flora and fauna.

Source: EIS (NGRL 2008).

5.3.2 Compensation Measures

A preliminary cost-benefit assessment was completed and it appears that Project-affected communities and residents (**Table C-2**) will be no worse off and will be fully compensated for Project residual impacts on the use and enjoyment of biodiversity. People in the Mining Area will be compensated for the loss of their land, their homes, their crops, and their community and individual shrines in a fully transparent manner, with compensation rates developed in conjunction with representatives of the communities. **Table 3**, taken from the EIS (NGRL 2008), presents a summary of proposed mitigations that would be completed to address issues and potential impacts relative to the human environment and social and economic resources expressed by stakeholders.

TABLE 3
Summary of Proposed Mitigations
Human Environment
Akyem Project

General Issue or Impact Identified by Public Stakeholder, Government Stakeholder or Company	Proposed Mitigation(s)
Loss of farm holdings. Loss of agricultural land and lifestyles. Increased vibrations from blasting that could impact structures. Increased noise levels.	• Implement COMPENSATION programme for crops, outbuildings and livestock. • Development and implementation of various programmes including: o Alternative Land Access, o Managed/Controlled Farm Lands, o Livelihood Replacement Programme and o Vulnerables Programme. • Implement noise reduction and blast management measures to reduce effects including blast schedule, technology, maintain buffer zone.
Resettlement of Yayaaso, multiple hamlets and farmsteads.	• Implement resettlement/relocation programme • Compensate for loss of residential and non-residential structures and commercial business. • Development and implementation of various programmes including: o Alternative Land Access, o Managed/Controlled Farm Lands, o Livelihood Replacement Programme and o Vulnerables Programme. • Implementation of education and training programmes for money management, micro-enterprise development.
Compensation process and procedures.	• Implement open and transparent interactions. • Establish Resettlement Negotiation Committee.
Increased vibrations from blasting that could damage structures. Increased noise levels.	• Implement structure and foundation assessment programme. • Communicate blasting schedule. • Implement controlled blasting technology.
Disruption of socioeconomic conditions. Influx of outsiders. Changes to the social fabric of local communities.	• Implement hiring policy emphasising local labour pool . • Develop local training initiatives. • Conduct open and transparent interactions.
Respect for Traditional Authorities and traditional ways of life.	• Conduct open and transparent interactions. • Conduct periodic information meetings.
Clear and transparent communication.	• Conduct open and transparent interactions.

TABLE 3 (continued) Summary of Proposed Mitigations Human Environment Akyem Project	
General Issue or Impact Identified by Public Stakeholder, Government Stakeholder or Company	**Proposed Mitigation(s)**
Positive socioeconomic impacts such as increased employment, tax, and improved infrastructure.	• Implement hiring policy emphasising local labour pool. • Collaboration with local and district governments on infrastructure improvements. • Payment of taxes and royalties to provide revenue to the District.
Special employment schemes for youth and women.	• Implement hiring policy emphasising local labour pool. • Support business opportunities for women and youth. • Implement contractor hiring and procurement policies.
Success of reclamation with a view to future generations. Long-term public safety implications.	• Implement sustainable development programme. • Collaborate with stakeholders to establish suitable post-mining land uses and use of infrastructure.

Source: EIS (NGRL 2008).

Table C-4 presents a summary of the compensation measures proposed by NGRL for the loss of land, homes, and farms within the Mining Area. The loss with the most relevance to biodiversity is sacred sites and cemeteries, as discussed below.

According to the EIS (NGRL 2008), in Ghanaian society, cemeteries and shrine sites are associated with the sacred. They are locations defined as much by their physical properties as by the spiritual forces that the people of Ghana believe occupied and operated from these locations. It is at these sites that the separate and intimately related worlds of the material and the spiritual come together.

To a large extent, community consciousness revolves around the recognition of the ancestors. Libation is perhaps the best known way by which communion may be achieved with the ancestors. Prayers offered in ritual situations have basically the same characteristics: invocation, petition and conclusion. The clan and ancestors are contacted in situations of grave importance to the clan or community. The Akyems' sense of community requires the recognition of the presence of the ancestors as the rallying point of the group's solidarity. Ancestors, as the custodians of law and morality, may punish or reward in order to ensure the maintenance of the group's equilibrium.

As noted in EIS (NGRL 2008), a general procedure for moving shrines consists of contacting the Chief on whose land the shrine occurs. In return, he will inform the keeper of the shrine and ask him about the required pacification and purification rights. The latter often involve slaughtering of an animal, pouring of libation, prayers and a monetary payment to the shrine steward and/or traditional authorities. The same approach would apply to the relocation of graves.

5.4 POTENTIAL RESIDUAL BIODIVERSITY IMPACT AND OFFSET REQUIREMENT

5.4.1 Identification of Benchmark and Attributes

To quantify residual impacts, the impact site needs to be evaluated against, or relative to, a BENCHMARK. This section presents the process used to quantify residual impacts relative to a benchmark to determine the offset requirement.

The following benchmark ATTRIBUTES were selected to quantitatively evaluate the proposed Project's impacts on biodiversity components and to determine levels of compensatory activities (offset) that would be required to result in NO NET LOSS of biodiversity. Many of the attribute values have not been accurately measured in a benchmark site or in the Impact area; therefore, METRICS for these attributes should be viewed as "virtual" since some have been obtained from a study of the literature. All attribute values can be quantitatively determined (and may be in the future) as the BBOP process becomes finalised and if the Project is developed.

BENCHMARK IDENTIFICATION

Based on studies conducted by CI–Ghana (2006), an interior portion of the 5,300 hectare Mamang River Forest (MRFR) (**Figure 2**) was selected as the benchmark site for evaluating and managing biodiversity for the proposed Project. The portion of the MRFR selected for the benchmark site (2,196 hectares) was surveyed by CI–Ghana (2006) and found to support high levels of biodiversity. Biodiversity information was not collected for the southern extension of the MRFR; consequently, the entire forest reserve was not identified as the benchmark area. CI–Ghana (2006) reported that the MRFR represents one of the last remaining continuously forested sites in southeastern Ghana and is a biodiversity priority on local and national levels.

BENCHMARK ATTRIBUTES

The benchmark attributes for quantitatively assessing biodiversity at the Akyem project site have been identified based on their value as proxies for overall BIODIVERSITY LOSSES and the expected impacts that would occur at the project site. Key biodiversity components that would have the potential to be affected include ecological services provided by intact forest communities, nine species of trees that are Vulnerable, three species of Near-Threatened and Vulnerable Upper Guinean Forest birds, one Vulnerable species of fruit bat, three Near-Threatened species of duiker, one Near-Threatened species of anomalure, and one Vulnerable tortoise. The species listed in the Key Biodiversity Component Matrix (**Table B-3**) are of conservation concern mostly because of losses of forest habitat; intensive, selective timber harvesting; bush meat hunting; and collection for the pet trade.

Key habitats that would be affected are patches of Eastern Guinean Forest. The loss and degradation of Upper Guinean Forest is the primary reason for losses in biodiversity of forest-dependent species. Forest communities also provide ecological services associated with carbon sequestration, watershed

maintenance, and nutrient cycling. Other biodiversity components that would be affected are associated with habitats altered by patterns of AGROFORESTRY that have led to a predominance of floral and faunal species adapted to human activities and non-forest vegetation ("habitat generalists").

The following benchmark attributes were used in the analysis to assess and understand the biodiversity at the Akyem project site so that the residual impacts to biodiversity that will result from the project can be quantified. Other benchmark attributes associated with ecological services will also be considered as more data becomes available concerning the role of ECOSYSTEM components in processes such as carbon sequestration, watershed maintenance, nutrient cycling, and microclimate modification.

Structural Attributes

- Forest Condition Class (Hawthorne and Abu-Juam, 1995).
- Patch size (hectares of intact forest).
- Large trees density (trees > 30 centimetres, diameter at breast height).
- Proximity/connectedness to other forest reserves.

Compositional Attributes

- Genetic Heat Index (genetic diversity based on species composition).
- IUCN "Vulnerable" tree species more than 30 centimetres, diameter at breast height.
- Maxwell's duiker comprising at least nine percent of large mammals.
- Zenker's fruit bat comprising at least two percent of bat species.

Social/Cultural Attributes

- Non-timber forest products comprising at least 30 percent of species inventoried.

5.4.1.1 Structural Attributes

FOREST CONDITION CLASS

Natural vegetation in the Project Area is part of the broad Eastern Guinean Forest, which has been further characterised as the Moist Semi-deciduous Zone. One of the best correlates of biodiversity is Forest Condition Class. This parameter is derived as described in **Table 4.** Typically, native forest communities are characterised by a three-story canopy structure with emergent tall trees often exceeding 50 metres in height, with the uppermost canopy often having a mixture of evergreen and deciduous species. The Forest Condition Class of the benchmark has been determined by CI–Ghana (2006) and Hawthorne and Abu-Juam (1995). The benchmark portion of the MRFR is Forest Condition Class 2; therefore, this was designated as the maximum benchmark value.

Forest Condition Class is a SURROGATE for evaluating ecological services associated with carbon sequestration, watershed maintenance, and nutrient cycling. The forest communities in the highest condition classes provide the maximum levels of ecosystem services. The attribute may be disaggregated to more precisely measure ecological services if the proposed project develops beyond the planning stages. Watershed maintenance functions could include analysis of hydrological conditions associated with topography, amount and type of vegetation, and land use. Nutrient recycling is a critical ecosystem

component that could be refined and interpreted by measuring INDICATORS such as density of termite mounds. Termites are a critical component in recycling nutrients in fallow areas and forest communities.

The attribute of forest condition class also provides a basis for assessing biodiversity values associated with a wide range of forest species including the rufous-winged illadopsis, grey parrot, green-tailed bristlebill, duiker species, fruit bats, and a diversity of tree species.

FOREST PATCH SIZE

Removal of forest habitat would likely reduce populations of obligate forest birds and other wildlife species. Beier *et al.* (2002) studied birds in a forest of central Ghana and found that as the size of contiguous forest decreased, species richness of birds decreased. The size of the patch of contiguous forest that is part of the benchmark area (within the MRFR) has been determined to be 2,196 hectares; therefore, this patch size was selected as the benchmark value. This attribute provides a basis for assessing biodiversity values associated with a wide range of obligate forest species including the rufous-winged illadopsis, grey parrot, green-tailed bristlebill, duiker species, fruit bats, and a diversity of tree species.

TABLE 4
Forest Condition Scores

Score	Definition
1	EXCELLENT with few signs of (<2%) of human disturbance (logging/farms) or fire damage, with good canopy and virgin or late secondary forest throughout.
2	GOOD with < 10% heavily disturbed. Logging damage restricted or light and well dispersed. Fire damage none or peripheral.
3	SLIGHTLY DEGRADED: Obviously disturbed or degraded and usually patchy, but with good forest predominant, max. 25% with serious scars and poor regeneration; max 50% slightly disturbed, with broken upper canopy.
4	MOSTLY DEGRADED: Obviously disturbed and patchy, but with bad forest predominant; 25 - 50% serious scars but max. 75% heavily disrupted canopy. Or forest lightly burnt throughout.
5	VERY POOR: Forest with coherent canopy <25% (more than three quarters disturbed), or more than half the forest with serious scars and poor or no forest regeneration; or almost all heavily burnt with conspicuous Chromolaena odorata and other pioneers throughout. Not, however, qualifying as condition 6.
6	NO SIGNIFICANT FOREST LEFT: Almost all deforested with savanna, plantation or farm etc; < 2% good forest; or 2 - 5% very disturbed forest left; or 5 – 10% left in extremely poor condition e.g. as scattered trees or riverine fragments, remnants with little chance of surviving 10 years.

Source: Hawthorne and Abu-Juam (1995)

NUMBER OF LARGE TREES

Large trees (>30 centimetres diameter breast height) provide overstory canopy cover and have a substantial influence on habitat features that develop at ground level and at intermediate canopy heights.

Large trees tend to produce more fruit for wildlife species and provide habitat for a greater variety of species. Data for the MRFR indicate that, on average, there is a density of 39 trees >30 centimetres diameter breast height per hectare (3900 per square kilometre) (Hawthorne and Abu-Juam 1995); therefore this was designated as the benchmark value. Mature trees provide food and roosting/breeding habitat for Zenker's fruit bat, grey parrot, rufous-winged illadopsis, green-tailed bristlebill, Pel's anomalure, and a variety of other mammalians and avian species.

HABITAT CONNECTEDNESS (DISTANCE, IN KILOMETRES, FROM NEAREST NON-CONTIGUOUS PATCH OF INTACT NATURAL HABITAT GREATER THAN 1,000 HECTARES IN AREA)

Throughout Ghana, forested habitats are fragmented and under pressure from logging, bushmeat hunting, and gathering of non-timber forest products. Forest patches are often isolated in a matrix of farms and fallow. The potential for animals to move among nearby patches of forest habitat helps maintain genetic diversity and allows interior forest species greater habitat security. The benchmark area is less than 0.5 kilometres from the Auro River Forest Reserve (**Figure 2**), which is connected to other adjacent forest reserves. This benchmark attribute has a maximum value because it is within 0.5 kilometre or less from another intact patch of habitat 1,000 hectares or larger.

5.4.1.2 Compositional Attributes

GENETIC HEAT INDEX

In Ghana, a measure of bioquality has been developed that rates individual plant species on their conservation priorities, based on "star ratings" for individual species (**Table 1**). Of the approximately 3,600 plant species in Ghana most, with the exception of some weedy species, have been given star ratings. The star ratings for composite species in plant communities are incorporated into a weighted model whose output is a "Genetic Heat Index" (GHI) for a given community. The GHI reflects the concentration of rare species in plant communities rather than the number of species per unit area, thus allowing prioritisation of conservation areas. A sample with the highest GHI does not necessarily have the highest diversity of species, but it does have the highest abundance of rare and globally significant species and therefore the highest 'bioquality' in conservation terms. Geomatrix derived GHI values from data collected by CI–Ghana (2006). The GHI value for the benchmark area is 91.

A Genetic Heat Index (GHI) is calculated as follows:

$$GHI = \frac{(BK \times BK\ weight) + (GD \times GD\ weight) + (Bu \times Bu\ weight) + (Rd \times Rd\ weight) \times 100}{BK + GD + BU + Rd + Gn}$$

Where: BK = Number of Black Star species;
GD = Number of Gold Star species;
Rd = Number of Red, Scarlet, and Pink Star species;
Gn = Number of Green Star species

Weights are: 27 for Black Star, 9 for Gold Star, 3 for Blue Star, 1 for Scarlet, Red, and Pink, and 0 for Green Star species.

IUCN "VULNERABLE" TREES >30 CENTIMETRES DIAMETER BREAST HEIGHT

Studies conducted by CI–Ghana (2006) determined that the following species of trees present in the benchmark area are listed on the IUCN RED LIST as Vulnerable: *Albizia ferruginea, Entandophragma angolense, Entandophragma cylindricum, Nauclea diderrichii, Nesogordonia papaverifera, Pterygota macrocarpa, Terminalia ivorensis*, and *Antiaris toxicaria.* The average density for various size classes of Vulnerable species in moist forest zones of Ghana is shown in **Table 5.**

Of the 3,900 trees with stems over 30 centimetres diameter breast height, it could be expected that, on average, six percent of large trees would be IUCN Vulnerable species (241/3900 = 6 percent); therefore, the benchmark value for this attribute is 6 percent or more of large trees being composed of IUCN Vulnerable species. Although this attribute does not specify the relative proportions of sensitive species that would comprise the 6 percent of species of conservation concern, it is assumed that in post-mine reclamation and in management of Offset biodiversity that the goal would be to closely approximate species diversity conditions that existed under natural conditions.

TABLE 5
Average Density of Age Classes
Vulnerable Trees (stems/km^2) in Moist Ghana Forests

	Size Class (centimetres diameter breast height)			
Species	**5 - <30**	**30 -<60**	**60 ->90**	**90+**
Albizia ferruginea	19	10	5	4
Entandophragma angolense	510	60	15	2
Entandophragma cylindricum	185	18	8	6
Nauclea diderrichii	32	5	6	3
Nesogordonia papaverifera	830	75	10	0
Pterygota macrocarpa	195	30	18	2
Terminalia ivorensis	14	3	5	2
Antiaris toxicaria	305	40	15	8
Totals	2090	241	82	31

Source: Hawthorne (1995)

ZENKER'S FRUIT BAT (NEAR THREATENED)

Studies conducted by the Ghana Wildlife Society (2007) and Geomatrix (2008a) at the Akyem site recorded seven species of fruit bats captured with mist nets from a variety of habitats. Of the individual bats captured, three percent were Zenker's fruit bat. The Zenker's fruit bat serves as a PROXY for all

fruit bats in the project area. Fruit bats also provide important ecosystem functions such pollination and reseeding of forest trees.

The benchmark value is designated as three percent or more of the bat species surveyed being Zenker's fruit bat. Although the absolute number of Zenker's fruit bats could decline and still equal or exceed the three percent benchmark value, (if total numbers of bats decrease), decreases in total numbers of fruit bats would be determined through regular monitoring. If total numbers of fruit bats decrease, as indicated by rates of capture, the interpretation of this parameter would evaluated and adaptive management would focus on potential causes of declines.

