FINAL REPORT
Environmental Impact Assessment Study

Rehabilitation of
Bolgatanga – Bawku – Pulmakom Road Project

Prepared by:

DELIN CONSULT LTD.

2nd Floor, Diamond House
Off Starlets 91 Road, Accra, Ghana
PMB 4, TUC Post Office, Accra
Tel: 0302682417 | 0302631086
Email: delin@delincl.com | delin_consult@yahoo.co.uk

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ACRONYMS

AER	-	Annual Environmental Report
AIDS	-	Acquired Immune Deficiency Syndrome
BOQ	-	Bill of Quantities
CBO	-	Community-Based Organization
DFR	-	Department of Feeder Roads
DVLA	-	Driver and Vehicle Licensing Authority
DUR	-	Department of Urban Roads
EA	-	Environmental Assessment
EAR	-	Environmental Assessment Regulations
EIA	-	Environmental Impact Assessment
EIS	-	Environmental Impact Statement
EMP	-	Environmental Management Plan
EMU	-	Environmental Management Unit
EP	-	Environmental Permit
EPA	-	Environmental Protection Agency
FSD	-	Forest Service Division
GHA	-	Ghana Highway Authority
GPRS II	-	Ghana's Growth and Poverty Reduction Strategy II
HIV	-	Human Immune Virus
L.I	-	Legislative Instrument
MRH	-	Ministry of Roads and Highways
NGO	-	Non-Governmental Organization
RSED	-	Road Safety and Environment Division
STI	-	Sexually Transmitted Infections
TOR	-	Terms of Reference
WRC	-	Water Resources Commission

Contents

Executive Study

Background

The Government of the Republic of Ghana (GoG) has a policy of constructing new roads and rehabilitating existing ones to facilitate easy movement of freight and passengers. In this regard, the GoG, through the Ministry of Roads and Highways and the Ghana Highway Authority has selected the Bolgatanga-Bawku-Pulmakom road in the Upper East region of Ghana for rehabilitation. The project is to be executed by the China Jiangsu Janda Construction Company Inc.

The implementation of the project, however, is likely to be associated with some negative impacts. In view of this likelihood, Ghanaian legislation requires that an Environmental Impact Assessment (EIA) should be prepared for development project of this type.

The main tool for implementing environmental policy is the Environmental Impact Assessment Regulation (LI 1652, 1999). Under the environmental regulations, it is mandatory for a detailed EIA study to be provided for the project.

Project Location

The Bolgatanga-Bawku-Pulmakom road is located in the Upper East region of Ghana. The 106.9 km road passes through six administrative areas. These are:

- Bolgatanga Municipal Assembly;
- Nabdam District Assembly;
- Bawku West District Assembly;
- Binduri District Assembly;
- Bawku Municipal Assembly; and
- Pusiga District Assembly

It is a 2-lane carriageway with an average width between 7-11 metres. The road passes through several settlements as indicated in table below.

Major Settlements along the Bolgatanga-Bawku-Pulmakom Road

Town/Village	Chainage
Zuarungu	10+000
Longrepotia	13+400
Kongo Township	15+100
Nangondi	19+000
Tilli	30+000
Zebilla	41+700
Yikurugu	48+800
Binduri	61+400
Kaplugu	74+000

Bawku	76+000
Missiga	86+000
Terago	91+000
Kodorko	92+500
Pusiga	93+600
Mandago	97+300
Sugudi	98+300
Timbiku	101+700
Kuose	112+900
Pulmakom	117+100

The exercise undertaken to prepare this document made it possible to examine the environmental effects and propose an environmental impact management plan for the Bolgatanga-Bawku-Pulmakom road link project.

The analysis was conducted based on information in existing documents gathered during two field missions to meet with responsible authorities and members of the technical team designing the project. It also takes into account local and international environmental protection requirements.

Impact Identification

From the impact identification analysis, the main negative impacts anticipated as a result of the implementation of the proposed project are as follows:

- Air pollution;
- Noise and Vibration;
- Soil erosion;
- Damage to vegetation;
- Waste generation and disposal;
- Public Health and Safety
- Occupational health and safety;
- Depletion of natural resources (water, gravel, etc.);
- Landscape impact;
- Inadequate compensation;
- Vehicular traffic

MITIGATION MEASURES

Potential negative Impacts and Recommended Mitigation Measures

Potential Impacts	Mitigation Measures
Air Quality	The Contractor should restrict dust producing activities (e.g. haulage of materials) to normal working hours and possibly to shorter periods in very sensitive areas. Contractor to water working surfaces adequately and at regular intervals
Noise Pollution/Vibration	Contractor to pay attention to servicing of his equipment such as vibrators and noise related machines to control noise and vibration to the comfort of the communities along the project
Water Resources	The Contractor should consult the local communities as well as other stakeholders like GHA, Water Resource Commission before any water diversion activity.

	Adequate drainage should be provided in order not to channel unwanted materials into rivers and streams along the road
Flora and Fauna	Top Soil removal and excavation of borrow pits should be discrete in order to keep the earthworks within approved limits and to reduce destruction of vegetation. The contractor should consult the local communities before falling trees to ensure that no tree of cultural, religious, economic or other value was fell without the appropriate consent of affected persons. The contractor should inform his workers that illegal activities like poaching along the project corridor will not be tolerated
Erosion	Cut slopes should be stabilized by pitching. Erosion susceptible surfaces should be protected by grass planting.
Landscape and Aesthetic	Aesthetic values must be taken care under the project implementation Landscaping activity should involve grassing of cut slopes and planting of road side trees.
Public Health and Safety	GHA to monitor frequently, adequacy of the Contractor's pollution control system. GHA to enforce compliance to mitigation measures by the Contractor.
Occupation Health and Safety	The contractor to provide on-site first aid kits; Enforce the use of PPE provided to workers; improve worker's awareness of HIV/AIDS.
Compensation	Adequate compensation to be paid to owners of affected properties
Vehicular Traffic	Contractor to provide appropriate speed limits where the road corridor passes through towns and settlements. To secure and provide safe detouring of traffic 24 hours a day during construction phase.