MAXWELL'S DUIKER (NEAR THREATENED)

Surveys conducted by the Ghana Wildlife Society (2007) at the Akyem study site found that nine percent of the large mammals recorded were Maxwell's duikers. Because this species is a Near-Threatened species and highly favored by bushmeat hunters, it is selected to represent the impact of bushmeat hunting on preferred species (e.g., Maxwell's duiker, black duiker, and royal antelope). The benchmark value is nine percent of more large of mammals observed from transect counts being Maxwell's duiker. As is addressed in the previous section on Zenker's fruit bat, the absolute number of large mammal observations could decrease, while maintaining or exceeding the nine percent benchmark value. Monitoring and ADAPTIVE MANAGEMENT would provide a basis for interpreting and addressing this possibility.

5.4.1.3 Social/Cultural Attributes

PLANT SPECIES PROVIDING NON-TIMBER FOREST PRODUCTS (NTFP)

Non-cultivated native plants in the Akyem Study Area are widely used by residents for fuel, food, medicine, spices, building materials, and forage for livestock. Some of these non-timber forest produce recorded in the baseline study include, chewing sponge from *Acacia kamerunensis*, firewood and charcoal mostly from hardwood species with *Celtis zenkeri* being the preferred species, kola nut from *Cola nitida*, and wrapping leaves from Maranthaceae species. A comparison of the species recorded in the Study Area with published sources of information on use of plants by native peoples indicates that 104 species (31 percent) are of medicinal value (Ghana Wildlife Society 2007).

CI–Ghana (2005) evaluated the use of plants by local residents in the Akyem area in and around the Ajenjua Bepo Forest Reserve and found that 24 percent of the flora was used for herbal medicine. For this analysis, medicinal plants were selected as a proxy for non-timber forest products. The benchmark level for this attribute is that 24 percent of plant species are of medicinal value.

5.4.2 Selection and Weight of Benchmark Attributes

WEIGHTING factors assigned to benchmark attributes discussed above are summarised in **Table 6**. The weighting factors are subjective, based on experience and research in Ghana, and were assigned using multiples of five, ranging from 5 to 20, and were assigned for ecological attributes that could be depicted quantitatively. The only social and cultural attribute assigned a weighted values is NTFP, which also has measurable biodiversity implications.

TABLE 6
Benchmark Area Attribute Weighting Factors

Grouping	Benchmark Area Attribute	Weighting Factor
Structural	Forest Condition Class	20
	Patch size	15
	Large tree density	15
	Connectedness	10
Compositional	Genetic Heat Index	10
	IUCN Vulnerable Plants	10
	Zenker's fruit bat	5
	Maxwell's duiker	10
Social/Cultural	Non-Timber Forest Products	5

Using the nine BENCHMARK ATTRIBUTES composed of structural, compositional and social/cultural characteristics associated with the benchmark area, an overall biodiversity loss was calculated at the IMPACT SITE using the BBOP tools. **Table B-5** presents the matrix which shows a loss in biodiversity for each benchmark attribute and a cumulative loss of 320 habitat hectares.

In Ghana, it generally takes about 10 years for disturbed sites to revert to young, secondary forest; therefore, with intense reclamation practices to plant a diversity of native species, including Vulnerable and Endangered plants, it is likely that after 10 years modest levels of biodiversity functions and values would become re-established on sites reclaimed as forest. After 30 years, it is projected that biodiversity of reclaimed areas would approach but not equal pre-mining biodiversity values. For purposes of this analysis, it is assumed that 50 percent of the Waste Rock Disposal Facility would be converted to forest and 50 percent would be converted to cropland. The composition of cropland would be 50 percent food crops and 50 percent cash crops.

Several aspects of site decommissioning and reclamation planning have been incorporated into the initial design of the Project. Specific reclamation objectives to be included in the Project's Closure and Decommissioning Plan include:

- Legal Compliance – Meet all statutory requirements.
- Landform Stability – Ensure that land is left in a stable condition that minimises long-term environmental impacts and does not compromise proposed post mining land uses.

- Ecosystem Re-establishment – Reclaiming as much of the affected area as possible to a condition where its pre-mining usage can resume and ensuring the ECOSYSTEM FUNCTION is representative of this land-use. The primary pre-mining uses include cropland, livestock grazing and small residential development.
- Water Quality – Ensure that the quality and quantity of water that discharges from the reclaimed mine area meets standards for the immediate downstream use.
- Public Safety – Ensure that reclaimed land is physically safe for people to access and does not pose a human health risk.
- Infrastructure – Decontaminate, decommission, salvage or demolish all structures on the site according to the terms of the mining agreement. These include facilities, ancillary equipment and buildings.
- Biodiversity – Ensure that the biodiversity of the Mining Area is maintained at pre-disturbance levels or improves.

Additional details regarding CLOSURE, decommissioning and reclamation are provided in the EIS (NGRL 2008).

In total, approximately, 1,428 hectares would be directly affected by the proposed Project. The composition of this land following reclamation (30 years) would include re-establishment of forest, plantations, and crops. **Table B-6** presents the anticipated hectares of reclamation (forest, plantation and cropland) relative to the various mine facilities. Areas that would not be reclaimed include the open pit and steep high walls, and buildings that would be retained as infrastructure for community use.

Based on the composition of land use (e.g., vegetative cover types) following reclamation, the biodiversity of the Mine Area was calculated by applying the same BBOP tool used to calculate the biodiversity loss at the impact site as presented in **Table B-5**. After 30 years of reclamation, the calculated biodiversity value for the nine benchmark attributes is 240 habitat hectares (**Table B-7**).

Table B-8 provides a comparison between pre-project biodiversity and expected biodiversity after 30 years of reclamation and RESTORATION. The residual loss of biodiversity resulting from the Akyem Project as currently planned is 80 habitat hectares.

5.5 OFFSET SITE SELECTION AND EVALUATION

Based on field studies and reviews of biodiversity data, the BBOP team developed a process to identify, select and evaluate candidate biodiversity offset options for the Project. The process and findings are documented in CI-Ghana (2008b) and Sections 5.5.1 through 5.5.3 of this document were adapted from their report.

The most appropriate offset for the Project is "IN-KIND" or "LIKE-FOR-LIKE". The flora and fauna of the impact site (Mining Area) and offset area are characteristic of the Moist Semi-deciduous element of the Eastern Guinean Forest. Species of conservation concern are at risk because this once-widespread ECOSYSTEM has been fragmented and degraded. Management of the offset would focus on ENHANCEMENT of habitat and protection of populations of species that have a strong habitat affinity for the Eastern Guinean Forest.

5.5.1 Identification of Potential Offset Options

A list of potential offset options for the Project was developed and ranked for socioeconomic and biodiversity parameters (CI-Ghana 2008b). The potential offset options identified and evaluated are listed below. **Figure 6** shows locations of the candidate forest reserve offset sites relative to the Mining Area:

- Mamang River Forest Reserve,
- Nsuensa Forest Reserve,
- Auro River Forest Reserve,
- Contribution to Globally Significant Biodiversity Area Fund and
- Establishment of District Assembly Environmental Fund.

5.5.2 Description of Candidate Offset Options

The following information was obtained from CI-Ghana (2008b) and provides succinct descriptions of the five candidate offset options. **Table 7** lists key information regarding each site.

MAMANG RIVER FOREST RESERVE

The Mamang River Forest Reserve is approximately 53 square kilometres in size and is characterised by relatively flat topography with an elevation of 158 metres above mean sea level. The reserve was disturbed through logging in the 1970s and has a Condition Score of 2 (good) inside the Abenaso area.

NSUENSA FOREST RESERVE

The Nsuensa Forest Reserve (54 square kilometres) is a Condition 3 forest with a GHI of 46. Parts of the reserve were damaged by fire in 1983. The reserve has also been designated as an IMPORTANT BIRD AREA by Birdlife International. The site also has 2 important sacred groves for the people of Ajuafo and Akokoaso. The terrain is gently undulating and supports moist semi-deciduous forest. The reserve was logged between 1975 and 1991, but areas around the sacred groves remain intact.

AURO RIVER FOREST RESERVE

The Auro River Forest Reserve (8.6 square kilometres) is characterised by steep hills and undulating landscape with elevations ranging from 155 metres to over 295 metres above mean sea level. The Auro River Forest Reserve was established in 1948.

GLOBALLY SIGNIFICANT BIODIVERSITY AREAS

In 1999 the Government of Ghana designated 30 forest reserves with a high concentration of biological resources of global conservation concerns as Globally Significant Biodiversity Areas (GSBAs). Management Plans have been prepared for the GSBAs and efforts are underway to establish a trust fund. The fund would help ensure technical and financial sustainability of the GSBAs into PERPETUITY. The fund is expected to be located at the Ministry of Lands, Forestry and Mines. The total value of the offset could be paid into this fund for nation-wide utilisation on all the GSBAs.

TABLE 7
Comparison of Biodiversity Status of Candidate Forest Reserve Offset Sites

Biodiversity INDICATORS	Mamang River Forest Reserve[1]	Nsuesa Forest Reserve[2]	Auro River Forest Reserve[2]
Elevation (metres above mean sea level)	130-135	Not Available	155-295
Area (km^2)	53.0	54.4	8.6
Forest Reserve Condition Scores	2	3	Not recognised by the IUCN management Category
Habitat	Relatively flat topography, 'good' condition moist semi-deciduous forest. Uniform forest with dense tangles of lianas and a thick leaf layer.	The terrain is gently undulating 'mostly degraded' with small patches of original moist semi-deciduous forest	The area is characterised by steep hills and undulating landscape and mostly degraded with under-storey relatively thin in most places and limited regeneration activity of indigenous species
Species of conservation concern*	8	3	2
Plants	215 3 black star species Larger area of continuous good forest	112 2 black star species	54 1 black star species
Logging	Limited logging in the 1970s	Extensive between 1975 and 1991	Extensively logged in the 1970s
Ants	101	98	72
Diurnal Butterflies	116	82	65
Freshwater macro-invertebrates	29 families	26 families	18 families
Fishes	16	7	3
Amphibians and Reptiles	30	31	12
Birds	115	95	54
Small mammals	13	8	5
Large mammals	16	10	8
Total	654	469	291

Sources: (1) CI-Ghana (2008b)

(2) Data obtained in 2008 by CI-Ghana during interviews with representatives of the Ghana Wildlife and Forest Services Divisions, and the Ghana Wildlife Society. Data are contained in the Multi-stakeholder Assessment Report (RMSC 2001), Management Plans, and other unpublished resource information for both the Nsuesa and Auro River Forest Reserves.

* Species of global conservation concern as listed by IUCN (2007) and of national conservation concern (Black Star plant species).

DISTRICT ASSEMBLY ENVIRONMENTAL FUND

An Environmental Fund could be established at the New Abirem District Assembly to support BIODIVERSITY CONSERVATION in the District. The seed money could come from the total value of the offset resulting from the gold mining operations in the District. This fund could also attract other donors and would be managed by a Board of Trustees. Members of the Board of the Trustees would be drawn from key stakeholders, the private sector and development partners. Its main focus will be on ensuring biodiversity conservation in the District. This is an innovative approach to ensure that policies and programmes of the District Assemblies are managed properly with flexible funding.

5.5.3 Screening of Candidate Offset Options

The five candidate offset options were screened according to 22 criteria. These criteria were grouped into the following four categories:

Local community use:

- Community benefits,
- Biodiversity ENHANCEMENT/benefit,
- Social/cultural acceptance,
- Avoidance of tribal conflict,
- Conformity to local natural landscape plan and
- Ability to galvanise community support.

Habitat status:

- Suitable seed bank or refugia,
- Land tenure compatibility,
- Suitability for demonstration,
- Structure of forest landscape,
- Infrastructure availability and
- Proximity to mining site and communities.

Ecological status:

- Species variability, diversity and use (e.g., IUCN/Black Stars/local use),
- Ecological services delivery potential,
- Ability to achieve Global Conservation Concerns,
- Proximity to human disturbances (e.g., farming),
- Management suitability and capacity,
- Conformity to government objective and
- Addressing biodiversity problem.

Organisational appropriateness:

- Credibility for NGRL,
- Cost effectiveness and
- Geo-political soundness.

Using a relative scoring system ranging from 1 (least desirable) to 5 (most desirable) (**Table 8**), scores were assigned for each criteria in their screening process.

TABLE 8
Screening Criteria Score For
Potential Candidate Offset Options

Score	Description
1	UNSUITABLE: site has weak biological status, faces a lot of threats and investments may not show significant returns; must not be considered for the offset project.
2	POOR: site has weak capacity to maintain present resources, faces a lot of threats and will not give any good dividend even in the long term.
3	AVERAGE: site faces threats and investment may yield minimum results in the long run.
4	GOOD: Sites may require a lot of investment to show good results in the long term.
5	EXCELLENT: site possesses improved biodiversity status.

Note:
Source: CI-Ghana (2008b)

The Nsuensa Forest Reserve was scored 77, followed by the Auro River Forest Reserve with a score of 63 (**Table B-9**). Each forest reserve candidate offset site scored higher than the non-forest options (GSBA Trust Fund and District Assembly Environmental Fund). A general payment into a GSBA Trust Fund ranked fourth lowest because of the uncertainty that forest reserves in the area would receive sufficient funds from the GSBA Trust Fund for adequate protection and enhancement of biodiversity. The District Assembly Environmental Fund ranked lowest indicating that this candidate offset option is not a suitable offset option.

Of the five candidate biodiversity offset options, the MRFR scored highest (**Table B-9**). This is a relatively large forest reserve which provides continuous habitat for flora and fauna, and is more resilient to disturbances caused by activities that affect biodiversity. The MRFR is a part of a larger series of forest reserves, making it a candidate for part of a wildlife corridor. The BBOP team believed that resources would usually best be spent in safeguarding areas which are viable and important for biodiversity, but which are threatened by factors that can be controlled and where investment will be likely to succeed and be cost effective. In addition, a number of communities that fringe the MRFR have active cadre of community forest volunteers that collaborate with the Ghanaian Forestry Services to protect the forest and their support will be critical in the offset project.

The MRFR offset site has the potential to provide an important corridor linking off-reserve areas, farm lands and other forest reserves such as Nsuensa and Auro. It could also serve as a refuge for animals which would be affected by the construction of the mining facilities and structures. The conservation of this forest would also protect threatened species and seed banks for species of conservation concern.

The site could provide opportunities for ECOTOURISM, which would provide revenue and employment for the local economy.

Although not originally evaluated as a potential offset area by CI-Ghana, the portion of the Ajenjua Bepo Forest Reserve that would not be affected by mining has potential to serve as an offset area for several reasons. It is close to the area of impact and like-for-like biodiversity management is feasible with a high potential for ADDITIONALITY. Recent studies conducted by CI (2008) indicate that relatively undisturbed portions of the Ajenjua Bepo Forest Reserve have relatively high biodiversity values for species of conservation concern that are not dependent on large blocks of intact forest. For purposes of this Case Study, however, the Ajenjua Bepo Forest Reserve was not evaluated as a potential offset area.

5.5.4 Potential for Additionality at the Preferred Offset Site

Demonstration of additionality requires analysis of whether CONSERVATION GAINS at the offset sites would not have happened in the absence of intervention by the project developer. At the preferred offset site in the MRFR, NGRL proposes to address threats to biodiversity through:

- Positive management interventions that include RESTORATION of forest vegetation with an optimum component of vulnerable plant species and species of ethnobotanical importance and removal of invasive, alien species (e.g., Devil's teak).

- Curtailing degradation resulting from unauthorised uses such as timber harvest, land clearing for crop production, and livestock grazing, and bushmeat hunting. Levels of sustainable utilisation will be identified and management will focus on controlled consumptive use of all forest products.

- Averting risks associated with future activities by working with local communities to develop conservation agreements and practices to allow sustainable, multiple uses of the offset area, while preserving KEY BIODIVERSITY COMPONENTS.

In the absence of interventions by NGRL, key biodiversity components would be at risk from the same ongoing activities that have led to their current precarious conservation status. NGRL's management interventions at the offset site would reduce the risks of unsustainable exploitation of biodiversity. The probability that the interventions at the offset site would deliver the desired biodiversity outcomes is high because NGRL has a strong corporate commitment to achieving enhanced biodiversity at the offsite site and improving socioeconomic well-being of local communities. Also, there is expanded local awareness that conservation stewardship is necessary to help ensure that consumptive uses of forest resources do not exceed sustainable levels. Additionally, the BIOTIC and ABIOTIC conditions at the offset site favor the ecological succession from land affected by AGROFORESTRY to forest communities with biodiversity typical of

the Eastern Guinean Forest. The rapid succession from cleared land to forest, even in the absence of management interventions, is evidence that natural processes of ecological succession tend to re-establish habitats and species associations that were more widespread prior to high levels of landscape conversions associated with agroforestry.

Key assumptions associated with the determination that conservation gains can be achieved at the offset sites are that:

- Natural versus human-caused changes in conditions of the offset site can be distinguished through monitoring studies.

- Management interventions and conservation activities likely to positively affect biodiversity have been identified and are practicable to implement.

- Proposed conservation interventions can be fully executed under prevailing socioeconomic conditions in Ghana and locally.

5.5.5 Consideration of Conservation Priority and Additional Offset Site Evaluation Criteria

Conservation priority is determined by IRREPLACEABILITY and VULNERABILITY, with the highest priority being assigned to sites with high irreplaceability, high species-based vulnerability, and high site-based vulnerability. These factors are integrated as shown in **Table 9**.

TABLE 9
Irreplaceability Scores for Species-Site Combinations

Irreplaceability Score	Data-Rich Scenario	Data-Poor Scenario
Extreme	Sites known of inferred to hold ≥ 95 % of the global population of a species	Sites holding a species ENDEMIC to the country/region that is not known to occur at any other site
High	Sites known or inferred to hold ≥ 10 % of the global population of a species	Sites holding a species endemic to the country/ region that is known at 2 to 10 sites OR Sites holding a species that globally is known from 2 to 10 sites.
Medium	Sites known of inferred to hold ≥ 1 % but < % of the global population of a species.	Sites holding a species endemic to the country/region known to occur at 11 to 100 sites OR Sites holding a species that is known from 11 to 100 sites.
Low	Sites known or inferred to hold a < 1 % of the global population of a species	Sites holding a species endemic to the country/region that occurs at more than 100 sites. OR Sites holding a species that globally is known from more than 100 sites.

Based on irreplaceability scores for species-site combinations that would be affected by the proposed Akyem Project, all species have a low irreplaceability score. All species of conservation concern in the Mining Area are species associated with Guinean Forest habitats, which extend from Guinea to Cameroon. The Vulnerable plant species are mostly common timber species that are widespread.

Fauna species of concern that would be affected are also widespread but there is not comprehensive data to document the number of occurrences of these species that occur in forest habitat throughout a large part of West Africa in Guinean Forest habitats.

Based on analyses previously presented, the selected offset site within the MRFR represents the best opportunity to achieve the desired biodiversity ENHANCEMENT; therefore additional evaluation criteria are not being considered.

5.5.6 Offset Multiplier

MULTIPLIERS are used in biodiversity offset calculations to account for the risk that the subset of attributes used to calculate project losses may underestimate those loses or that some offsetting activities would not achieve their anticipated and full conservation potential. Typically, multipliers are used to adjust the size of the offset area. There are no elements of the biodiversity offset in the MRFR for the proposed Project that pose a high risk of failure. The land area allocated for offsetting impacts will be sufficient resulting in a NET GAIN if the anticipated biodiversity benefits accrue from successful implementation of the offset programme.

A temporal component has not been factored into the design of the offset. Due to the time lag following completion of reclamation following mining, and development of mature, fully functioning offset area, multipliers will be factored into the final determination of how temporal losses will be compensated in offset design and management.

5.6 POTENTIAL IMPACTS OF PROPOSED OFFSET ACTIVITIES ON LOCAL COMMUNITIES

This section generally addresses the potential impact of biodiversity offset activities on communities located proximal to the offset area in a general and hypothetical manner. Based on the process used to identify the offset for the proposed Akyem Project defined previously, the 53 square kilometer MRFR was selected as the offset. The specific offset, consisting of 250 hectares is located on the northern and eastern margin of the MRFR. This area, near the communities of Abirem, New Abirem, and Mamanso (**Figure 3**), has been altered by farming activities within the reserve (32 hectares), timber removal, and intensive cropping to the margin of the reserve (refer to **Figure 4**).

5.6.1 Offset Activities

Potential benefits of offset activities are listed in **Table C-1**. For the MRFR offset site, CI-Ghana (2008b) indicate that the offset could:

- Provide an important corridor linking off-reserve areas, farm lands and other forest reserves,
- Offer refuge for animals leaving Mining Area construction,
- Protect threatened species,
- Protect seed banks,
- Protect headwaters,

- Provide micro-climate modification and
- Offer provision of medicinal plants.

To realise these potential biodiversity values, management activities in the offset would include:

- Planting IUCN Vulnerable tree species at densities commensurate with benchmark conditions,
- Planting species with high ethobotanical values,
- Conversion of farm land within the forest reserve (32 hectares) to native plant species,
- Controlling undesirable, invasive plant species and
- Educating residents in sustainable practices in utilising non-timber forest products including bush meat.

NGRL has established nurseries to propagate IUCN Vulnerable species and species of ethnobotanical importance for planting in the offset area. Currently, over 90 species of plants are being propagated for use in reclamation and offset enhancement. Additional species of conservation concern (e.g., *Cola boxiana*) will be established in the nursery to offset losses that may result from mine development.

Because conversion of farm land at the offset area within the MRFR to native forest communities would result in a local loss of agricultural production, NGRL would compensate individuals for this loss in the same manner that other agricultural losses would be compensated. Compensation methods for farm land to be implemented by NGRL are addressed in detail in the EIS (NGRL 2008). In addition NGRL would provide supplemental fertiliser to affected farmers to increase productivity on other lands adjacent to the forest reserve. Other measures to offset socioeconomic effects would include establishment of aquaculture facilities to propagate fish for local consumption and establishment of facilities to propagate giant African snails, poultry and grasscutters. Educating residents in maintaining facilities to raise fish and other protein sources would be an integral part of the socioeconomic offset activities.

Tables B-10 and **B-11** provide calculations of biodiversity values of the offset prior to and following completion of offset activities, respectively. The offset would provide approximately 241 habitat hectares of biodiversity value. The residual loss of biodiversity at the Impact site following reclamation would be 80 habitat hectares (**Table B-8**). With completion of the offset the net increase in biodiversity would be 93 habitat hectares (241 habitat hectares minus 148 habitat hectares). Development of the offset area would start immediately on approval to mine and after consultation with stakeholders.

5.6.2 Impacts to Communities from Potential Offset Activities

The communities nearest the proposed offset site in the MRFR, and outside of the Mining Area, include Mamanso, Abirem, New Abirem (**Figure 3** and **Table C-2**). Numerous hamlets and farmsteads are also

located near the offset. Based on vegetation cover-type mapping (NGRL 2008 and **Figure 4**), 54 percent of the 32 hectares of farmland in the offset area consists of oil palm, citrus and cocoa plantations. The remaining 46 percent of farmland is used for other food crops. Information is not currently available regarding the use of the proposed 250 hectare offset for NTFP by the residents proximal to the offset area. In addition, demographic information regarding the farmers is not available. The most direct impact to communities from the potential offset activities would be the loss of farmland.

5.6.3 Estimate of Costs and Benefits to the Local Community

Key characteristics of communities in and near the impact site (Mining Area) and offset site are presented in **Table C-2**. Potential Project and offset activities affecting each community are also listed in **Table C-2**.

Table C-3 summarises the direct (consumptive), non-consumptive and cultural uses and values which are likely presently available to residents living proximal to the offset site in the MRFR. These uses and values are the same as those previously described for the residents of the Mining Area.

For medicinal plants, proxies were not considered for this offset activity component. However, any measured increase to LIVELIHOOD – and in particular health – realised from the Project may be considered a proxy benefit compensating for some or all of the loss associated with any decline in medicinal plant populations or access to them.

The market price method may be utilised for medicinal plants. However, additional data beyond that presented in NGRL (2008) may be required for baseline sources of medicinal plants, current population of plants, current harvest rate and local market price of plants. Consideration would also need to be given to sustainability of current practices. Additional plants added to the offset Area may stabilise sustainability of the current population if declining or increase the level of available plants in the future. Use of the plant would need to be evaluated for perceived or actual health effects.

5.6.4 Community Offset Package

Because the proposed Akyem Project has not been approved and STAKEHOLDER PARTICIPATION has not been integrated into this plan, the range of management practices that would be implemented to offset biodiversity and socioeconomic impacts is tentative. The socioeconomic impacts that would result from development of the mine and ancillary facilities would be mitigated or compensated through measures addressed in the EIS (NGRL 2008) and, consequently, are not fully discussed in this report. The only impacts for which mitigation and compensation are not addressed in the EIS are

associated with development of the 250-hectare offset area in the MRFR. Under existing conditions, there are 32 hectares of crop land within the boundaries of the MRFR. Proposed management activities in the offset area to compensate for lost and degraded biodiversity values would result in the conversion of this crop land to forest communities dominated by native species. The stakeholders that would be affected by this conversion of crop land would be compensated in the manner consistent with those committed to in the EIS for other affected crop land.

5.7 SUMMARY OF OFFSET PROCESS COSTS

Offset costs would include propagation and planting of trees raised in the NGRL nurseries; monitoring for unauthorised extractive uses of the offset area; coordination with and education of stakeholders to ensure sustainable use of the offset area; long-term oversight and monitoring of the offset area; compensation for lost agricultural land in the offset area; development of aquaculture facilities and facilities to raise other protein sources (giant African snails, grasscutters, and poultry); fertiliser costs for crop lands adjacent to but outside the offset area; and, costs associated with reduced compensation for timber production in the offset area.

5.8 IMPLEMENTATION AND LONG-TERM MANAGEMENT PLANS

5.8.1 Implementation Plan

The offset site will be managed to enhance biodiversity values by:

- Providing an important corridor linking off-reserve areas, farm lands and other forest reserves,
- Providing a refuge for animals leaving Mining Area construction,
- Protecting and enhancing species of conservation concern,
- Protecting seed banks,
- Protecting headwaters,
- Providing micro-climate modification and
- Providing medicinal plants and other non-timber forest products.

To realise these potential biodiversity values, management activities in the offset area would include:

- Planting IUCN Vulnerable tree species at densities commensurate with BENCHMARK conditions,
- Planting species with high ethnobotanical values,
- Conversion of farm land within the forest reserve (32 hectares) to native plant species,
- Controlling undesirable, invasive plant species and
- Educating residents in sustainable practices in utilising non-timber forest products including bush meat.

NGRL has established nurseries to propagate IUCN Vulnerable species and species of ethnobotanical importance for planting in the offset area. Currently, over 90 species of plants are being propagated for use in reclamation and offset enhancement. Additional species of conservation concern (e.g., *Cola boxiana*) may be established in the nursery as a component of biodiversity enhancement.

Because conversion of farm land within the MRFR to native forest communities would result in a local loss of some agricultural production, NGRL would compensate individuals for this loss in the same manner that other agricultural losses would be compensated. Compensation for farm land is addressed in detail in the EIS (NGRL 2008). In addition, NGRL would provide supplemental fertiliser to affected farmers to increase productivity on other lands directly adjacent to the forest reserve. Other measures to offset socioeconomic effects would include establishment of aquaculture facilities to propagate fish for local consumption and establishment of facilities to propagate giant African snails and grasscutters. Educating residents in maintaining facilities to raise fish and other protein sources would be an integral part of the socioeconomic offset activities.

5.8.2 Long-Term Management Plan

The long-term management of the offset site will consist of ongoing coordination with stakeholders and monitoring of biodiversity values. If adverse factors are reducing or threatening to reduce biodiversity values, remedial measures will be implemented to maintain the conditions required to result in a long-term net gain in biodiversity.

5.9 PROJECT OUTCOMES

Prior to construction of the proposed project, the area that would be directly impacted by mine development would have a biodiversity value of 320 habitat hectares (**Table B-8**). Following mining and 30 years of reclamation activities, the biodiversity value of the area of direct impact would be 240 habitat hectares (**Table B-8**). The residual loss of biodiversity value would be 80 habitat hectares (320 habitat hectares minus 240 habitat hectares). Prior to management of the offset area to provide biodiversity benefits, the 250-hectare offset area would have a biodiversity value of 148 habitat hectares. Following offset management to enhance biodiversity values, the offset area would have a biodiversity value of 241 habitat hectares (**Table B-10 and B-11**), which represents a gain of 93 habitat hectares over existing conditions. Because RESIDUAL IMPACTS from the project would total 80 habitat hectares, the offset area would have to provide at least this level of compensation to result in NO NET LOSS of biodiversity. Because the proposed offset area would provide an increase in biodiversity value of 13 habitat hectares (93 habitat hectares minus 80 habitat hectares), there would be a net increase of biodiversity value as a result of reclamation activities and establishment of an offset. Development of the offset area would start immediately on approval to mine and after consultation with stakeholders.

Agricultural land that would be taken out of production as a result of the offset would be compensated as specified in the EIS (NGRL 2008). A range of socioeconomic mitigation and compensation measures that would be implemented if the Akyem Project is developed are captured in the Project's commitment register resulting from the EIS.

6.0 NEXT STEPS

The following steps have been identified to move the BBOP process described in this Case Study from a virtual to a genuine exercise:

- Conduct stakeholder meetings and incorporate stakeholder input into the design and implementation of the offset, including identifying which plants are of highest ethnobotanical significance to stakeholders,

- Conduct additional field studies to more accurately define certain METRICS used in the biodiversity analysis,

- Develop a detailed OFFSET MANAGEMENT PLAN, including a funding framework and

- Meet with the Ghana Forestry Commission to determine the compatibility of offset design and implementation with management policy of the Mamang River Forest Reserve.

7.0 CONCLUSION

Analysis of pre-project and post-project conditions indicates that the biodiversity ATTRIBUTES selected as proxies to represent compositional and structural features of impacted biological communities in the Project Area would largely be mitigated through post-mining reclamation. Attributes with residual impacts following mining and reclamation (30 years) would be the density of large trees and IUCN Vulnerable plants (**Table B-8**). Other attributes of biodiversity would have much smaller losses in HABITAT HECTARES and the attribute of patch size would realise a small NET GAIN following reclamation. To attain no net loss in biodiversity from development of the proposed Project, it would be necessary to offset a total of 80 habitat hectares at an offset site located in the Mamang River Forest Reserve. The primary biodiversity offset benefit to local communities would be the provision of medicinal plants and other non-timber forest products.

As a result of working through the BBOP Design Handbook methodology (BBOP 2008a), the following areas of improvement or modification have been identified to more clearly explain or demonstrate the methodologies.

- The Design and Cost-Benefit Handbooks (dated January 2008) are very helpful but somewhat redundant. It was difficult to integrate the socioeconomic components of the BBOP process into the biological components of BBOP. A single streamlined BBOP guidance manual that integrates the activities/steps/stages of both biological design and cost-benefit components would be helpful.

- The "tools-based" methodology specified in the Handbook for designing an offset is relatively rigid. A "principles-based" approach may facilitate innovation and result in a focused, locally adapted offset that achieves the necessary CONSERVATION OUTCOMES.

- The mechanism by which the BBOP methodology accounts for socioeconomic and biodiversity gains resulting from mitigation (reclamation of mined land) or net positive socioeconomic effects of project development could be addressed more explicitly. For the proposed Akyem Project, the compensation of biodiversity impacts through AVOIDANCE and reclamation would provide substantial compensation for expected losses in biodiversity. It is conceivable that post-mining biodiversity values could exceed pre-project levels and, consequently, no offset would be required. The BBOP methodology should more explicitly reflect this possibility.

- There is little guidance in the BBOP methodology to account for the time lag between impact and successful reclamation and establishment/development of an offset. Some biodiversity parameters such as the re-establishment of large-diameter trees would take approximately 50 to 70 years; therefore, some biodiversity gains would not be realised until well after cessation of mining.

- The BBOP methodology should address the potential difficulties and possible solutions in finding expanses of land available for implementing offset activities. In Ghana, nearly all of the land is either part of the shifting agricultural system of fallow and crops or is held in forest reserves. Conversion of agricultural land for biodiversity ENHANCEMENT can result in a net loss of agricultural production. Because forest reserves were established and are managed for

sustainable timber production, use of forest reserves for biodiversity offsets may not be compatible with logging practices and other managed extractive uses promoted by the Ghanaian government.

- Selection of an offset area is necessarily site-specific to the project's location and socioeconomic conditions. Although the priority is to develop local offsets where benefits and CONSERVATION GAIN from the offset will be experienced by residents local to the project, the realities of land availability, existing land uses and land controls may require consideration of a regional offset location to deliver true conservation benefit. A local offset was identified in this Case Study for the proposed Akyem Project but the maximum conservation gain may be achieved at a regional offset site. However, if a regional offset site is required or selected, an existing PROTECTED AREA might be selected to maximise the conservation gain.

- Prior to development of the BBOP concepts, BASELINE biodiversity studies and rapid assessments were conducted to assist in mine development (avoidance of CRITICAL HABITATS) and impact assessment. Typically, impact assessments involve qualitative analyses for biological components that are difficult to measure. Because of specific data needs for most environmental impact assessments, only the most basic biological components, such as amounts of various HABITAT TYPES, are quantitatively assessed. The BBOP methodology, however, has different data collection requirements than those typically required for impact assessments. BBOP requires analysis of METRICS that may not be routinely collected in studies conducted prior to project development. If it is anticipated that a project will be subjected to analysis and development in accordance with the BBOP approach, pre-project studies should be designed and conducted to provide quantitative measures of key biological parameters that will be needed to comport with the BBOP methodology as well as meeting data requirements for impact assessments. Consequently, results of these pre-project scientific studies would satisfy the objectives of both impact assessments and BBOP.

- The BBOP approach to selecting offset sites results in identification of POTENTIAL OFFSET SITES with existing relatively high biodiversity values. For example, for the Akyem Project, the Mamang River Forest Reserve was selected as the offset site. This forest reserve has the highest biodiversity values in the regional vicinity of the proposed project. Because an offset is established to compensate for lost and degraded biodiversity values (habitat hectares), management actions must be imposed on the offset to increase existing biodiversity values. For an offset with existing high biodiversity values, it is difficult to manage for and measure small incremental increases in biodiversity. Selection of an offset in a more degraded condition and managing to improve the biodiversity values would result in a larger net gain in biodiversity per unit land area.