In light of the results obtained, it appears the project will have no significant environmental impact, provided the protective, mitigating and optimisation measures recommended in this document are heeded. Applying the proposed preventive, mitigating and optimisation measures will reduce the impact feared such that Bolgatanga-Bawku-Pulmakom road link project will have little or negligible impact. The primary residual consequences of concern are as follows:

- The modification of the built environment in the communities the road link crosses through: loss of homes, loss of subdivided areas
- The loss of agricultural areas: zones that are cultivated, irrigated, planted, etc.
- The crossing through of Forest Reserve in the Upper East
- Disturbance of public services: power transmission lines, telephone networks, natural gas distribution networks, telecommunications antennas
- Potential destruction of archaeological ruins
- Disturbance of sacred groves and tombs

It is important to note, however, that some of the impacts expected could be eliminated during the route optimisation work that will take place during the development of detailed plans. This applies specifically to the last two impacts concerning the possible destruction of archaeological remains and the disturbance of sacred groves and tombs.

The project will also have positive effects on the environment. The most significant include:

- A reduction in traffic accidents on the highway connecting Bolgatanga-Bawku-Pulmakom and the increased safety of passengers and goods
- The creation of employment during the construction and operating phases

- Improved access to certain renowned tourist sites such as the Kulungungu Bombsite, Naa Gbewaa Shrine at Pusiga, Yarigungu Crocodile Pond and Zawse hills

1 INTRODUCTION

1.1 Context and objectives of the study

On March 3, 2014, Delin Consult entered into an agreement for the preparation of a feasibility study for the Bolgatanga-Bawku-Pulmakom road project.

The feasibility study comprises the completion of the following deliverable products:

1) Inception report

2) Fact-finding report and environmental impact management plan

3) Fact-finding report of social impact including a draft of the gender equity plan and a gender equality plan

4) Report introducing the legal and regulatory framework study and a technical fact-finding report

5) Report updating the environmental impact study and management plan following the consideration of the technical study findings an economic and financial fact-finding report and a report analysing the training needs and a training plan

6) Final project report and a series of administrative documents making it possible to conclude the feasibility study phase of the project

This document constitutes Deliverable 2 of the feasibility study. Its aim is to identify and analyse the main environmental impacts that could be created by Bolgatanga-Bawku-Pulmakom road link project on the physical, natural and human environment and the area of influence of the project throughout the phases of choosing the route of the Road link, its construction and operation.

1.2 Approach

1.2.1 General approach

Although the Bolgatanga-Bawku-Pulmakom road project is still in the feasibility study phase, this environmental study was prepared in compliance with the requirements of the *Ghanaian Environmental Assessment Regulations 1999 (LI 1652).*

After the project launch, the content of this document could eventually serve as a starting point for the undertaking and be integrated into the content of environmental studies required by the Ghanaian Environmental Protection Agency.

1.2.2 Approach used

This report is based on:

- Findings of an inception mission carried out in Bolgatanga, Bawku and Pulmakom by Delin Consult's technical experts in March, 2014
- Findings of an environmental fact-finding and site exploration mission carried out in Bolgatanga, Bawku and Pulmakom by Delin Consult environmental studies specialist during March 2014

The inception mission made it possible to contact local representatives of the various Administrative regions, validate their expectations, discuss the project planning, gather available data and meet certain local offices in order to initiate discussions leading to a reference route for the road project to be developed.

During the environmental fact-finding and site exploration mission it was possible, based on the previously developed reference route, to collect enough information in the capital cities and during field visits to describe elements of the physical, natural and human environment of the area of study and to identify the main issues associated with carrying out the project.

1.2.3 People Met

About 70 representatives from ministries, municipalities and various organizations were met and discussions on the project were held, in Bolgatanga, Bawku and Pulmakom.

Consultations were held with relevant stakeholders. They included regulatory agencies, institutions, interested bodies and the general public. The objective was to collect and collate the opinions of the stakeholders as part of the public/community participation process on the project. The discussions centred on several issues the main ones being the following:

- Land use planning;
- Proposed road alignment;
- Environmental issues;
- Historical or cultural concern; and
- Resettlement and compensation issues

The following stakeholders were identified:

- Bawku Municipal Assembly;
- Bolgatanga Municipal Assembly;
- Nabdam District Assembly;
- Environmental Protection Agency-Bolgatanga;
- Plant Protection and Regulatory Services;
- Ghana Tourist Authority;
- Ghana Highway Authority, Bolgatanga;
- Forestry Commission, Bolgatanga;
- Pusiga District Assembly;
- Binduri District Assembly;
- Ghana Revenue Authority (Customs) Pulmakom;
- GPRTU – Bolgatanga;
- Fuel Stations;
- Roadside Artisans; and
- Opinion Leaders and Individuals

Some of the stakeholders met are indicated in table below.

Name	Organisation	Position
Moses Debrah, 0243141470	Ghana Revenue Authority (GRA) Customs division, Pulmakom	Officer in Charge
Alhassan Hamla, 0242372665	Pusiga District Assembly	District Development Planning Officer
Robert Deri, 0208158736	Forest Services Division, Bolgatanga	District Manager
Alhaji Ismael Hakeem, 0382023416	Ghana Tourism Authority, Bolgatanga	Regional director
Archibald Dery, 0249195172	Ghana Highway Authority, Bolgatanga	Road Maintenance Manager
Issah Abubakar,0200197206	MOFA (Plant Protection), Missiga	Agriculturist
Hamidu Abdulai,0501301586	Environmental protection Agency (EPA), Bolgatanga	Assistant programme Officer
Oswin Langmagne, 0209560853	Nabdam District Assembly, Nangodi-Bolgatanga	Assistant Director
Abugre Joseph Atogyirie, 0241649661/0507360867	Bawku Municipal Assembly	Municipal Development Planning Officer
Mrs Lily Amoro, 0200161530	Ghana Revenue Authority (GRA) Customs division, Binduri	Officer in Charge
Edward Mann, 0203759729	Ghana prison service, Bawku Local Prisons	Officer in Charge
Gaspard Dery, 0244106774	Bolgatanga Municipal Assembly	Municipal Planning Officer
Nar-ire P. David, 0208322416/0249728966	Binduri District Assembly	District Co-ord. Director

1.3 Report Structure and Content

This document comprises nine distinct sections:

INTRODUCTION presenting the context and objectives of the study as well as the approach used

LEGAL AND REGULATORY FRAMEWORK describing Ghanaian environmental requirements with which this environmental assessment and those in the future must comply

PROJECT DESCRIPTION presenting the project rationale and the reasons supporting the technical choices made and route determination.