- The BBOP approach should not discourage the adoption of degraded areas to serve as offsets. Gains in biodiversity in a degraded area may be greater than gains realised in areas that initially have higher biodiversity. The use of degraded areas has been variously referred to a "easy gains" or "picking low-hanging fruit". Observations in Ghana indicate that even slight improvements in degraded areas can result in substantial biodiversity gains because of linkage

effects for dispersing species or as islands of habitat in a matrix of developed land. There does not appear to be a scientific basis for focusing offset activities on areas with high biodiversity values as compared to focusing biodiversity management on degraded areas.

- The EIS for the Akyem Project identifies many environmental and socioeconomic commitments that must be completed as a condition of mine development. Many of the commitments have the same objectives as the BBOP process. For example, mitigation and compensation for socioeconomic impacts are specified in the EIS. Consequently, the methods specified in the EIS were adopted in lieu of development of specific mitigation and compensation measures following the BBOP methodology. The only socioeconomic impacts that were not addressed in the EIS are those associated with development of the offset area (e.g., conversion of 32 hectares of crop land to forest). Based on precedents established in the EIS for compensation, the loss of cropland in offset area would be compensated in the same manner as farm land outside of the offset. Essentially, the BBOP methodology for socioeconomic compensation was displaced by EIS requirements.

General comments regarding our application of the Cost-Benefit Handbook (BBOP 2008b) to the proposed Akyem Project include:

- The methodology is difficult to use on a large-scale project, and the information gathered during the biological portion of the study is not readily transferable to the cost-benefit analysis. The tools in the Cost-Benefit Handbook do not contain the same information blocks as those contained in Design Handbook tools. Consequently, columns were added to several of the cost-benefit worksheets to facilitate the transfer of information from one analysis to the other.

- The cost-benefit analysis does not work well for projects that are still in the planning stages and have not yet been approved by stakeholders, the government or company directors. Selecting an offset site and the attendant communities that would be affected is premature until the project is approved.

- The sequencing of steps and stages in the Cost-Benefit Handbook is difficult to apply for projects that are in planning stages. To complete the tools for Activity B (Identify the Impacts of Proposed Offset Activities on Local Communities) one must presume both the offset location(s) and offset activities prior to determining them

- The cost-benefit analysis does not appear to allow biodiversity benefits of the proposed Project to be considered. For example, NGRL (2008) identified the issue of hunting as a biodiversity issue that could be managed within the context of the Project and would implement community education programmes to develop alternative means to secure bushmeat; forums for reducing pressure on fauna and establishing farms to raise bushmeat and snails; and administrative controls including policies that prohibit employees and contractors from engaging in hunting activities on all mine properties. Other benefits for the proposed Akyem project (NGRL 2008) include plans to complete a detailed health assessment and improvements to care, and initiate programmes in local schools discussing the environment and environmental quality.

- A provision to account for the benefits of reclaimed/restored land and its uses does not appear to be addressed in the Cost-Benefit Handbook. Part of the analysis of the biodiversity impact should include consideration for the amount of reclaimed land which is being restored to original uses. Unlike many projects, mining is a finite activity and with good reclamation planning and implementation, a significant portion of the land for productive use would be available to the next generation.

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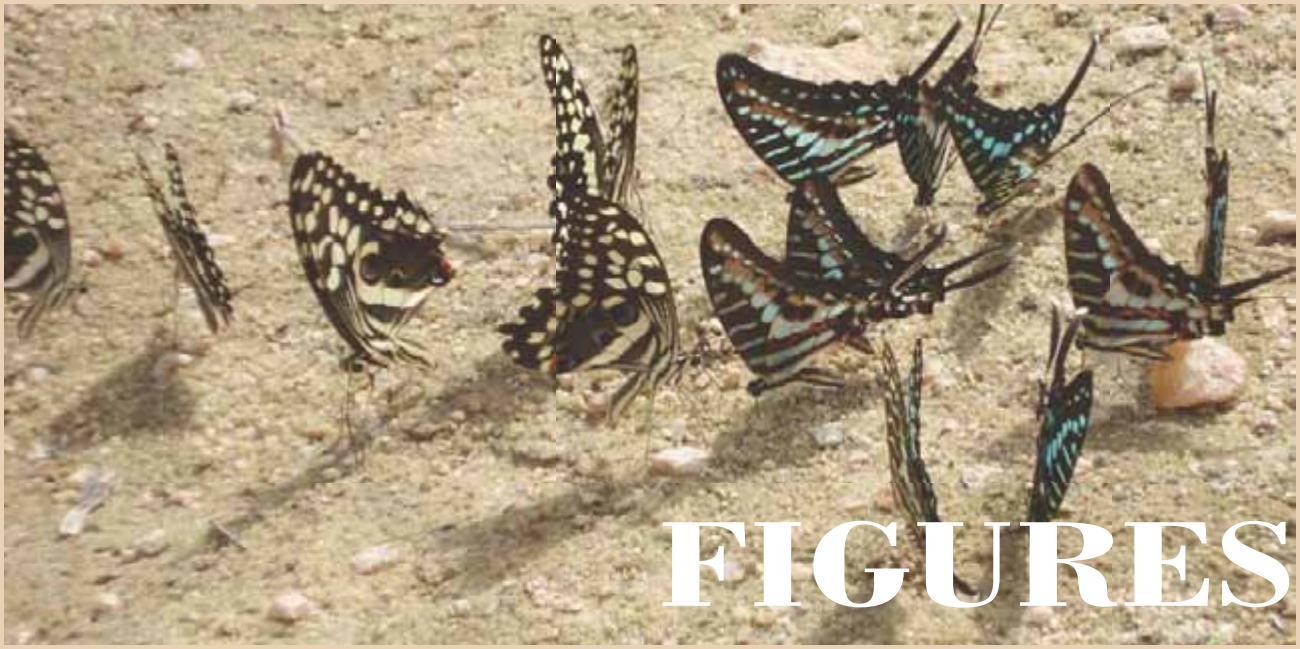
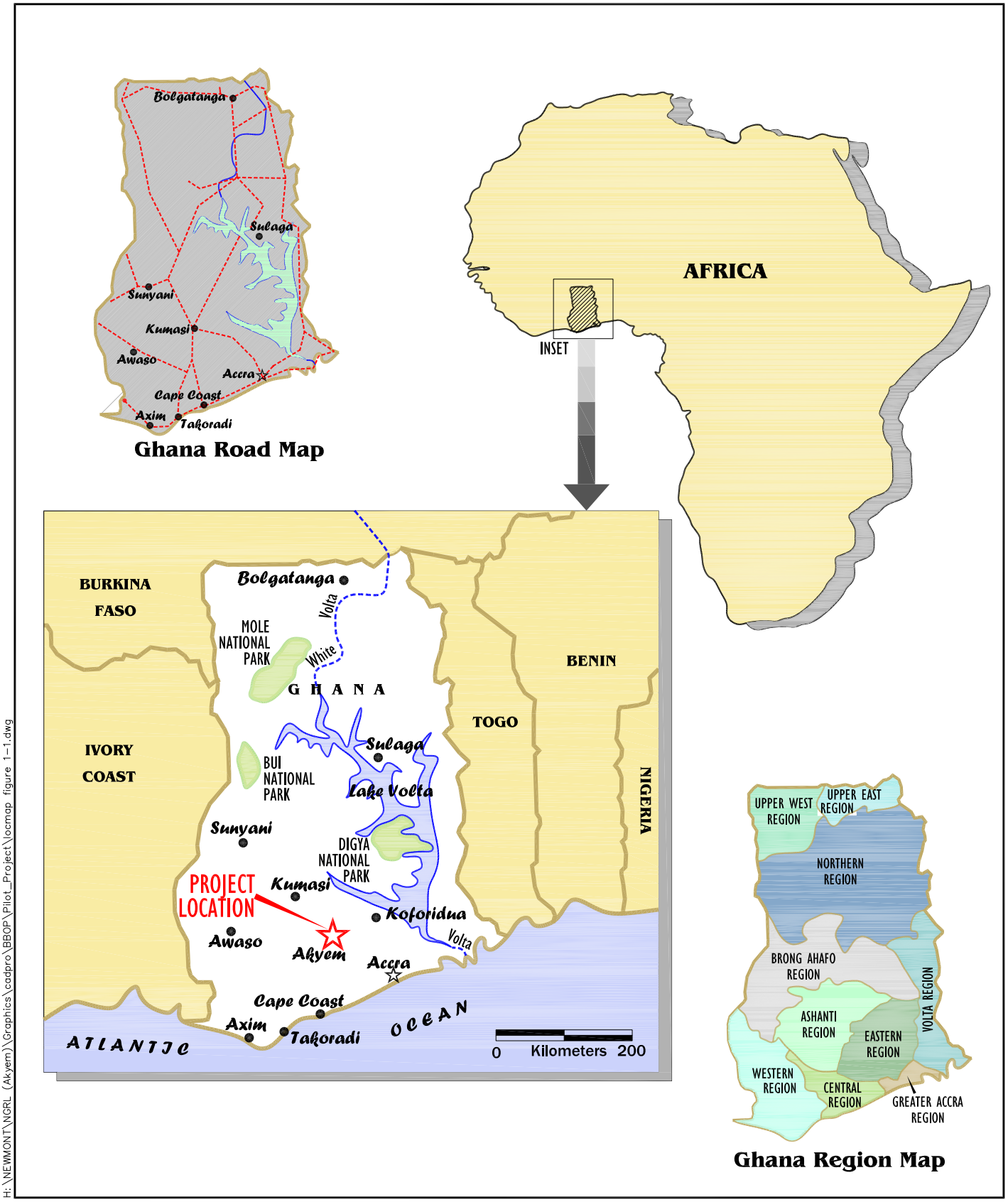
APPENDIX A



FIGURES



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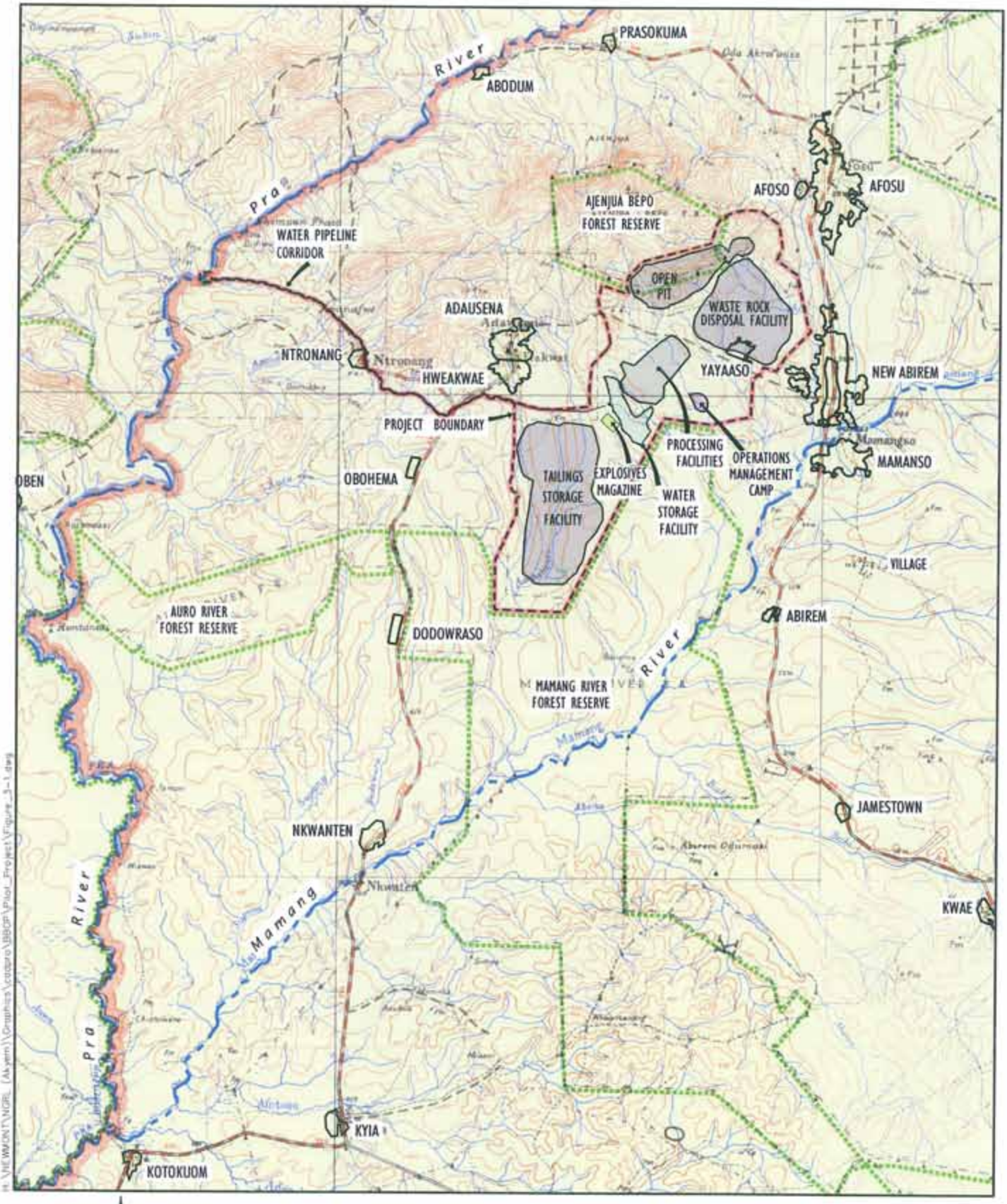
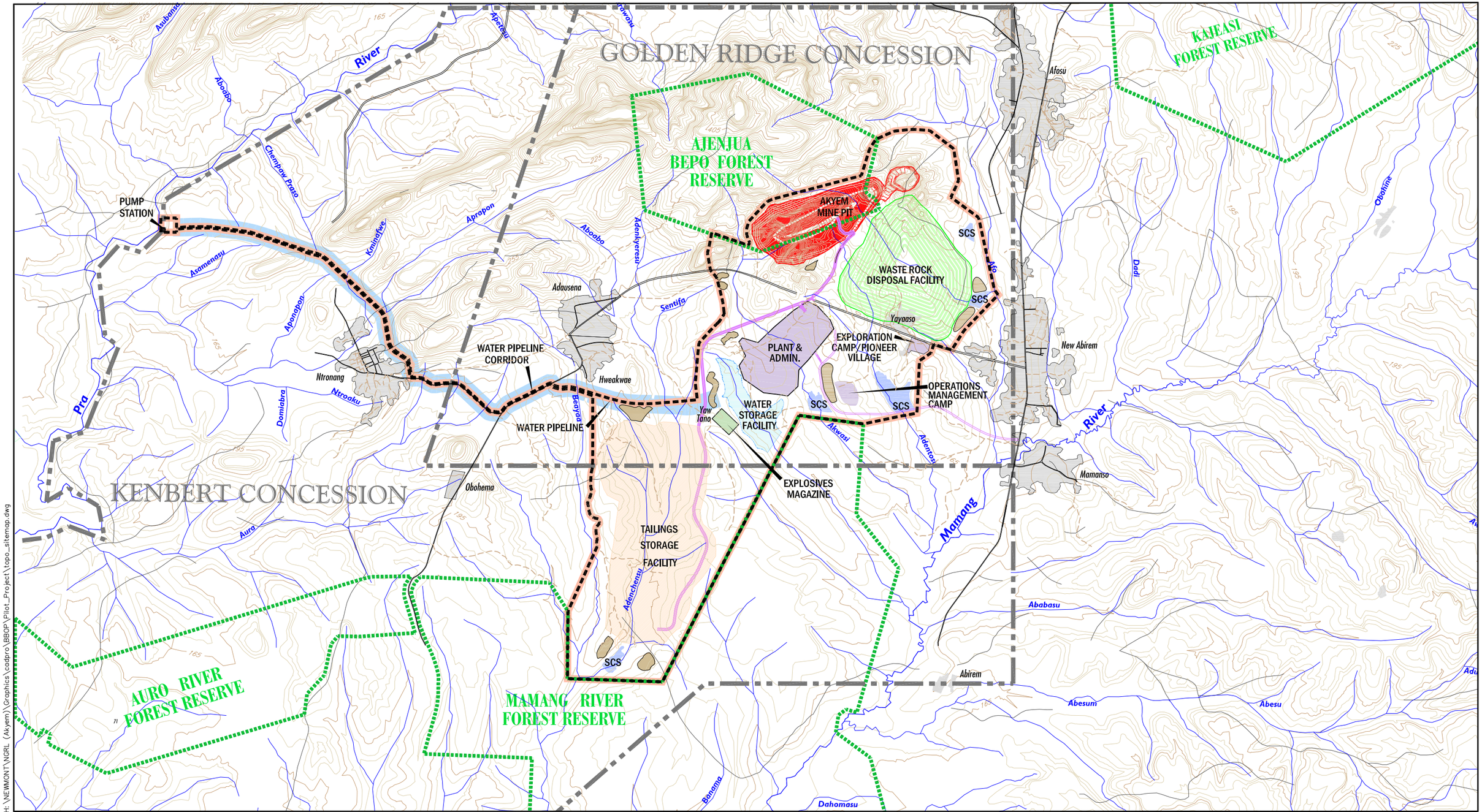
AMEC Geomatrix