DESCRIPTION OF THE ENVIRONMENT presenting the main components of the physical, natural and human environment that will be affected by the project

IDENTIFICATION AND ASSESSMENT OF THE ENVIRONMENTAL IMPACT OF THE PROJECT presenting the method used, sources of potential impact and the assessment of anticipated environmental impact, including public concerns

MANAGEMENT AND ENVIRONMENTAL MONITORING PROGRAMME describing the proposed mitigation measures in order to reduce the impact of the project on the environment, residual effects that may remain even after these measures are taken, and the supervision and monitoring programme aimed at ensuring the accuracy of impacts identified and the pertinence of proposed mitigation measures

CUMULATIVE IMPACT AND OTHER POTENTIAL IMPACT making it possible to situate potential impact in the overall ecological and socioeconomic context

ENVIRONMENTAL ASSESSMENT AND RECOMMENDATIONS passing judgment on the environmental feasibility of the project and identifying the environmental components to include in the training programme.

2 LEGAL AND INSTITUTIONAL FRAMEWORK

As part of the Bolgatanga-Bawku-Pulmakom road project, Delin Consult has obtained funding to carry out an infrastructure project feasibility study (professional services). At this phase, the environmental impact assessment will make it possible to:

- Assess the probable environmental effects of the project and their significance, with a view to the biophysical and socioeconomic context
- Identify any public concerns associated with the project and indicate how they have been addressed
- Define feasible measures to mitigate any adverse environmental and social effects and optimise spin-offs for the environment and community
- Determine the need for monitoring, follow-up or an environmental management plan and procedures

The *Handbook on the Integration of Environmental Considerations into Proposals* provides suggested content for the environmental assessment report. While this format and content are not mandatory, the environmental assessment report should deal adequately with the principal components. The principal components suggested are:

Summary	Presents the principal findings, the proposed measures to mitigate the adverse effects of the project and enhance its environmental benefits, and the follow-up measures.
Purpose of the project and alternatives	Describes the rationale for the project, any alternative options and the reason for selecting the proposed option.
Description of the project and its components	Presents the list and location of the activities, site layout and project design, construction plans and scheduling, magnitude or scale of the work, quantitative and qualitative estimate of emissions, pollution-control devices (for industrial projects), operating methods and decommissioning plans.
Environmental regulatory context	Describes the host country's environmental requirements (laws, bylaws, standards, guidelines, local land use bylaws, etc.) and international environmental standards applicable to the project.
Description of the environment	Summary of the current context and description of the status of the receiving environment, including the social environment. This description need not be exhaustive, but should focus on those components relevant to the project.
Environmental effects	Assesses the project's adverse environmental effects and describes the methods used to collect and analyse the necessary data and assess the environmental effects. Clearly describes the analytical methods. The assessment must consider the environmental effects of all operations, including those relating to the location of the project, site preparation, construction, operation and, if relevant, decommissioning or abandonment of the facilities. The effects on the natural and social environment must be considered. The assessment must also consider the effects of malfunctions or accidents, cumulative effects and environmental effects on the project.
Proposed mitigation measures	Lists and describes the technically and financially feasible measures proposed to mitigate any significant adverse environmental effects of the project.
Nature and significance of residual effects	Discusses the residual environmental effects and significance of these effects once they have been applied in the existing ecological

	and human context. Indicates as well whether these effects are certain or uncertain.
Public concerns	Describes the nature of public participation in the environmental assessment, concerns raised by the project and proposed means of addressing them.
Follow-up programme	Defines the need for, and requirements of, a follow-up programme.
Environmental management plan	When required, describes the mechanisms used to ensure the implementation and effectiveness of the proposed mitigation measures by identifying the responsible authorities, follow-up programme, environmental components to be integrated into the training programme and any other relevant information.

2.1 GHANA GOVERNMENT'S ENVIRONMENTAL POLICY

The ultimate aim of the National Environmental Policy of Ghana is to improve the surroundings, living conditions and the quality of life for all citizens, both present and future. It seeks to ensure reconciliation between economic development and natural resource conservation, to make high quality environment a key element supporting the country's economic and social development (EPA, 1991).

This environmental policy specifically seeks to:
- Maintain ecosystems and ecological processes essential for the functioning of the biosphere;
- Ensure sound management of natural resources and the environment;
- Adequately protect humans, animals and plants, their biological communities and habitats against harmful impacts and destructive practices, and preservation biological diversity;
- Guide development in accordance with quality requirements to prevent, reduce, and as far as possible, eliminate pollution and nuisances;
- Integrate environmental considerations in sectoral, structural and socio-economic planning at the national, regional, district and grassroots levels;
- Seek common solutions to environmental problems in West Africa, Africa and the world at large.

Environmental protection in Ghana therefore is guided by the preventive approach, that is, with the recognition that socio-economic development must be undertaken in such a way as to avoid the creation of environmental problems. This is reflected in the Environmental Policy of Ghana formulated in the National Environmental Action Plan (NEAP) of 1993. The NEAP defined a set of policy and other actions that would make Ghana's development strategy more environmentally sustainable. The policy seeks reconciliation between economic planning and environmental resources development with the view to achieving sustainable national development.