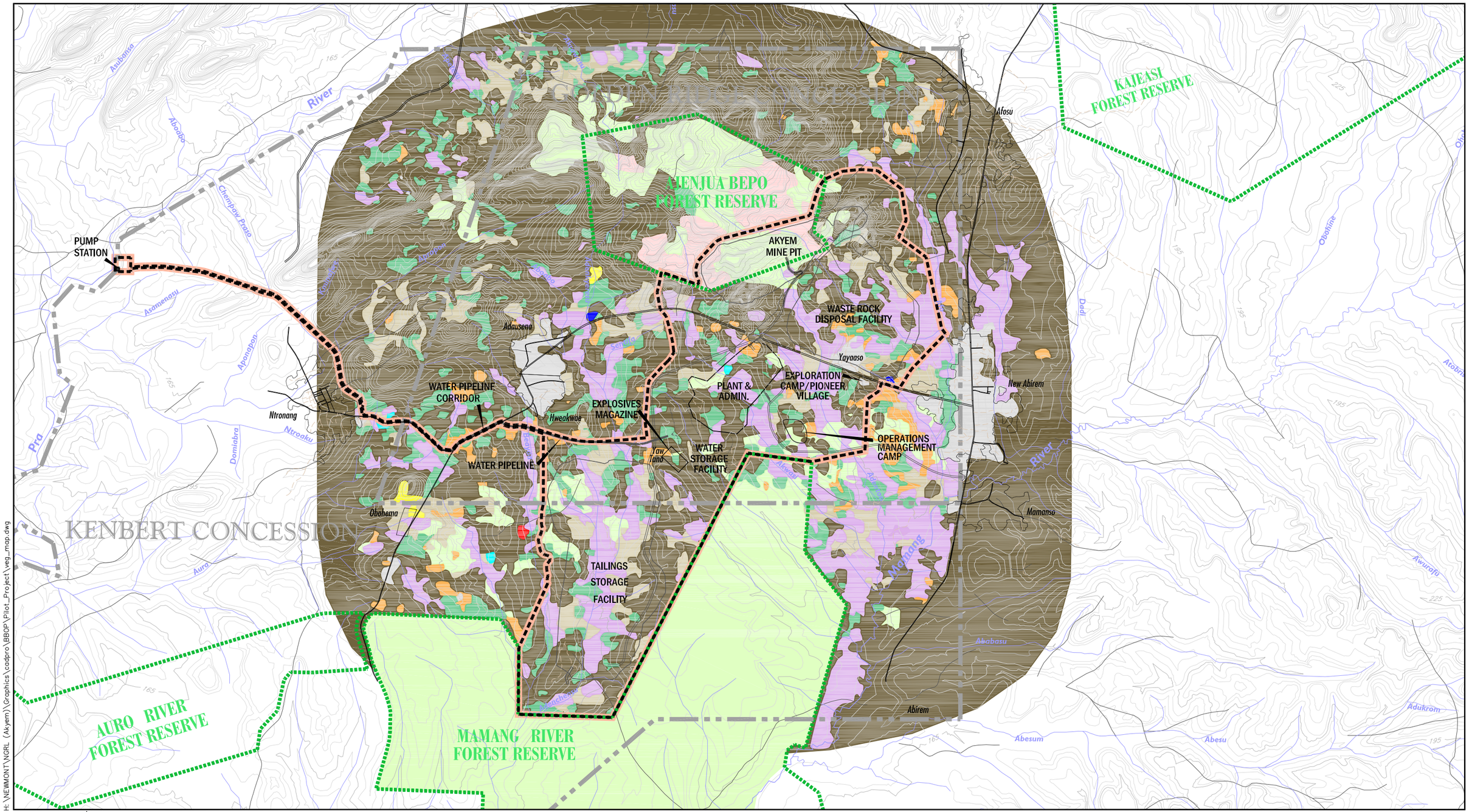
General Location Map
Akyem Project
Eastern Region, Ghana
FIGURE 1



Site Features Map
Akyem Project
Eastern Region, Ghana
FIGURE 2



Primary Project Features
Akyem Project
Eastern Region, Ghana
FIGURE 3



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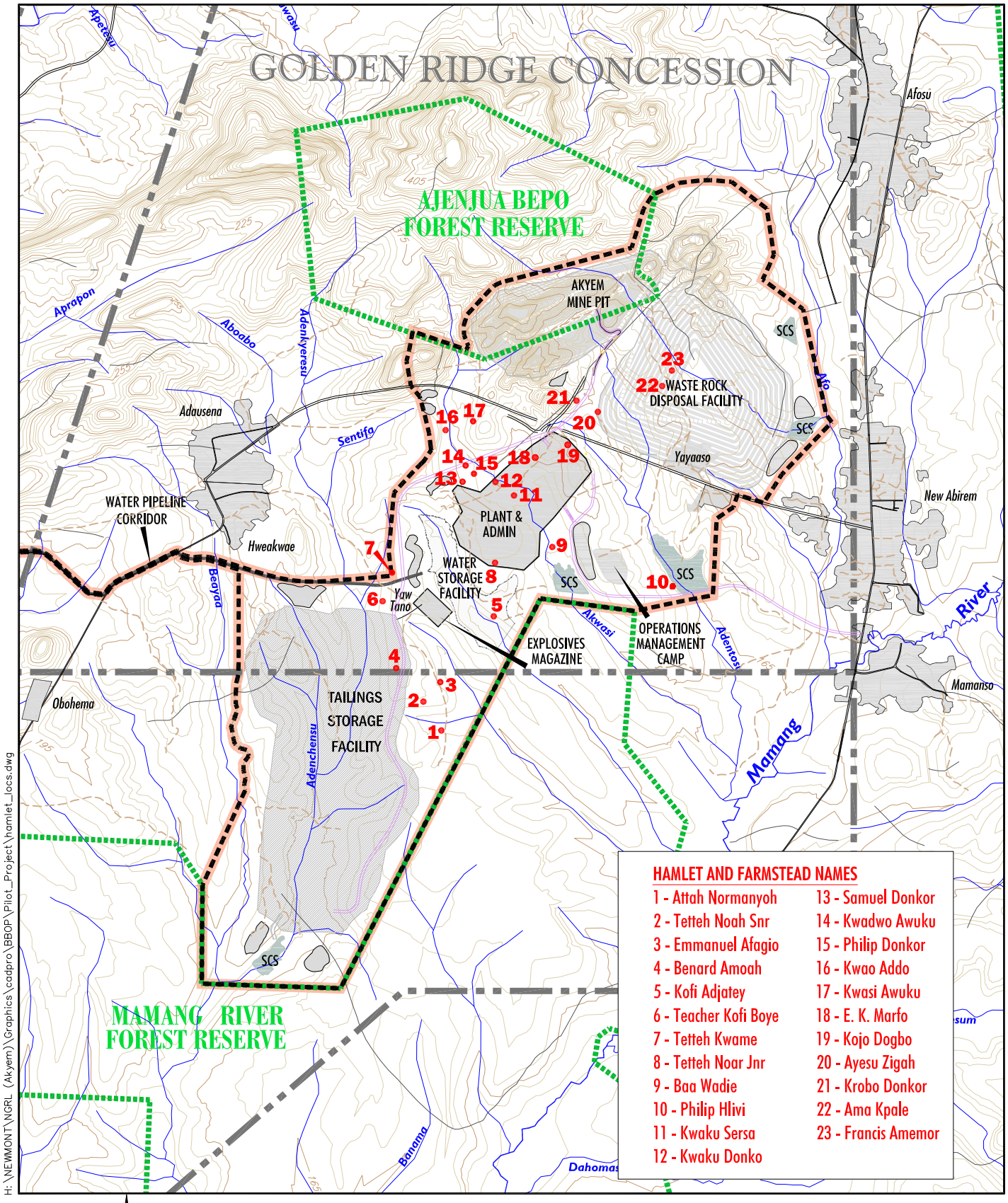
AMEC Geomatrix

- Concession Boundary
- Mining Area
- Forest Reserve Boundary
- Stream/Drainage
- Existing Access Road
- Proposed Road

LAND USE TYPES

Casava	Forest
Cedrela	Developed Areas
Citrus	Oil Palm
Cocoa	Plantain
Crop	Teak
Fallow	Wetland

Land Use Type Map
Akyem Project
Eastern Region, Ghana
FIGURE 4



Hamlet and Farmstead Locations
Akyem Project
Eastern Region, Ghana
FIGURE 5

MIRASA HILLS FOREST RESERVE
Pra
AJENJUA BEPO FOREST RESERVE
AFOSO
AFOSU
LARBIKROM
ADAUSENA
NTRONANG
HWEAKWA
NEW ABIREM
MAMANSO
KOKOBEN
OBOHEMA
MINE PROJECT BOUNDARY
VILLAGE
AURO RIVER FOREST RESERVE
ABIREM
DODOWRASO
River
PRA-ANUM GOVERNMENT FOREST RESERVE
MAMANG RIVER FOREST RESERVE
JAMESTOWN
ASUOM
NKWANTEN
Mamang
KWAE
River
Pra
MMURONAM
AMANTIA
OTUMI
KYIA
KOTOKUOM
PRASO
ABOMPE
ADWAFO
BRENASE
NSUENSA FOREST RESERVE
BEDIAKO FOREST RESERVE
AIYAOLA FOREST RESERVE

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Project Boundary
Forest Reserve Boundary
Major Drainage
Primary Road
Secondary Road (from other sources)
Townsite (from other sources)
Forest Reserve Offsite Sites

Candidate Forest Reserve Offset Sites
Akyem Project
Eastern Region, Ghana
FIGURE 6

APPENDIX B

DESIGN TABLES

TABLE B-1

Project Activities and Elements

BBOP Pilot Project, Akyem Site

ACTIVITY WITHIN MINING AREA	ACTIVITY / MINE FACILITY	LOCATION	DURATION	DEGREE OF CERTAINTY	TOTAL HECTARES	PRE-PROJECT COVER TYPES*		
						HECTARES	TYPE	CONDITION CLASS
DISTRUBED BY MINING	Mine Pit	Within and Outside of Ajenua Bepo Forest Reserve	Life of Mine	High	139	76	Secondary Forest	I
						61	Plantations	II
						2	Cropland	III
	Waste Rock Disposal Facility	Outside of Forest Reserve	Life of Mine	High	246	0.3	Secondary Forest	I
						206	Plantations	II
						40	Cropland	III
	Tailing Storage Facility	Outside of Forest Reserve	Life of Mine	High	419	29	Secondary Forest	I
						333	Plantations	II
						57	Cropland	III
	Water Storage Facility	Outside of Forest Reserve	Life of Mine	High	56	5	Secondary Forest	I
						47	Plantations	II
						4	Cropland	III
	Water Pipeline Corridor	Outside of Forest Reserve	Life of Mine	High	17	0	Secondary Forest	I
						13	Plantations	II
						4	Cropland	III
	Sediment Control Structures	Outside of Forest Reserve	Life of Mine	High	35	8	Secondary Forest	I
						25	Plantations	II
						2	Cropland	III
	Process Plant, mill, offices	Outside of Forest Reserve	Life of Mine	High	85	8	Secondary Forest	I
						64	Plantations	II
						13	Cropland	III
	Other Mine Facilities (stockpiles, laydown, ROM Pad, Haul/Access Roads, and	Outside of Forest Reserve	Life of Mine	High	423	17	Secondary Forest	I
						342	Plantations	II
						64	Cropland	III
	Operations Management Camp	Outside of Forest Reserve	Life of Mine	High	8	3	Secondary Forest	I
						4	Plantations	II
						1	Cropland	III
				TOTALS	**1428**	**1428**		
NOT DISTURBED BY MINING	Buffer Zone	Outside of Forest Reserve	Life of Mine	High	15	6	Secondary Forest	I
						9	Plantations	II
						0	Cropland	III
	Controlled Farmland	Outside of Forest Reserve	Life of Mine	High	460	17	Secondary Forest	I
						390	Plantations	II
						53	Cropland	III
				TOTALS	**475**	**475**		

Notes:

* Cover type mapping described in: Geomatrix Consultants, Inc. Draft Final, Baseline Technical Report, Flora, Akyem Project, Eastern Region, Ghana. Dated January 2008.

Condition Classes

I - Secondary Forest

II - Plantations (oil palm, cocoa, cedrela, citrus) and fallow agricultural land

III - Crops (maize, cassava, etc.), unrelaimed land (pit lake, process plant, buildings, mill, infrastracture, etc.)

Table B-2
Stakeholder Participation Plan Table
BBOP Pilot Project, Akyem Site

NAME OF STAKEHOLDER GROUP	INTEREST	KEY STAGES FOR ENGAGEMENT	PREDICTED TIMING	RESOURCES REQUIRED
Local Government Authorities				
Birim North District Assembly District Chief Executive District Coordinating Director District Planning Coordinating Unit Rural Enterprise Programme Regional Minister Regional Coordinating Director Regional Coordinating Council (RCC) Member of Parliament for Abirem Constituency Assembly Members (both elected and government appointees) Unit Committee Members Regional and District Ministries, Departments and Agencies (MDAs) Regional and District Security Agencies Town and Area Councils of Birim North District: Praman Area Council in Ntronang; Abirem/Afosu Area Council in New Abirem	Political decisions and advisors on policies in the district (area)	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation	6-9 months prior to construction up to and including offset selection.	EIA Public Participation Workshops, Briefings, and Site Visits

Table B-2 (Continued)
Stakeholder Participation Plan Table
BBOP Pilot Project, Akyem Site

NAME OF STAKEHOLDER GROUP	INTEREST	KEY STAGES FOR ENGAGEMENT	PREDICTED TIMING	RESOURCES REQUIRED
Local Communities				
Local residents in Study Area: Ntronang Yaayaso Abirem Mamanso Hweakwae Adausena New Abirem Afosu Yaw Tano and other Hamlets	Farmers in the area Directly impacted people – positive and negative Sources of information on forestry use in the area Visible impact of any environmental change consequence	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation	6-9 months prior to construction – up to and including offset selection.	EIA Public Participation Workshops, Briefings, and Site Visits
Traditional Authorities				
Omanhene[1] of Akyem Kotoku Traditional Area Akyem Kotoku Traditional Council Birim North Association of Chiefs Stool Land[2] Owners (Ntronang, Afosu, Abirem, and Adausena) Other Chiefs in the Project-affected area (Hweakwae, Mamanso, Yayaaso) Chief and Elders of Adjenua Ankobeahene, a sub-chief of Adausena who administers the community of Yayaaso Headmen in Yaw Tano and the other Hamlets	Overlords of the land, change managers Directly impacted	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation	6-9 months prior to construction up to and including offset selection	EIA Public Participation Workshops, Briefings, and Site Visits

Table B-2 (Continued)
Stakeholder Participation Plan Table
BBOP Pilot Project, Akyem Site

NAME OF STAKEHOLDER GROUP	INTEREST	KEY STAGES FOR ENGAGEMENT	PREDICTED TIMING	RESOURCES REQUIRED
Focused Groups				
Community Consultative Committee (CCC) Compensation Negotiation Committee (CNC) Youth Groups Farmers' Groups Farmers and Landlords Religious Leaders Akyem Contractors and Suppliers Association Pensioners' Association Artisans Hairdressers and Barbers Tailors and Seamstresses	Collaborate on issues management	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation	6-9 months prior to construction – up to and including offset selection.	EIA Public Participation Workshops, Briefings, and Site Visits
Others Groups Media Civil Society Groups such as Wassa Area Communities Affected by Mining (WACAM), etc.	Re-echoing community and NGOs sentiments on project and its environmental implications			
Regulatory Agencies				
Environmental Protection Agency	Environment and impacts on society	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation.	6-9 months prior to construction – up to and including offset selection.	EIA Public Participation Workshops, Briefings, and Site Visits
Ministry of Lands, Forestry and Mines	Mining of minerals and energy requirements	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation.	6-9 months prior to construction – up to and including offset selection.	EIA Public Participation Workshops, Briefings, and Site Visits
Lands Commission	Legal and appropriate use of lands	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation.	6-9 months prior to construction – up to and including offset selection.	EIA Public Participation Workshops, Briefings, and Site Visits

Table B-2 (Continued)
Stakeholder Participation Plan Table
BBOP Pilot Project, Akyem Site

NAME OF STAKEHOLDER GROUP	INTEREST	KEY STAGES FOR ENGAGEMENT	PREDICTED TIMING	RESOURCES REQUIRED
Forestry Commission	Legal and appropriate use of the forestry resources	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation.	6-9 months prior to construction – up to and including offset selection.	EIA Public Participation Workshops, Briefings, and Site Visits
Land Valuation Board	Proper Valuation procedures	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation.	6-9 months prior to construction – up to and including offset selection.	EIA Public Participation Workshops, Briefings, and Site Visits
Ministry of Local Government, Rural Development and Environment	Oversight responsibility of some of the regulatory agencies	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation.	6-9 months prior to construction – up to and including offset selection.	EIA Public Participation Workshops, Briefings, and Site Visits
Ghana Museum and Monument Board and Ghana National Commission on Culture	Protection of heritage and archaeological resources	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation.	6-9 months prior to construction – up to and including offset selection.	EIA Public Participation Workshops, Briefings, and Site Visits
Ministry of Education / Ghana Education Service	Human capital/resource management	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation	6-9 months prior to construction	EIA Public Participation Workshops, Briefings, and Site Visits
Water Resources Commission	Water quality and water allocation	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation	6-9 months prior to construction	EIA Public Participation Workshops, Briefings, and Site Visits
Ghana Highway Authority	New road construction; road and road safety	Pre-Exploration (EIA), Exploration, Construction	6-9 months prior to construction	EIA Public Participation Workshops, Briefings, and Site Visits
Non-Governmental Organizations				
Conservation International	Biodiversity and environment Replacement and restoration of forest	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation	6-9 months prior to construction	EIA Public Participation Workshops, Briefings, and Site Visits

Table B-2 (Continued)
Stakeholder Participation Plan Table
BBOP Pilot Project, Akyem Site

NAME OF STAKEHOLDER GROUP	INTEREST	KEY STAGES FOR ENGAGEMENT	PREDICTED TIMING	RESOURCES REQUIRED
OICI	Economic diversification	Pre-Exploration (EIA) and Rehabilitation	6-9 months prior to construction	EIA Public Participation Workshops, Briefings, and Site Visits
Ghana Wildlife Society	Natural resources watchdog	Pre-Exploration (EIA) and Rehabilitation	6-9 months prior to construction	EIA Public Participation Workshops, Briefings, and Site Visits
Third World Network	Climate change and environment	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation	6-9 months prior to construction	EIA Public Participation Workshops, Briefings, and Site Visits
World Wildlife	Natural resource watchdog	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation	6-9 months prior to construction	EIA Public Participation Workshops, Briefings, and Site Visits
Private Sector				
Ghana Oil Palm Development Company (GOPDC)	Oil palm out growers	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation	6-9 months prior to construction	EIA Public Participation Workshops, Briefings, and Site Visits
Landowners	Agriculture, Tourism, Environment	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation	6-9 months prior to construction	EIA Public Participation Workshops, Briefings, and Site Visits
Academic Institutions				
University of Ghana (Archaeology Department, School of Botany and Zoology)	Natural resource study and management	Pre-Exploration (EIA), Exploration, Construction, Production and Rehabilitation	6-9 months prior to construction	EIA Public Participation Workshops, Briefings, and Site Visits

Reference: Draft BBOP Design Handbook, Activity 1, Step 2 (dated January 2008).