Creation of awareness, among all sections of the community, of the environment and its relationship to socio-economic development, and of the necessity for rational resource use among all sectors of the country, is a vital part of the overall objective. Public participation in the environmental decision-making process is an important element of government policy.

2.2 ROAD SECTOR POLICY AND ADMINISTRATIVE FRAMEWORK

The Government of Ghana's (GoG) transport policy provides for continued improvements to the nation's rural and urban roads network. This objective will be met through an improved road maintenance as well as rehabilitation and construction programme.

The Ministry of Roads and Highways (MRH) is responsible for formulating policies and overall strategies on roads and vehicular transport. The Ghana Highway Authority (GHA), Department of Feeder Roads (DFR) and Department of Urban Roads (DUR) are the organizations under the MRH which carry out actual implementation of road policies. Ghana Highway Authority is responsible for 14,900 km of roads about 65% of which are gravel roads. The current project falls within the jurisdiction of Ghana Highway Authority.

Specifically, the Roads Sector Policy seeks to:

- Achieve sustainable improvements in the performance of trunk, feeder and urban roads and road transport services in all regions of Ghana;
- Strengthen the capabilities for management and implementation in the road sector; and
- Establish management systems that will ensure the upgrading and preservation of an improved road system and the use thereof in an environmentally, socially and financially sustainable fashion.

2.2.1 Environmental and Social Management Framework (ESMF) and Resettlement Policy Framework (RPF)

The Ministry of Roads and Highways (MRH) has prepared an Environmental and Social Management Framework (ESMF) as well as a Resettlement Policy Framework (RPF) to be used as guidelines for the Transport Sector Development Program (TSDP) but with focus on road sector projects.

The ESMF and RPF represent statements of policy, guiding principles and procedures, as well as environmental and social safeguards instruments of reference for the road sector projects, agreeable to all key stakeholders such as the EPA, the World Bank, Danida, EU, AfDB, MRH and the implementing Agencies.

The purpose of the ESMF and RPF is to provide corporate environmental, social and resettlement safeguard policy frameworks, institutional arrangements and capacity available to identify and mitigate potential safeguard issues and impacts of each sub-project. It is envisaged that with the preparation and use of the above-mentioned documents/guidelines, national, local environmental and social requirements will be met which will also be consistent with the World Bank's OP4.01, OP4.12 and other applicable safeguards.

This ESIA study has thus been conducted within the framework of the ESMF and RPF of the Roads Sector.

2.3 LEGAL FRAMEWORK

In Ghana, there are a number of laws and regulations concerned with development, health related matters and the environment in general. The major laws related to this project include:

- Environmental Assessment Regulation LI 1652, 1999 - The LI 1652 provides guidance and ensure adequate consideration of biodiversity and related sensitive resources for Environmental Impact Assessments in Ghana. Section 4 of LI 1652 states that "(1) A person required under regulation 1 or 2 to register an undertaking and obtain an environmental permit shall submit to the Agency an application in

such form as the Agency shall determine. (2) There shall be paid for the application such fee as the Agency shall determine. (3) In addition to any information that an applicant is required to provide on application, the Agency may require an applicant to submit such other information on the undertaking as the Agency considers necessary for the initial assessment of the environmental impact of the undertaking".

- Schedules 1 and 2 of the Environmental Assessment Regulations also provide the list of undertakings for which an environmental permit is required and EIA is mandatory.

- Fees and Charges (Amendment) Instrument, 2015 (LI 2228) – This instrument requires Proponents to pay processing and permitting fees before permits are issued.

- Environmental Protection Agency, Act 490, 1994 – Responsible for advising government on all matters relating to the environment – monitoring sound ecological balance and coordinating environment activities, educating and research. The Act also specifies requirements for the production of an EIA for various proposed works.

- Criminal Code (Act 29) Section 296-297, 1960 – Prevents the accumulation and exposure of filth and refuse of all kinds and the prohibition of activities, which may endanger public health or cause damage to lands, crops, cattle or goods. Any project activities that will pose danger to health and safety will be infringing on this law.

- Water Resources Commission Act 522 (1996) – provides for the preparation of comprehensive plans for the regulation, utilization, conservation, development and improvement of water resources and develops policy framework for water resources management in the country. This Act also grants rights to exploit water resources.

- Wild Life Reserve Regulations (LI 710) 1971 – Creation of wildlife reserves and the prohibition of water pollution within the reserve. This Act would be particularly relevant where the road passes through or near a Game Reserve.

- Local Government Act 462, 1994, - District Assemblies will therefore be responsible for the development, improvement and maintenance of human settlements and environment in the district and local levels. The Assemblies will therefore be responsible for the management and maintenance of the roads within their respective jurisdiction.

- Town and Country Planning Cap 84, 1951 – Preparation of district layout plans, and protection and preservation of amenities and public services such as drainage, roads, refuse disposal sewerage and water supply.

2.4 ENVIRONMENTAL ASSESSMENT REGULATIONS AND PROCEDURES

Under Ghana's Environmental laws, an EIA is mandatory for seventeen (17) types of activities classified as environmentally critical and require an Environmental Permit (EP).

Construction of roads and bridges is one of these critical undertakings and therefore an EIA and EP are mandatory for the proposed project.

2.5 INSTITUTIONAL FRAMEWORK

Institutional responsibilities for the co-ordination, planning, administration, management and control of development and environmental issues are fragmented among a number of agencies, ministries and organizations. The major institutions involved include:

Environmental Protection Agency
Ministry of Water Resources, Works and Housing
Water Resources Commission
Ministry of Roads and Highways
Ghana Highway Authority
Ministry of Local Government and Rural Development
District Assemblies
Ministry of Lands and Forestry
Ministry of Food and Agriculture
Council for Scientific and Industrial Research (CSIR)
Department of Town and Country Planning
National Development Planning Commission (NDPC)

During the preparation of the EIA some of these major institutions and/or their documents were consulted for their technical advice, expert knowledge and concerns or future programmes as related to the project.

2.5.1 Institutional and Implementation Arrangements

Ministry of Roads and Highways (MRH)
The MRH has the specific task of coordinating and guiding the activities of the three main executing agencies in the road sector under the Ministry. The MRH has a Deputy Director in charge of Road Safety and Environment (RSE).

The MRH has responsibility for the:
- Formulation and implementation of integrated transport policy and planning;
- Promotion of strategic investment in the sector;
- Development, implementation and monitoring of road projects; and
- Regulation of standards

Ghana Highway Authority (GHA)

The GHA is a semi-autonomous body with a responsibility for the provision and management of trunk roads. It was originally established in 1974 as the organization responsible for the development and administration of the entire national road network. Since the GHA Act 540 of December 1997, its role has been limited to the administration, control, development and maintenance of trunk roads and related facilities subject to the policies of the MRH.

The GHA has a 4-person Environmental Management Unit (EMU) that has oversight on environmental and social issues of the Authority's mandate. The EMU operates under the Road Safety and Environment Division (RSED).

Environmental Protection Agency (EPA)

The EPA has the mandate to decide on project screening, guide the conduct of any EA studies and to grant environmental approval for road sector projects to commence. Its mandate also covers monitoring of implementation phase of road and bridge projects to ensure compliance with approval conditions, mitigation measures, and other environmental commitments and quality standards.

Resource Management Institutions

The Water Resources Commission (WRS), Wildlife Division (WD) and the Forest Services Division (FSD) of the Forestry Commission (FC) are the water, wildlife and forest resources management institutions respectively. These institutions become relevant whenever such resources under their management are likely to be impacted on or implicated in a proposed road project. Such stakeholder institutions would then be consulted in the planning and decision processing to prevent, avoid, reduce or mitigate the likely impact of the project. They may also have to give their consent with respect to the extent to which such resources may be affected or lost as a result of the road development.

Utility Service Providing Institutions

The Electricity Company of Ghana (ECG), Ghana Water Company Limited (GWCL), Ghana Telecom (GT) and Bulk Oil Storage and Transport (BOST) are public / private institutions that provide and / manage utility services including electricity, water, telecommunication and petroleum transmission and storage infrastructure. These are all linear transmission facilities either through underground pipes or overhead lines, often along existing road network corridors (where roads exist) Road construction or reconstruction and other services and interventions tend to affect such transmission lines. These often require relocation, realignment, etc. to make room for the road project, which calls for the involvement of the respective utility companies or institutions to be consulted in the road project decision-making processes as appropriate.

2.5.2 Planning Documentation

In Ghana, several districts situated along the route of the Bolgatanga-Bawku-Pulmakom road have development plans which are tools developed in concert with local stakeholders that reflect local objectives. Table 2-5 shows the development focus areas identified by authorities for the districts of Bolgatanga, Bawku, Musiga, Pusiga and Pulmakom.

Table 2-5: Development focus areas

Economic development through improved productivity in the farming, industrial and services sectors
Reorganisation of the economic sphere through the creation of service centres, decentralisation of development and the establishment of effective transportation links and communications
Electricity supply
Refurbishing of roads
Construction of sanitation equipment
Construction of healthcare equipment
Drinking water supply
Construction of educational equipment
Public markets
Police stations

Banking facilities
Social development
Improvements in the quality of the environment to provide a better living environment and improve the level of economic activity
Development of administrative and institutional capabilities

As can be seen, several development focus areas tie in with the objectives of the Bolgatanga-Bawku-Pulmakom road project.

3 PROJECT DESCRIPTION

The section that follows is largely drawn from the engineering study prepared by Delin Consult and deals namely with the design criteria and standards, proposed routes and cursory estimates of costs and implementation schedules.

3.1 Objectives

The objective of the road project is to upgrade the deplorable road conditions in the Northern corridor of Ghana, thereby increasing trade and stimulating economic and social development. This project will make it possible to create, indirectly, favourable impacts on the economies of neighbouring border countries.

3.2 Route

The entire Bolgatanga-Bawku-Pulmakom road is approximately 106.9km stretching from Bolgatanga town through Bawku to Pulmakom.

The route was defined to serve the following cities/towns:

- Bolgatanga, Zuarangu, Kongo, Tilli, Zebilla, Bazua, Gunyoro, Kwalugu, Bawku, Musiga, Pusiga, Sugudi,Basyondi, Pulmakom

The project road is highlighted in yellow on the satellite pictures as shown in Figure3.1, Figure 3.2 and Figure 3.3. Some of the landmarks and areas of importance are also shown in pictures along the road corridor.

The longer section of the road corridor in Figure 3.1 is the Bolgatanga-Nangodi section; the Volta River is located approximately 1.4km away from Bolgatanga on this section (see Bridge Volta River on fig. 3.1). There are a lot of key landmarks on the route. Some of these are shown in the figures below.