Source: Key information in the table was obtained from Section 9 of the Final EIS for the Akyem Project, dated November 2008.

Notes:

1 Omanhene refers to the traditional chief of highest ranking.

2 Stool lands are community property managed by the Chief; ultimately lands are owned by the Government of Ghana.

Table B-3
Key Biodiversity Components Matrix
BBOP Pilot Project, Akyem Project

Biodiversity Component	Biodiversity Assessment								Justification
	Intrinsic, 'non use' Values						Use Values		
	Significance			Irreplaceability			Socioeconomic Values	Cultural Values	
	Global	National	Local	Site Endemic	Localized	Widespread			
Species									
Cussonia bancoensis	VU	Gold Star				X	Timber species		Occurs in all forest zones and regenerates freely
Entandophragma angolense	VU	Red Star				X	Timber species		Historically common but heavily exploited for timber
Entandrophragma cylindricum	VU	Scarlet Star				X	Timber species		Historically common but heavily exploited for timber
Nauclea diderrichii	VU	Scarlet Star				X	Timber species		Historically common but heavily exploited for timber
Nesogordonia papaverifera	VU	Red Star				X	Timber species		Historically common but heavily exploited for timber
Albizia ferruginea	VU	Scarlet Star				X	Timber species		Historically common but heavily exploited for timber
Pterygota macrocarpa	VU	Red Star				X	Timber species		Historically common but heavily exploited for timber
Terminalia ivorensis	VU	Scarlet Star				X	Timber species		Historically common but heavily exploited for timber
Rufous-winged illadopsis	NT					X			Endemic to Upper Guinea forests
Green-tailed bristle-bill	EN					X			Endemic to Upper Guinea forests
Zenker's fruit bat	VU	Schedule 1				X			Represents Ghana fruit bat species
Maxwell's duiker	NT	Schedule 1				X	Bush meat		Widely distributed in West Africa in moist forest
Royal antelope	NT	Schedule 1				X	Bush meat		Widely distributed in West Africa in moist forest
Black duiker	NT	Schedule 1				X	Bush meat		Widely distributed in West Africa in moist forest
Pel's anomalure	NT	Schedule 1				X	Bush meat		Dependent on large trees with cavities. Competes with hornbills for cavities in large trees
Hinged tortoise	VU	Schedule 1				X	Pet trade		Savannahs and forests of West Africa
Medicinal plant species*						X	Medicinal		Represents socioeconomic and traditional values
Communities/Habitats									
Secondary forest						X	NTFP ** and ecosystem services		Represents native forest habitats and ecosystem services

Key to Global Significance Criteria **Further detailed information is available at** http://www.iucnredlist.org/info/categories_criteria2001

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.

NEAR THREATENED (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

Notes:

* Twenty-four (24) percent of the flora in the Akyem area is used medicinally (CI 2006).

** NTFP - Non-timber forest products

Table B-4
Impact Assessment and Mitigation Hierarchy
BBOP Pilot Project, Akyem Site

Biodiversity Component	Biodiversity Assessment								Impact Assessment		Mitigation Hierarchy*					Justification *(insert comments here explaining data entered in columns J to P)*
	Intrinsic, 'non use' Values						Use Values				Avoid	Mitigate	Offset	In-kind restriction on offset? (Y/N)	Avoidance or mitigation strategy	
	Significance			Irreplaceability *(mark only one)*			Socioeconomic Values	Cultural Values	Project Activity	Likely Impact (qualitative based on EIA?)	*(check the principal step)*					
	Global	National	Local	Site Endemic	Localized	Widespread										
Species																
Cussonia bancoensis	VU	Gold Star				X	Timber species		Mine development	Removal of individuals in forest and cocoa plantations		X	X	No	Revegetate disturbed sites with this species	
Entandophragma angolense	VU	Red Star				X	Timber species		Mine development	Removal of individuals in forest and cocoa plantations		X	X	No	Revegetate disturbed sites with this species	
Entandrophragma cylindricum	VU	Scarlet Star				X	Timber species		Mine development	Removal of individuals in forest and cocoa plantations		X	X	No	Revegetate disturbed sites with this species	
Nauclea diderrichii	VU	Scarlet Star				X	Timber species		Mine development	Removal of individuals in forest and cocoa plantations		X	X	No	Revegetate disturbed sites with this species	
Nesogordonia papaverifera	VU	Red Star				X	Timber species		Mine development	Removal of individuals in forest and cocoa plantations		X	X	No	Revegetate disturbed sites with this species	
Albizia ferruginea	VU	Scarlet Star				X	Timber species		Mine development	Removal of individuals in forest and cocoa plantations		X	X	No	Revegetate disturbed sites with this species	
Pterygota macrocarpa	VU	Red Star				X	Timber species		Mine development	Removal of individuals in forest and cocoa plantations		X	X	No	Revegetate disturbed sites with this species	
Terminalia ivorensis	VU	Scarlet Star				X	Timber species		Mine development	Removal of individuals in forest and cocoa plantations		X	X	No	Revegetate disturbed sites with this species	
Rufous-winged illadopsis	NT					X			Mine development	Removal of forest habitat		X	X	No	Re-establish forest habitat on disturbed sites	
Green-tailed bristle-bill	EN	Schedule 1				X			Mine development	Removal of forest habitat		X	X	No	Re-establish forest habitat on disturbed sites	
Zenker's fruit bat	VU	Schedule 1				X			Mine development	Removal of forest habitat		X	X	No	Re-establish forest habitat on disturbed sites	
Maxwell's duiker	NT	Schedule 1				X	Bush meat		Mine development	Reductions in habitat and increased bush meat hunting		X	X	No	Re-establish forest habitat on disturbed sites	
Royal antelope	NT	Schedule 1				X	Bush meat		Mine development	Reductions in habitat and increased bush meat hunting		X	X	No	Re-establish forest habitat on disturbed sites	
Black duiker	NT	Schedule 1				X	Bush meat		Mine development	Reductions in habitat and increased bush meat hunting		X	X	No	Re-establish forest habitat on disturbed sites	
Pel's anomalure	NT	Schedule 1				X	Bush meat		Mine development	Reductions in habitat and increased bush meat hunting		X	X	No	Re-establish forest habitat on disturbed sites	
Hinged tortoise	VU	Schedule 1				X	Pet Trade		Mine devleopment	Loss of habitat		X	X	No	Re-establish forest habitat on disturbed sites	
Whole Landscapes/Ecosystems																
Secondary forest						X			Mine devleopment	Loss of habitat				No	Re-establish forest habitat on disturbed sites	

Note:

* Potential Impacts would be mitigated to the extent possible; residual impacts would be offset.

Table B-5
Calculation of Biodiversity Loss at Impact Site
BBOP Pilot Project, Akyem Site

CALCULATING BIODIVERSITY LOSS AT IMPACT SITE
(Quantifcation of Biodiversity Loss Through Project Impact, via Habitat Hectares)

Habitat Type 1: Forest Habitats

Total Habitat Hectares Lost: 320

1. To the left, label each pre-project site condition class found.
(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)

… of Condition Class 1: Degraded	…of Condition Class 2: Poor	…of Condition Class 3: No value

2. Fill in the area of …
(enter "0" for non-relevent condition classes and impact levels)

Each Site Class…	146	1091	191
Post-Project, High Impact Sites…	146	1091	191
Post-Project, Medium Impact	0	0	0
Post-Project, Low Impact Sites…	0	0	0

3. For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…

Attribute	BENCHMARK: Reference Level #	BENCHMARK: Reference Level Units/ Bands	Weight	Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Degraded — Condition/ Level	Condition Class 1: Degraded — *Net Loss*	Condition Class 2: Poor — Condition/ Level	Condition Class 2: Poor — *Net Loss*	Condition Class 3: No value — Condition/ Level	Condition Class 3: No value — *Net Loss*	Habitat Hectares Lost	Rationale *(enter comments explaining data in columns B to Q)*
Forest Condition	1		0.2	NT	Pre-Project	0.75		0.25		0		76.5	Provided in Case Study Report
					Post-Project, High Impact Sites	0	*0.75*	0	*0.25*		*0*		
					Post-Project, Medium Impact Sites	0	*0.75*	0	*0.25*		*0*		
					Post-Project, Low Impact Sites	0	*0.75*	0	*0.25*		*0*		
Patch size	1		0.15	NA	Pre-Project	0.01		0		0		0.2	Provided in Case Study Report
					Post-Project, High Impact Sites	0	*0.01*		*0*		*0*		
					Post-Project, Medium Impact Sites	0	*0.01*		*0*		*0*		
					Post-Project, Low Impact Sites	0	*0.01*		*0*		*0*		
Large tree density	1		0.15	T	Pre-Project	0.75		0.25		0		57.3	Provided in Case Study Report
					Post-Project, High Impact Sites	0	*0.75*	0	*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0.75*		*0.25*		*0*		
Connectedness	1		0.1	T	Pre-Project	0		0		0		0.0	Provided in Case Study Report
					Post-Project, High Impact Sites	0	*0*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0*		*0*		*0*		
					Post-Project, Low Impact Sites		*0*		*0*		*0*		
Genetic Heat Index	1		0.1	T	Pre-Project	0.91		0.25		0		40.6	Provided in Case Study Report
					Post-Project, High Impact Sites	0	*0.91*		*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0.91*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0.91*		*0.25*		*0*		
IUCN Vulnerable plants	1		0.1	T	Pre-Project	1		0.5		0		69.2	Provided in Case Study Report
					Post-Project, High Impact Sites	0	*1*		*0.5*		*0*		
					Post-Project, Medium Impact Sites		*1*		*0.5*		*0*		
					Post-Project, Low Impact Sites		*1*		*0.5*		*0*		
Zenker's fruit bat	1		0.05	T	Pre-Project	0.75		0.25		0		19.1	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0.75*		*0.25*		*0*		
Maxwell's duiker	1		0.1	T	Pre-Project	0.75		0.25				38.2	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0.75*		*0.25*		*0*		
Non-timber forest products	1		0.05	NA	Pre-Project	0.75		0.25		0		19.1	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0.75*		*0.25*		*0*		

TABLE B-6

Reclamation of Mine Disturbance

BBOP Pilot Project, Akyem Site

MINE FACILITY	TOTAL HECTARES	RECLAMATION			
		HECTARES	TYPE	CONDITION CLASS	COMMENT
Mine Pit	139	35	Plantation	II	
		35	Crop	III	
		69	Unreclaimed (pit lake	III	Steep walls and depth preclude reclamation. Water depth may preclude use as aquaculture resource.
Waste Rock Disposal Facility (WRDF)	246	122	Forest	I	On side slopes of WRDF
		62	Plantation	II	On flat top of WRDF
		62	Crop	III	On flat top of WRDF
Tailing Storage Facility	419	419	Forest	I	Includes embankment slopes
Water Storage Facility (WSF)	56	28	Plantation	II	WSF would be breached after mining
		28	Crop	III	
Water Pipeline Corridor	17	9	Plantation	II	
		8	Crop	III	
Sediment Control Structures	35	17	Plantation	II	
		18	Crop	III	
Process Plant, mill, offices	85	85	Unreclaimed	III	
Other facilities (Stockpiles, laydown, ROM, Pad, Haul/access roads)	423	211	Plantation	II	
		212	Crop	III	
Operations Management Camp	8	8	Unreclaimed	III	Maintained as infrastructure
TOTALS	**1428**	**1428**			

Notes:

Condition Classes

I - Secondary Forest

II - Plantations (oil palm, cocoa, cedrela, citrus) and fallow agricultural land

III - Crops (maize, cassava, etc.), unrelaimed land (pit lake, process plant, buildings, mill, infrastracture, etc.)

Assumptions

Secondary Forest	451 hectares would be reclaimed to forest
Plantations	435 hectares would be reclaimed to plantations (363 hectares reclaimed for plantations evaluated with 73 acres of fallow cropland; approximately 20 percent of cropland would remain in fallow at any one time)
Crops	290 hectares evaluated for crops (363 hectares reclaimed to crops minus 20 percent of cropland (73 hectares) which would remain fallow at any period of time
Unreclaimed	162 hectares would be unreclaimed such as the mine pit and facilities that would be retained as infrastructure

Table B-7

Calculation of Biodiversity at Impact Site After 30 Years of Reclamation

BBOP Pilot Project, Akyem Site

LOSS AT IMPACT SITE

(Quantifcation of Biodiversity Loss Through Project Impact, via Habitat Hectares)

Habitat Type 1: Forest Habitats

Total Habitat Hectares Lost: 240

1. To the left, label each pre-project site condition class found.

(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)

2. Fill in the area of … *(enter "0" for non-relevent condition classes and impact levels)*

Each Site Class…	… of Condition Class 1: Degraded	…of Condition Class 2: Poor	…of Condition Class 3: No Value
Each Site Class…	**541**	**362**	**525**
Post-Project, High Impact Sites…	541	362	525
Post-Project, Medium Impact Sites…	0	0	0
Post-Project, Low Impact Sites…	0	0	0

3. For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…

Attribute	BENCHMARK: Reference Level #	BENCHMARK: Reference Level Units/ Bands	Weight	Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Degraded — Condition/ Level	Condition Class 1: Degraded — *Net Loss*	Condition Class 2: Poor — Condition/ Level	Condition Class 2: Poor — *Net Loss*	Condition Class 3: No Value — Condition/ Level	Condition Class 3: No Value — *Net Loss*	Habitat Hectares Lost	Rationale *(enter comments explaining data in columns B to Q)*
Forest condition class	1		0.2	NT	Pre-Project	0.5		0.25		0		72.2	Provided in Case Study Report
					Post-Project, High Impact Sites	0	*0.5*	0	*0.25*	0			
					Post-Project, Medium Impact Sites	0	*0.5*	0	*0.25*	0			
					Post-Project, Low Impact Sites	0	*0.5*	0		0			
Patch size	1		0.15		Pre-Project	0.01		0		0		0.8	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.01*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0.01*		*0*		*0*		
					Post-Project, Low Impact Sites	0	*0.01*		*0*		*0*		
Large tree density	1		0.15		Pre-Project	0						0.0	Provided in Case Study Report
					Post-Project, High Impact Sites		*0*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0*		*0*		*0*		
					Post-Project, Low Impact Sites		*0*		*0*		*0*		
Connectedness	1		0.1		Pre-Project	0		0		0		0.0	Provided in Case Study Report
					Post-Project, High Impact Sites		*0*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0*		*0*		*0*		
					Post-Project, Low Impact Sites		*0*		*0*		*0*		
Genetic Heat Index	1		0.1		Pre-Project	0.5		0.25				36.1	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.5*		*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0.5*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0.5*		*0.25*		*0*		
IUCN Vulnerable plants	1		0.1		Pre-Project	0.75		0.5				58.7	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.75*		*0.5*		*0*		
					Post-Project, Medium Impact Sites		*0.75*		*0.5*		*0*		
					Post-Project, Low Impact Sites		*0.75*		*0.5*		*0*		
Zenker's Fruit Bat	1		0.05		Pre-Project	0.5		0.25				18.1	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.5*		*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0.5*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0.5*		*0.25*		*0*		
Maxwell's duiker	1		0.1		Pre-Project	0.5		0.25				36.1	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.5*		*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0.5*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0.5*		*0.25*		*0*		
Non-timber Forest Products	1		0.05		Pre-Project	0.5		0.25				18.1	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.5*		*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0.5*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0.5*		*0.25*		*0*		