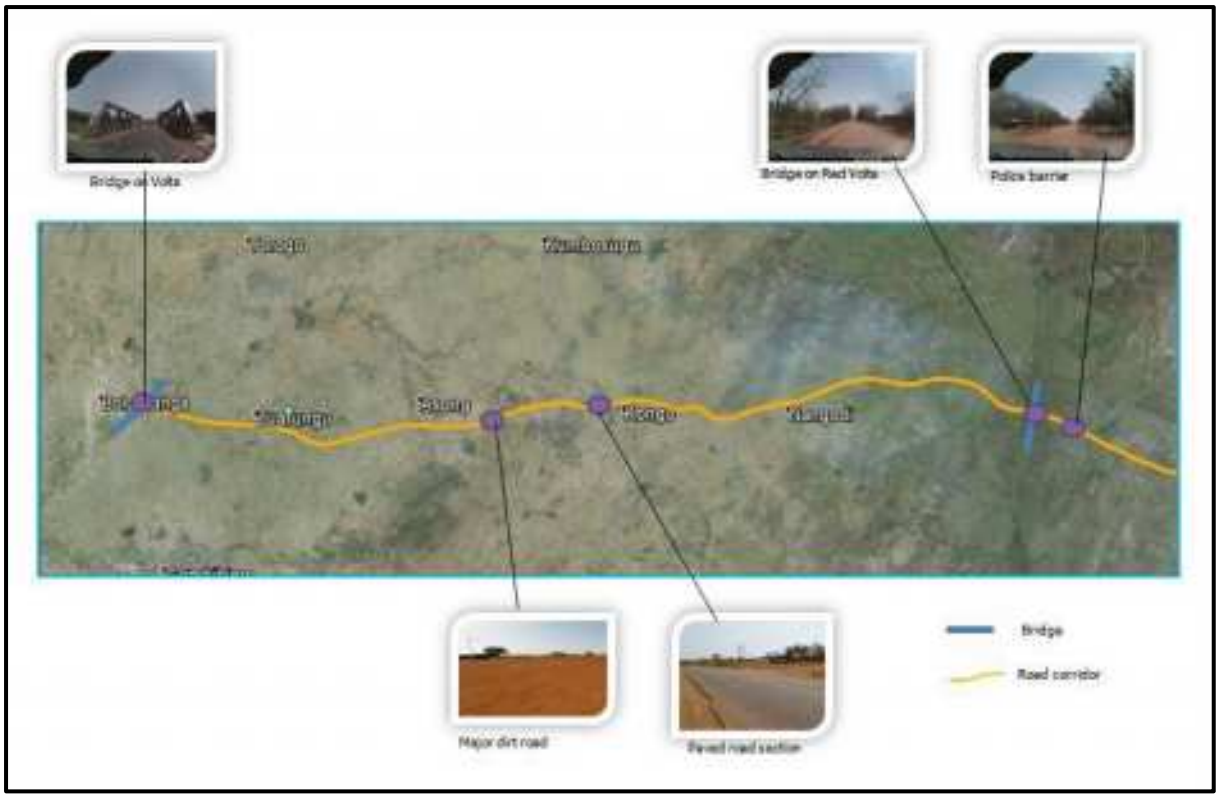


Figure 3.1: Landmarks on the Bolgatanga-Bawku-Pulmakom corridor, section starts

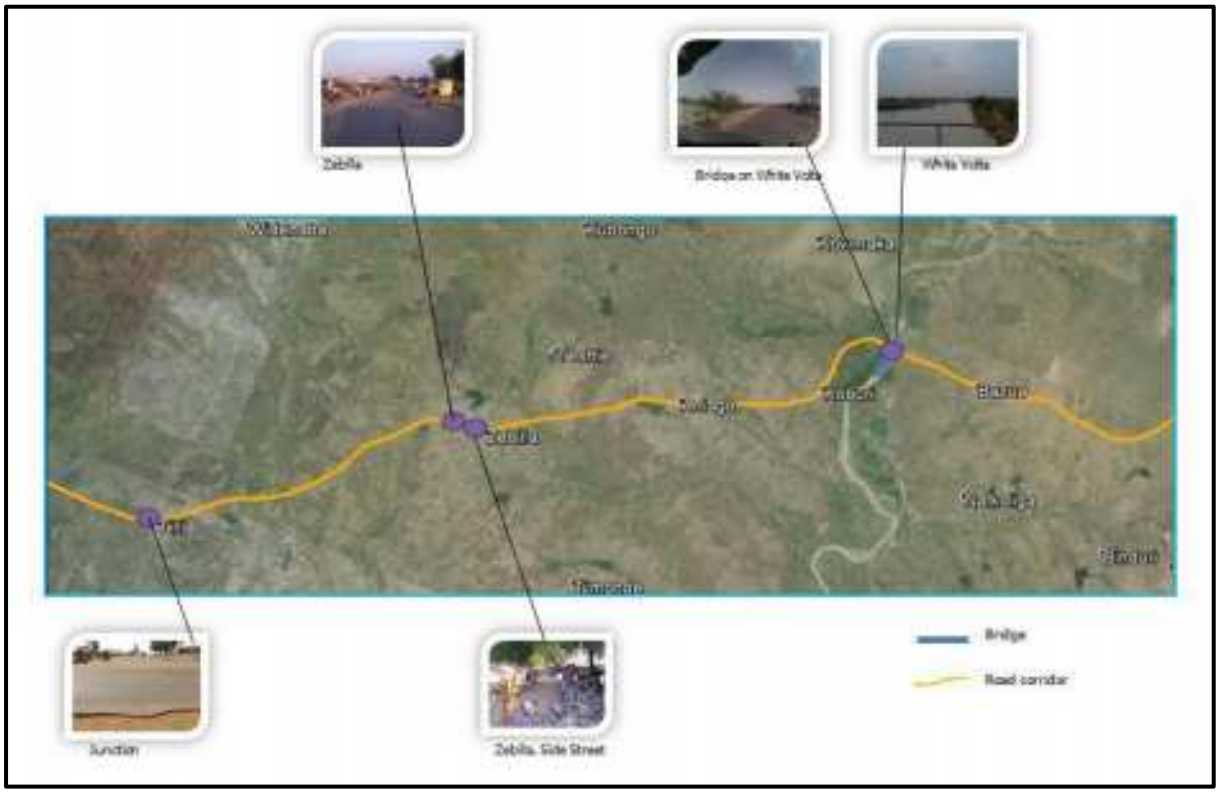


Figure 3.2: Landmarks on the Bolgatanga-Bawku-Pulmakom corridor, section continued from Figure 3.1

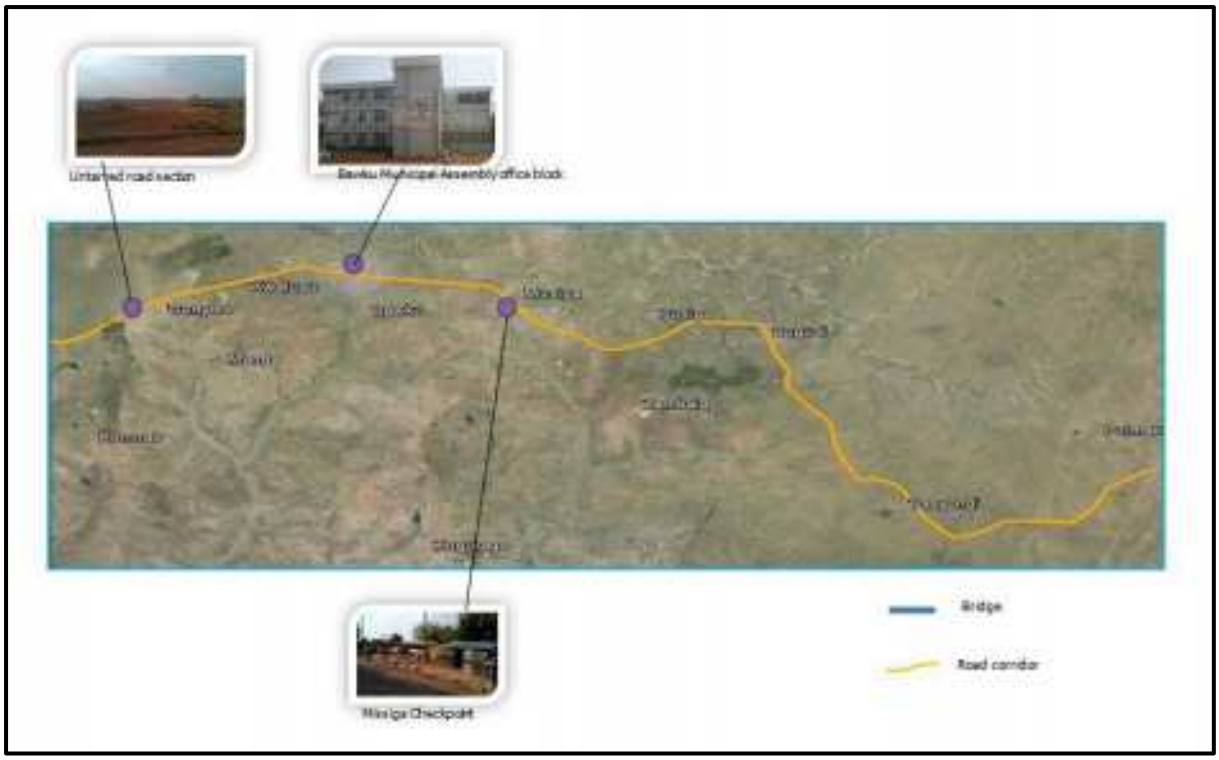


Figure 3.3: Landmarks on the Bolgatanga-Bawku-Pulmakom corridor, section continued from Figure 3.2

3.3 Construction Work

The following activities are expected to be carried out;

- The construction work will involve the installation of a temporary camp along the route corridor. Two sites are planned along the route. The camp will make it possible to house construction staff and inspection staff.

- Operation of Borrow Pits; potential sources of borrow pits will be identified along the route. Large quantities of gravel materials and sand will be required for the road construction. Borrow sites will be identified and approved by the proponent, i.e., Ghana Highway Authority (GHA) and will be presented to EPA for final approval before gravel is obtained.

- Clearing of Right of Way (ROW); there will be initial clearing of existing road reservation. As a result, there will be loss of vegetation and properties.

- Operation of Quarry and Stone Crushing Plant; quarry products of various sizes will be needed for the project. The location of quarry materials will be identified and approved by Ghana Highway Authority, in consultation with EPA.

- Material Transport; construction materials such as rocks, gravel, bitumen, cement, sand, concrete etc. will be transported to the project site.

- Earthworks; this activity will include cutting and filling and could include removal of road-side vegetation.

- Concrete Works; the project activity will include construction of new drains, repairs and refurbishment of existing drains.

- Construction of base or sub-base course; Heavy, noisy and vibrating equipment will be employed to prepare the base and sub-base of the construction.

- Bitumen Overlaying; this will consists of the overlaying of bitumen layer for the entire road construction.

- Provision of Road Furniture; road signs and road line markings will be provided after the road construction. The effects of all these project activities on the environment as well as on the socio-economic conditions of the local communities along the corridors.

3.3.1 Signalling

The Contractor shall install and maintain on the worksite and periphery of the worksite road signalling and lighting, traffic lights, reflective panels, barriers and other equipment intended to direct and regulate road traffic in order to guarantee the safety of users.

4 ENVIRONMENTAL DESCRIPTION

4.1 Definition of the study zone

The study zone used for the purposes of this environmental evaluation extend for a distance of 1 km on either side of the reference axis located at the centre of the existing road corridor.

The width of the zone is sufficient to take into consideration the direct and indirect impacts the project will generate. The zone extends for a distance of approximately 106.9km between the towns of Bolgatanga and Polimakom The principal towns passed through along the route are, from north to north-east: Bolgatanga, Zuarangu, Kongo, Tilli, Zebilla, Bazua, Gunyoro, Kwalugu, Bawku, Pusiga, Sugudi,Basyondi, Pulmakom, Missiga (see fig 3.1-3.3)

4.2 Physical Environment

4.2.1 Precipitation and Temperature

4.2.1.1 Climatology

The study zone lies in the Upper east region and straddles the continental tropical (or savannah) zone. See map 4.2. Bolgatanga is the regional capital of the region and is characterized by one rainy season from May/June to September/October. The rainfall is erratic spatially and in duration. There is a long spell of dry season from November to Mid-February, characterized by cold, dry and dusty harmattan winds. The average rainfall, temperature, relative humidity, wind speed and sunshine of the area are 885 mm, 28.6°C, 54%, 81 km/day and 7.9 hours respectively. Evaporation-transpiration is 1,652 mm per year.