TABLE B-8
SUMMARY OF BIODIVERSITY LOSS IN HABITAT HECTARES
BBOP PILOT PROJECT, AKYEM SITE

PROJECT STAGE	HECTARES					
	CLASS I (Degraded) Secondary Forest		CLASS II (Poor) Plantation		CLASS III (No Value) Crops, Fallow Lands	
Pre Project	(A)	146	(B)	1091	(C)	191
After 30 Years of Reclamatic	(M)	541	(N)	362	(O)	525

		(D)	(E)	(G)	(H)		(J)	(K)	(L)		(Q)	R)		(T)	(U)	(V)	
ATTRIBUTE	BENCHMARK Reference Level	WEIGHT	PRE-PROJECT							AFTER 30 YEARS OF RECLAMATION							HABITAT HECTARES LOST
			Condition Class I (Degraded)			Condition Class II (Poor)			TOTAL HABITAT HECTARES	Condition Class I (Degraded)			Condition Class II (Poor)			TOTAL HABITAT HECTARES	
			Level	Habitat hectares / hectare	Habitat Hectares	Level	Habitat hectares / hectare	Habitat Hectares		Level	Habitat hectares / hectare	Habitat Hectares	Level	Habitat hectares / hectare	Habitat Hectares		
			(F)	(F/D)*E	G*A	(I)	(I/D)*E	J*B	H+K	(P)	(P/D)*E	Q*M	(S)	(S/D)*E	T*N	R+U	V - L
Forest Condition	1	0.20	0.75	0.15	21.90	0.25	0.05	54.55	76.45	0.50	0.10	54.10	0.25	0.05	18.10	72.20	(4.25)
Patch Size	1	0.15	0.01	0.00	0.22	0.00	0.00	0.00	0.22	0.01	0.00	0.81	0.00	0.00	0.00	0.81	0.59
Large Tree Density	1	0.15	0.75	0.11	16.43	0.25	0.04	40.91	57.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57.34)
Connectedness	1	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Genetic Heat Index	1	0.10	0.91	0.09	13.29	0.25	0.03	27.28	40.56	0.50	0.05	27.05	0.25	0.03	9.05	36.10	(4.46)
IUCN Vulnerable Plants	1	0.10	1.00	0.10	14.60	0.50	0.05	54.55	69.15	0.75	0.08	40.58	0.50	0.05	18.10	58.68	(10.48)
Zenker's Fruit Bat	1	0.05	0.75	0.04	5.48	0.25	0.01	13.64	19.11	0.50	0.03	13.53	0.25	0.01	4.53	18.05	(1.06)
Maxwell's Duiker	1	0.10	0.75	0.08	10.95	0.25	0.03	27.28	38.23	0.50	0.05	27.05	0.25	0.03	9.05	36.10	(2.13)
Non-timber Forest Products	1	0.05	0.75	0.04	5.48	0.25	0.01	13.64	19.11	0.50	0.03	13.53	0.25	0.01	4.53	18.05	(1.06)
TOTAL HABITAT HECTARES									320							240	(80)

Notes:

Refer to Tables B-1 and B-6 for hectares of disturbance and reclamation,respectively, relative to each project element

Condition Class III (no value) -- these lands are not considered in biodiversity calculations

Table B-9
Screening Summary of Candidate Biodiversity Offset Options
BBOP Pilot Project, Akyem Site

Candidate Offset Sites	Local Community Use						Habitat Status/Location						Ecological Status							Org. Appropriateness			Total Score	Rank
	Local Community Benefit	Local Biodiversity Enhancement / Benefit	Socio-cultural Acceptance	Avoidance of Tribal Conflicts	Conformity to Local and Natural Landscape Plan	Ability to Galvanise CommunitySupport	Suitable Seed Bank or Refugia	Land Tenure compatibility	Suitable for Demonstration	Structure of Forest landscape	Infrastructure Availability	Proximity to Mining Site & Community	Species Variability	Ecological Services Delivery Potential	Ability to achieve Global Conservation Concerns	Proximity to anthropogenic disturnbances eg farming	Management Suitability and Capacity	Conformity to Government Objective	Addressing Biodiversity Problem	Credibility for Newmont	Cost Effectiveness	Geo-political Soundness		
Mamang River Forest Reserve	5	4	5	5	5	4	5	4	5	5	3	4	5	5	4	3	4	3	5	5	5	5	98	5
Nsuensa Forest Reserve	4	5	4	3	4	3	4	5	3	3	2	2	4	3	3	4	3	2	4	4	4	4	77	4
Auro River Forest Reserve	3	3	3	4	3	2	3	3	4	2	1	3	3	4	2	5	2	1	3	3	3	3	63	3
GSBA Trust Fund	1	1	1	1	1	1	2	1	2	0	5	1	0	0	5	2	5	5	2	2	2	2	42	2
District Assembly Environmental Fund	2	2	2	2	2	5	1	2	0	0	4	5	0	0	1	1	1	4	1	1	1	1	38	1

Notes:
Source: Conservation International - Ghana (2008)

SCORE (1-5)	
1	Unsuitable
2	Poor
3	Average
4	Good
5	Excellent

Table B-10
Calculation of Biodiversity Loss at Offset Site Before Offset Activities
BBOP Pilot Project, Akyem Site

Pre-Project Offset Site

Total Habitat Hectares 147.6

1. To the left, label each pre-project site condition class found.

(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)

2. Fill in the area of … (enter "0" for non-relevent condition classes and impact levels)

Each Site Class…	… of Condition Class 1: Degraded	…of Condition Class 2: Poor	…of Condition Class 3: No Value
	218	**18**	**14**
Post-Project, High Impact Sites…	218	18	14
Post-Project, Medium Impact Sites…	0	0	0
Post-Project, Low Impact Sites…	0	0	0

3. For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…

Attribute	BENCHMARK: Reference Level #	BENCHMARK: Reference Level Units/ Bands	Weight	Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Degraded — Condition/ Level	Condition Class 1: Degraded — Net Loss	Condition Class 2: Poor — Condition/ Level	Condition Class 2: Poor — Net Loss	Condition Class 3: No Value — Condition/ Level	Condition Class 3: No Value — Net Loss	Habitat Hectares Lost	Rationale (enter comments explaining data in columns B to Q)
Forest Condition Class	1		0.2		Pre-Project	0.75		0.25		0		33.6	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0.75*		*0.25*		*0*		
Patch Size	1		0.15		Pre-Project	1		0		0		32.7	Provided in Case Study Report
					Post-Project, High Impact Sites		*1*		*0*		*0*		
					Post-Project, Medium Impact Sites		*1*		*0*		*0*		
					Post-Project, Low Impact Sites		*1*		*0*		*0*		
Large Tree Density	1		0.15		Pre-Project	0.75		0		0		24.5	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.75*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0.75*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.75*		*0*		*0*		
Connectedness	1		0.1		Pre-Project	1		0				21.8	Provided in Case Study Report
					Post-Project, High Impact Sites		*1*		*0*		*0*		
					Post-Project, Medium Impact Sites		*1*		*0*		*0*		
					Post-Project, Low Impact Sites		*1*		*0*		*0*		
Genetic Heat Index	1		0.1		Pre-Project			0.25				-15.9	Provided in Case Study Report
					Post-Project, High Impact Sites	0.75	*-0.75*		*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0*		*0.25*		*0*		
IUCN Vulnerable Plants	1		0.1		Pre-Project	0.75		0.5				17.3	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.75*		*0.5*		*0*		
					Post-Project, Medium Impact Sites		*0.75*		*0.5*		*0*		
					Post-Project, Low Impact Sites		*0.75*		*0.5*		*0*		
Zenker's fruit bat	1		0.05		Pre-Project	0.75		0.25				8.4	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0.75*		*0.25*		*0*		
Maxwell's duiker	1		0.1		Pre-Project	0.75		0.25				16.8	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0.75*		*0.25*		*0*		
Non-timber Forest Products	1		0.05		Pre-Project	0.75		0.25				8.4	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Medium Impact Sites		*0.75*		*0.25*		*0*		
					Post-Project, Low Impact Sites		*0.75*		*0.25*		*0*		

Table B-11
Calculation of Biodiversity Loss at Offset Site After Offset Activities
BBOP Pilot Project, Akyem Site

Post-Project Offset Site — **Total Habitat Hectares** **241**

1. To the left, label each pre-project site condition class found.
(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)

2. Fill in the area of … *(enter "0" for non-relevent condition classes and impact levels)*

Each Site Class…	… of Condition Class 1: Degraded	…of Condition Class 2: Poor	…of Condition Class 3: No Value
	250	**0**	**0**
Post-Project, High Impact Sites…	250	0	0
Post-Project, Medium Impact Sites…	0	0	0
Post-Project, Low Impact Sites…	0	0	0

3. For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…

Attribute	BENCHMARK Reference Level #	BENCHMARK Reference Level Units/ Bands	Weight	Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Degraded — Condition/ Level	Condition Class 1: Degraded — *Net Loss*	Condition Class 2: Poor — Condition/ Level	Condition Class 2: Poor — *Net Loss*	Condition Class 3: No Value — Condition/ Level	Condition Class 3: No Value — *Net Loss*	Habitat Hectares Lost	Rationale *(enter comments explaining data in columns B to Q)*
Forest Condition Class	1		0.2		Pre-Project	0.95		0		0		47.5	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.95*		*0*		*0*		
Patch Size	1		0.15		Pre-Project	1						37.5	Provided in Case Study Report
					Post-Project, High Impact Sites		*1*		*0*		*0*		
					Post-Project, Medium Impact Sites		*1*		*0*		*0*		
					Post-Project, Low Impact Sites		*1*		*0*		*0*		
Large Tree Density	1		0.15		Pre-Project	0.95						35.6	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.95*		*0*		*0*		
Connectedness	1		0.1		Pre-Project	1						25.0	Provided in Case Study Report
					Post-Project, High Impact Sites		*1*		*0*		*0*		
					Post-Project, Medium Impact Sites		*1*		*0*		*0*		
					Post-Project, Low Impact Sites		*1*		*0*		*0*		
Genetic Heat Index	1		0.1		Pre-Project	0.95						23.8	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.95*		*0*		*0*		
IUCN Vulnerable Plants	1		0.1		Pre-Project	0.95						23.8	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.95*		*0*		*0*		
Zenker's fruit bat	1		0.05		Pre-Project	0.95						11.9	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.95*		*0*		*0*		
Maxwell's duiker	1		0.1		Pre-Project	0.95						23.8	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.95*		*0*		*0*		
Non-timber Forest Products	1		0.05		Pre-Project	0.95						11.9	Provided in Case Study Report
					Post-Project, High Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0.95*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.95*		*0*		*0*		

APPENDIX C

COST BENEFIT TABLES

Table C-1
Project Activities, Offset Activities and the Communities Affected
(Stages A1.1, A1.2, B1.1, B2.1, C1.1)
BBOP Pilot Project, Akyem Site

PROJECT ACTIVITIES	Hectares of Disturbance	COMMUNITIES AFFECTED	Any groups within the community particularly affected?
Mine pit	139	Yayaaso, Hamlets and Farmsteads	Forest reserve, resident and non-resident farmers
Waste rock disposal facility	246	Yayaaso, Afosu, New Abirem, Hamlets and Farmsteads	
Tailings storage facility	419	Hweakwae, Hamlets and Farmsteads	
Water storage facility	56	Hweakwae, Hamlets and Farmsteads	
Water pipeline	17	Hweakwae, Ntronang, Hamlets and Farmsteads	
Sediment control structures	35	Yayaaso, Afosu, New Abirem, Hamlets and Farmsteads	
Process plant, mill, administrative offices	85	Yayaaso, Hamlets and Farmsteads	
Stockpiles	37	New Abirem, Hweakwae, Hamlets and Farmsteads	
Operations management camp	8	Yayaaso, Hamlets and Farmsteads	
RECLAMATION ACTIVITIES			
Mine pit	139 (35 ha crop; 35 ha plantation; 69 ha unreclaimed – pit lake)	Unknown since Yayaaso and Hamlets will be destroyed	
Waste Rock Facility	246 (62 ha crop, 62 ha plantation; 122 ha forest)	Afosu, New Abirem	
Tailings Storage Facility	419 (419ha forest)	Hweakwae	
Water Storage Facility	56 (28 ha crop; 25 ha plantation)	Hweakwae	
Water Pipeline	17 (8 ha crop; 9 ha plantation)	Hweakwae, Ntronang	

Table C-1
Project Activities, Offset Activities and the Communities Affected
(Stages A1.1, A1.2, B1.1, B2.1, C1.1)
BBOP Pilot Project, Akyem Site

PROJECT ACTIVITIES	Hectares of Disturbance	COMMUNITIES AFFECTED	Any groups within the community particularly affected?
Sediment Control Structures	35 (17 ha crop; 18 ha plantation)	Unknown since Yayaaso and Hamlets will be destroyed	
Process Plant, Mill and Admin Offices	85 (99 ha unreclaimed, left as infrastructure)	Unknown since Yayaaso and Hamlets will be destroyed	
Stockpiles	37 (18 ha crop; 19 ha plantation)	New Abirem, Hweakwae	
Operations Management Camp	8 (8 ha unreclaimed, left as infrastructure	Unknown since Yayaaso and Hamlets will be destroyed	
RECLAMATION SUMMARY			
Land Use	**Number of Hectares**		
Reclaimed to forest	542		
Plantation and fallow	229		
Crop and unreclaimed	327		
OFFSET ACTIVITIES – Mamang River Forest Reserve*			
Important corridor linking off-reserve areas, farm lands and other forest reserves		Entire Project Area, including Mamanso and numerous hamlets	1840 residents; 330 farms; 540 non-resident farmers, and offset community residents
Refuge for animals leaving Mining Area construction		Entire Project Area, including Mamanso and numerous hamlets	
Protect threatened species		Entire Project Area, including Mamanso and numerous hamlets	
Protect seed banks		Entire Project Area, including Mamanso and numerous hamlets	

Table C-1
Project Activities, Offset Activities and the Communities Affected
(Stages A1.1, A1.2, B1.1, B2.1, C1.1)
BBOP Pilot Project, Akyem Site

PROJECT ACTIVITIES	Hectares of Disturbance	COMMUNITIES AFFECTED	Any groups within the community particularly affected?
Protect headwaters		NA at Mamang location	NA
Micro-climate modification		NA at Mamang location	NA
Provision of medicinal plants		Entire Project Area, including Mamanso and numerous hamlets	1840 residents; 330 farms; 540 non-resident farmers and offset community residents
Promotion of cocoa industry		Existing cocoa farmers	25 people, 5 farms, and the cocoa farmers current using the MRFR
Newmont demonstration project/proximity to mine		Mamanso, New Abiriem, Abirem and hamlets	
Eco-tourism attraction potential		Mamanso, New Abiriem, Abirem and hamlets	
Total offset	**250 hectares at Offset Site**		

Note:
* based on CI-Ghana's Offset Site Selection and Evaluation Report, May 2008.

Table C-2
Project Affected Communities
(Stages A1.1, A1.2, B1.1, B2.1, C1.1)
BBOP Pilot Project, Akyem Site

Communities Affected **Project Affected Communities**	**Summary description of community** (including the location, size, distribution and organisation of the community, and any key features about the population's work and livelihoods).	**Activities (Including Project and Offset) Affecting Each Community**	**Any groups within the community particularly affected by the project and offset** (e.g. women, landless families, elders, shamans)**?**
Yayaaso, hamlets, and farmsteads	The primary community in the Mining Area is Yayaaso. The community is still regarded as a settler community because the inhabitants are predominantly non-Akyem. The estimated population in 2000 was 570 occupying 100 houses. Using the 2000 Census figures, the International SOS May 2006 Health Survey estimated Yayaaso's population in 2006 at 700 persons. The initial SIA noted that Yayaaso is a very poor community for the Study Area with a striking feature of the community being the poor construction of most of the dwellings. The community is served by a piped water supply. A 120 cubic metre tank, which forms part of the water system, is located at Yayaaso and also provides water to Afosu, New Abirem and Mamanso. The community has two public water standpipes, one borehole and one hand dug well. The community has one public pit latrine and one dumping site neither of which is actively managed. The community has limited access to electricity and has one operating streetlight. Although the community has a health volunteer, there is no health facility in the community and the people travel to New Abirem (2 kilometres away) to seek medical attention. The people of Yayaaso are mainly farmers engaged in the cultivation of cocoa, oil palm, citrus, maize, cassava, plantain and cocoyam. Production of cocoa ranges between ½ bag and 30 bags from farms between 0.2 to 6 hectares in size. Food crop farms range from between 0.2 to 1.2 hectares; the two most important food crops are cassava and plantain. The community has four masons, two carpenters, two mechanics, two electricians, four seamstresses and two tailors. There are four stores, seven drinking spots, and two hair salons in Yayaaso. Of greatest economic value in the community is the presence of two oil palm processing facilities and three corn mills.	**Direct Project:** Mine Pit Waste rock disposal facility Tailings storage facility Water storage facility Sediment control structures Process plant, mill, admin offices Stockpiles Operations management camp **Offset:** No impact	Entire communities will be resettled*. 2,734 farms in the Mining Area will be displaced 1,331 residents/farmers* who live and farm within the Mining Area will be displaced 218 hectares* (242 households at 0.9 ha farm per household) of resident farm land will be destroyed. 1 school will be displaced* 2 churches will be displaced* 13 businesses will be displaced* 2 oil palm processing facilities will be displaced* 3 corn mills will be displaced* Water supply to Afosu, New Abirem, and Mamanso will be destroyed*

Table C-2
Project Affected Communities
(Stages A1.1, A1.2, B1.1, B2.1, C1.1)
BBOP Pilot Project, Akyem Site

Communities Affected Project Affected Communities	Summary description of community (including the location, size, distribution and organisation of the community, and any key features about the population's work and livelihoods).	Activities (Including Project and Offset) Affecting Each Community	Any groups within the community particularly affected by the project and offset (e.g. women, landless families, elders, shamans)?
	The community has a primary school and two churches - Pentecost and Mosama, both charismatic Christian religions. Hamlets, located within the Mining Area, which house approximately 631 people, include Nyamebekyere, Kerenkeren, Kwasi Kpofor, Badu, Kofi Aklo, Ayesu Zigah, Yaw Tano, and Metemano. There are also individual farmsteads located in the Mining Area. The buildings are structurally poor and are generally of wattle and daub construction with rammed earth floors and thatched or bamboo roofing with a few buildings having corrugated iron roofing sheets. There are no public facilities or services in these hamlets, and economic activity is limited to agricultural pursuits. Most of the residents of these hamlets raise cash crops of cocoa, oil palm and citrus and grow a variety of food crops including cassava, pineapple, cocoyam, plantain, maize, ginger and vegetables. Residents in the Mining Area belong to one or more identifiable communities or social groups, including religious and cultural groups and youth development associations.		2 cemeteries (Adausena stool) will be displaced* 12 household shrines (Adausena Stool) will be displaced* 3 community shrines (Adauasena, Hweakwae, and Abirem stools) will be displaced* 4 archaeological sites will be disturbed*
Afosu	Afosu is the largest community in the Study Area but it still classified as a community not a town because its population at 3,511 is below 5,000. The District Police station is located here. The Cocoa Research Institute has its main facility in Afosu and the Cocoa Marketing Board maintains a station in the town. There is a small health post run by the Ministry of Health. The Asuopra Rural Bank has a branch operation in this town and there are two sawmills and a carpentry shop in addition to drinking spots, hairdressers, and stores. There is a communications centre in Afosu but no post office. There are seven formal religious centres including Christian, Catholic, and Islamic facilities.	**Indirect Project:** Waste rock disposal facility Sediment control structures **Offset:** No impact	2,734 farms) in the Mining Area will be displaced totally 1,752 ha 7,937 non-resident farmers throughout the Study Area will be economically displaced

Table C-2
Project Affected Communities
(Stages A1.1, A1.2, B1.1, B2.1, C1.1)
BBOP Pilot Project, Akyem Site

Communities Affected Project Affected Communities	Summary description of community (including the location, size, distribution and organisation of the community, and any key features about the population's work and livelihoods).	Activities (Including Project and Offset) Affecting Each Community	Any groups within the community particularly affected by the project and offset (e.g. women, landless families, elders, shamans)?
New Abirem	New Abirem is the capital of the Birim North District and several ministries maintain officers in the town, including the offices of the District Assembly, Town & Country Planning, Information Services, National Mobilization Program, Electoral Commission, Electricity Cooperative, Food & Agriculture, and Range Forestry. There is a Ministry of Health clinic in New Abirem with 39 employees. There are 1,967 people living in New Abirem. Commerce in New Abirem includes two markets providing various goods, drinking spots, and two Ghanaian rural banks. There are three churches in New Abirem: Methodist, Presbyterian, and Roman Catholic.	**Indirect Project:** Waste rock disposal facility Sediment control structures Process plant, mill, admin offices Stockpiles Operations management camp **Offset:** Potential impact from the Mamang Forest Reserve	2,734 farms (1,752 ha) in the Mining Area will be displaced 7,937 non-resident farmers throughout the Study Area will be economically displaced*
Mamanso	Mamanso is a community of 2,000 persons south of New Abirem. There is a small health clinic and limited commercial activity in the community. The majority of the residents are subsistence farmers engaged in the cultivation of oil palm and cocoa. Excess food crops are sold at the New Abirem markets. There is no community centre or entertainment in Mamanso. There are nine religious facilities in Mamanso serving Christians, Catholics, and Muslims.	**Indirect Project:** No direct impact **Offset:** Potential impact from the Mamang Forest Reserve	2,734 farms* (1,752 ha) in the Mining Area will be displaced 7,937 non-resident farmers throughout the Study Area will be economically displaced*
Abirem	Abirem is a small community south of Mananso at the southern edge of the Study Area. The population is estimated at 1,400 people living in 330 houses most of which are in poor condition. Most of the residents of Abirem are farmers, primarily engaged in the production of oil palm with lesser emphasis on growing cocoa, vegetables, maize, and plantain. There are two chemist shops in the community but residents must travel to New Abirem for medical care. In addition to a few shops and drinking spots, there are three cocoa buying companies operating in Abirem. There are religious facilities to serve both Christians and Muslims.	**Indirect Project:** No impact **Offset:** Potential impact from the Mamang Forest Reserve	

Table C-2
Project Affected Communities
(Stages A1.1, A1.2, B1.1, B2.1, C1.1)
BBOP Pilot Project, Akyem Site

Communities Affected Project Affected Communities	Summary description of community (including the location, size, distribution and organisation of the community, and any key features about the population's work and livelihoods).	Activities (Including Project and Offset) Affecting Each Community	Any groups within the community particularly affected by the project and offset (e.g. women, landless families, elders, shamans)?
Adausena	This community has been recorded as the first community established within the Study Area. The 1,462 inhabitants are predominantly subsistence farmers; however, the community economy is dominated by the cultivation of cash crops including oil palm, citrus, cocoa, plantain, and cassava. Excess food crops are sold at either the New Abirem or Ntronang markets. Six Cocoa Purchasing Companies operate in Adausena and its environs. The only food processing facility in the community is a small oil palm processing plant belonging to the Church of Pentecost. There is also a small-scale sawmill, which employs between 3 and 15 employees. The community has a chemical store, 12 drinking spots, eight salons, and 12 stores. There is no entertainment or community centre. There are three Christian churches in Adausena. The Royal Family maintains a Palace in Adausena.	**Direct Project:**Road realignment **Offset:**Not available	2,734 farms* (1,752 ha) in the Mining Area will be displaced7,937 non-resident farmers throughout the Study Area will be economically displaced* 1 archaeological site will be disturbed
Hweakwae	The 1,249 inhabitants of Hweakwae are primarily subsistence farmers engaged in the cultivation of food crops - plantain, cassava, cocoyam, and cash crops such as oil palm, cocoa and citrus. The community has 10 stores, 10 drinking spots, five hair salons, and two chemical stores. There is no entertainment or community centre. There are five churches in Hweakwae serving Christians, Catholics, and Muslims.	**Direct Project:** Tailings storage facility Water storage facility Water pipeline **Offset:** Not available	2,734 farms* (1,752 ha) in the Mining Area will be displaced 7,937 non-resident farmers throughout the Study Area will be economically displaced* 7 archaeological sites will be disturbed*
Ntronang	An estimated 2,732 persons live in Ntronang. There is a police station in Ntronang as well as a small health clinic. Ntronang is the only other community in the Study Area besides New Abirem which has a formal market supplied by farmers in the surrounding communitys. Other commercial activities include stores, drinking spots, salons, and a chemical store. There are five churches in Ntronang serving Christians and Catholics. The Royal Family maintains a palace in Ntronang.	**Direct Project:** Water pipeline **Offset:** Not available	2,734 farms* (1,752 ha) in the Mining Area will be displaced 7,937 non-resident farmers throughout the Study Area will be economically displaced* 1 community shrine (at the end of the water pipe) will be displaced*

Table C-2
Project Affected Communities
(Stages A1.1, A1.2, B1.1, B2.1, C1.1)
BBOP Pilot Project, Akyem Site

Communities Affected Project Affected Communities	Summary description of community (including the location, size, distribution and organisation of the community, and any key features about the population's work and livelihoods).	Activities (Including Project and Offset) Affecting Each Community	Any groups within the community particularly affected by the project and offset (e.g. women, landless families, elders, shamans)?
OFFSET Communities	**Mamang River Forest Reserve****		
New Abirem, Abirem, Mamanso, hamlets	New Abirem is the capital of the Birim North District and several ministries maintain officers in the town, including the offices of the District Assembly, Town & Country Planning, Information Services, National Mobilization Program, Electoral Commission, Electricity Cooperative, Food & Agriculture, and Range Forestry. There is a Ministry of Health clinic in New Abirem with 39 employees. There are 1,967 people living in New Abirem. Commerce in New Abirem includes two markets providing various goods, drinking spots, and two Ghanaian rural banks. There are three churches in New Abirem: Methodist, Presbyterian, and Roman Catholic.	**Indirect Project:** No impact **Offset:** - Important corridor linking off-reserve areas, farm lands and other forest reserves - Refuge for animals leaving Mining Area construction - Protect threatened species - Protect seed banks - Provision of medicinal plants - Promotion of cocoa industry	Active cadre of community forest volunteers; mobilization of communities into an efficient co-management structure**

Notes:
* Source: NGRL Final Environmental Impact Statement, November 2008.
** Source: Conservation International-Ghana, Offset Site Selection and Evaluation, May 2008.

Table C-3
Current Community Use and Enjoyment of Biodiversity in Area of Project Activities
(Stages A1.3, C2.1)*
BBOP Pilot Project, Akyem Site

Affected / Involved Communities	Direct Use (Consumptive) Values			Non-Consumptive Use Values			Cultural Use/Non-Use Values			Future Trends/Changes
	Terrestrial	Fresh water	Marine	Terrestrial	Fresh water	Marine	Terrestrial	Fresh water	Marine	
DIRECT AREA OF INFLUENCE	**(Communities within or directly adjacent to the Mining Area)**									
Yayaaso	indigenous plants and herbs, charcoal, bushmeat, building materials	fish	Not Applicable	no info on recreation use		Not Applicable	floral resources, totem species		Not Applicable	35% goes to food requirements; 23% to herbal medicines, 20% to income (farming)14% to energy requirements
Hamlets:Yaw Tano, E.K. Marfo, Ayesu Zigah	indigenous plants and herbs, charcoal, bushmeat, building materials	fish	Not Applicable	no info on recreation use		Not Applicable	floral resources, totem species		Not Applicable	
Adausena	indigenous plants and herbs, charcoal, bushmeat, building materials	fish	Not Applicable	no info on recreation use		Not Applicable	floral resources, totem species		Not Applicable	
Hweakwae	indigenous plants and herbs, charcoal, bushmeat, building materials	fish	Not Applicable	no info on recreation use		Not Applicable	floral resources, totem species		Not Applicable	
Ntronang	indigenous plants and herbs, charcoal, bushmeat, building materials	fish	Not Applicable	no info on recreation use		Not Applicable	floral resources, totem species		Not Applicable	

Table C-3
Current Community Use and Enjoyment of Biodiversity in Area of Project Activities
(Stages A1.3, C2.1)*
BBOP Pilot Project, Akyem Site

Affected / Involved Communities	Direct Use (Consumptive) Values			Non-Consumptive Use Values			Cultural Use/Non-Use Values			Future Trends/Changes
	Terrestrial	Fresh water	Marine	Terrestrial	Fresh water	Marine	Terrestrial	Fresh water	Marine	
INDIRECT AREA OF INFLUENCE	**(Communities near the Mining Area that would be potentially affected by project development)**									
Afosu	indigenous plants and herbs, charcoal, bushmeat, building materials	fish	Not Applicable	no info on recreation use		Not Applicable	floral resources, totem species (grey parrot)		Not Applicable	Totem for chief
New Abirem	indigenous plants and herbs, charcoal, bushmeat, building materials	fish	Not Applicable	no info on recreation use		Not Applicable	floral resources, totem species		Not Applicable	
Mamanso	indigenous plants and herbs, charcoal, bushmeat, building materials	fish	Not Applicable	no info on recreation use		Not Applicable	floral resources, totem species		Not Applicable	
Abirem	indigenous plants and herbs, charcoal, bushmeat, building materials	fish	Not Applicable	no info on recreation use		Not Applicable	floral resources, totem species		Not Applicable	

Reference: Conservation International, Community Biodiversity Use Assessment, October 2006.

Table C-4
Potential Project Impacts of Project on Community Use, and Handling Residual Impacts
(Stages A1.4, A1.5, A1.6, C1.1)
BBOP Pilot Project, Akyem Site

Affected/Involved Communities	Project Activity	Impacts	Avoid?	Reduce?	Residual Impacts to Offset	Offsettable?	Offset Needed?
DIRECT AREA OF INFLUENCE	**(Communities within or directly adjacent to the Mining Area)**						
Yayaaso	Mining	Land clearing, loss of homes and farms	No	Resettle and compensate, new land access	None	NA	No
Hamlets and Homesteads	Mining	Land clearing, loss of homes and farms, possible loss of shrine	No	Resettle and compensate, new land access	None	NA	No
Adausena	Mining	Land clearing, loss of homes and farms	No	Document arch site; relocate and compensate cultural	None	NA	No
Hweakwae	Mining	Loss of archaeological and cultural sites in Mining Area	No	Document arch site; relocate and compensate cultural sites	None	NA	No
Ntronang	Pipeline	Loss of archaeological and cultural sites in Mining Area	No	Relocate and compensate cultural site	None	NA	No
INDIRECT AREA OF INFLUENCE	**(Communities near the Mining Area that would be potentially affected by project development)**						
Afosu	Mining	Loss of farms in Mining Area; potential loss of water supply	No	Crop compensation and new land access. Replace water supply	None	NA	No
New Abirem	Mining	Loss of farms in Mining Area; potential loss of water supply	No	Crop compensation and new land access. Replace water supply	None	NA	No

Table C-5
Proposed Compensation to Communities
(Activity D)
BBOP Pilot Project, Akyem Site

Affected / Involved Communities	**Impacts**	**Particularly affected groups.** Are any groups/ households within the Community particularly affected *(e.g. landless households, women, shamans)*?	**Valuation Results**	**Final Decision** on the Offset needed, and the values involved, including dollar values for compensation and amounts and nature of offsets measured in biodiversity proxies (eg volumes of medicinal plants, or hectares of woodlots, etc).	**Justification**
Yayaaso	Housing and Infrastructure	All Residents	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Consensus
	Land Use	All Residents	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Consensus
	Cemeteries	All Residents	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Negotiation with Chiefs and Elders
	Individual Shrine Sites	All Residents	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Negotiation with Chiefs and Elders
	Access to Forest Reserve	All Residents	Subject to off-set area location	Proxies may be warranted	Distance to substitute or proxy is sensitive to final location off-set area and relocation area

Table C-5
Proposed Compensation to Communities
(Activity D)
BBOP Pilot Project, Akyem Site

	Charcoal Making Activities	All Residents	Subject to off-set area location	Proxies may be warranted	Distance to substitute or proxy is sensitive to final location off-set area and relocation area
	Medicinal Plants	All Residents	Subject to off-set area location	Proxies may be warranted	Distance to substitute or proxy is sensitive to final location off-set area and relocation area
Hamlets and Homesteads	Housing and Infrastructure	All Residents	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Consensus
	Land Use	All Residents	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Consensus
	Farming	Resident Farmers	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Consensus
	Farming	Non-Resident Farmers	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Consensus
	Individual and Community Shrine Sites	All Residents	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Negotiation with Chiefs and Elders
	Archeological Sites	National Resource	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Negotiation with Chiefs and Elders

Table C-5
Proposed Compensation to Communities
(Activity D)
BBOP Pilot Project, Akyem Site

	Access to Forest Reserve	All Residents	Subject to off-set area location	Proxies may be warranted	Distance to substitute or proxy is sensitive to final location off-set area and relocation area
	Charcoal Making Activities	All Residents	Subject to off-set area location	Proxies may be warranted	Distance to substitute or proxy is sensitive to final location off-set area and relocation area
	Medicinal Plants	All Residents	Subject to off-set area location	Proxies may be warranted	Distance to substitute or proxy is sensitive to final location off-set area and relocation area
Adausena	Farming	Non-Resident Farmers	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Consensus
	Individual and Community Shrine Sites	All Residents	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Negotiation with Chiefs and Elders
	Archeological Sites	National Resource	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Not a Typical Compensation Point
	Access to Forest Reserve	All Residents	Subject to off-set area location	Proxies may be warranted	Distance to substitute or proxy is sensitive to final location off-set area and relocation area

Table C-5
Proposed Compensation to Communities
(Activity D)
BBOP Pilot Project, Akyem Site

Hweakwae	Farming	Non-Resident Farmers	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Consensus
	Individual and Community Shrine Sites	All Residents	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Negotiation with Chiefs and Elders
	Archeological Sites	National Resource	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Not a Typical Compensation Point
	Access to Forest Reserve	All Residents	Subject to off-set area location	Proxies may be warranted	Distance to substitute or proxy is sensitive to final location off-set area and relocation area
Ntronang	Farming	Non-Resident Farmers	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Consensus
	Individual and Community Shrine Sites	All Residents	Budget Established Based on CNC Negotiations - Confidential	No Residual Impact Anticipated	Value Established by Negotiation with Chiefs and Elders
	Access to Forest Reserve	All Residents	Subject to off-set area location	Proxies may be warranted	Distance to substitute or proxy is sensitive to final location off-set area and relocation area

To learn more about the BBOP principles, guidelines and optional methodologies, go to:

www.forest-trends.org/biodiversityoffsetprogram/guidelines