Map 4.1: Climatic Zones

4.2.2 Topography and Geology

In Ghana, more than half the area of the country is composed of a succession of plateaus of varying elevations, while the rest of the area is occupied by the Volta River basin. These elements have been grouped into five broad ensembles, of which three is crossed by the study zone:

- The high plains of the savannah are composed mostly of granite. Their relief is gently undulating and the altitude of the highest peaks, composed of isolated rounded hills, varies only from 180 to 300 meters above sea level.

- The Volta basin occupies an area of approximately 112,800 km2. It is basically composed of easily-eroded sandstone and schist, which has enabled the formation of an immense plain with an altitude varying from 60 to 150 meters above sea level.

- To the southwest, the Volta basin is bordered by the South Volta plateau, which extends from southeast to northwest and consists of a series of escarpments with an average elevation never less than 450 meters above sea level. The escarpments facing south are the most abrupt (see map 4-2).

Map 4.2: Relief Topography

4.2.3 Pedology (Soils)

The study zone route crosses two principal soil types: lateritic soils that are found mainly in the shrubby savannah located in the northern portion of the country, and savannah ochrosols that are mostly associated with the cliffy relief of the South Volta plateau that occupies the centre of the country.

- Lateritic soils usually develop on granites and schists. They are shallow, acid and low in organic material.

- Savannah ochrosols are well-drained, porous and malleable soils that also develop on granites and on sandstones. Their acidity varies from moderate to high. These may also contain plates of clayey soils.

4.2.4 Hydrography and hydrology

In Ghana, the Volta River is without question the largest waterway. Its watershed covers almost three quarters of the country's area. This immense area can be subdivided into four sub-basins; the Black Volta, the White Volta, the Oti and the Volta itself, which is the continuation of the Black Volta (see photos 4-3 and 4-4).

Here too the rivers dry up rapidly at the end of the rainy season, especially in the northern part of the country. On the other hand, in the rainy season they contain so much water that they sometimes overflow, causing floods and damaging the neighbouring territories. Only the principal waterway is permanent and its flow is regulated by Lake Volta, created following construction of the Akosombo dam. If the rainfall in the watersheds of the Black Volta, White Volta and Oti River is too substantial and threatens to overflow the reservoir, then the floodgates of the dam are opened and the excess waters are released into the sea.

Photo 4-3: The Black Volta near Kolawupa in Ghana

Photo 4-4: The White Volta at Ypala in Ghana

Water Bodies in Study Area

The predominant sources of water for the communities along the road corridor include rivers, dams, bore-hole aside few communities that have pipe borne water. These sources of water are mainly used for domestic purposes, irrigation and for drinking by domestic animals. The predominant fishes in the rivers are tilapia, mudfish, electric fish and other reptiles including crocodile and the giant pangolin. There were also notable streams and dams at villages around Binduri including Widnaba River, Gumyoko River, Vako River, Nafkoliga dam, Nayoko dam and the Benguri dam. The streams are used for seasonal fishing especially during the rainy season and the dams are used for irrigation and other domestic purposes.

4.2.5 Hydrogeology

In Ghana, groundwater is found in sedimentary and non-sedimentary rock. Sedimentary rock is concentrated in the Volta River basin and in the central part of the coastal zone. The average flows obtained in these zones are in the order of 1–6 m^3/hour and can even reach 8 m^3/hour in certain locations.

In the regions in the northern part of the country characterized by savannah (upper west, upper east and northern regions), drilling is to an average depth of 40 m. Groundwater is used primarily for domestic purposes or for watering livestock.

4.2.6 Air quality and Sources of Noise

In Ghana, the most significant sources of air pollution in urban environments remain exhaust gases from transportation vehicles, dust from unpaved roads, smoke from roasting meat and fish, the burning of wood for heating, the emissions from permanent industries and brush fires. It also happens that, due to road accidents, hazardous materials catch fire (see Photo 4-5).

Photo 4-5: Tanker Truck in Flames near Bolgatanga

The principal polluting gases released are CO, CO2, NOx and HC, as well as soot. With regard to transportation, the dilapidation of the automobiles, the presence of lead in the fuel, the wrong mixture of two-stroke motor oil and the significant increase in moped vehicles in recent years are the origins of the gas emissions that are sources of air pollution.

4.3 Natural Environment

The study zone lies in the Guinean savannah. (Map 4-3).

Map 4.3: Vegetation

4.3.1 Flora

4.3.1.1 Major vegetation formations

The Guinean Savannah covers the majority of the northern portion of Ghana, or approximately 170,000 km2. Here are found such trees as baobab, shea, acacia and African locust bean. Grasses there grow in large clumps that may reach more than 3 m in height. The appearance of the region changes greatly with the seasons. During the wet season, the greenery dominates and the grasses grow rapidly.

However, shortly after the rains have ended, the leaves change colour rapidly and fall, leaving an impression of desolation. The Guinean savannah has been greatly transformed by humanity through the years, and the landscape as it now appears is the result of repeated assaults caused by the practice of agriculture, livestock breeding and brush fires.

There are three main ecosystems found within and around the study area. The first is the Riverine Forest which surrounds the intake source of the Black Volta River and is characterised by closed canopy vegetation. Further from the intake site from the river lies the Floodplain. This is differentiated by annual floods during the rainy season and is home to many species of water tolerant plants. Surrounding the floodplain is the Guinea Savannah which comprises of open grasslands dotted with tree species such as the Baobab, Kapok and Shea nut.

The Upper East Region has the natural vegetation of the savannah woodland characterized by short scattered drought-resistant trees and grass that gets burnt by bushfire or scorched by the sun during the long dry season. Human interference with ecology is significant, resulting in near semi-arid conditions. The most common economic trees are the sheanut, Dawadawa, baobab and acacia.

According to the officer in charge (Bolgatanga forest Commission) and the Misiga office of Plant Protection and Regulatory Services (a unit under the Ministry of Food and Agriculture responsible for the inspection of imported and the exported plants and plant products).

4.3.1.2 Species in the Study Zone

Table 4-4 presents the list of species in the study zone.
The common and useful plants have been categorized by their cultural, medicinal, wildlife and economic uses in the table below.

Table 4-4

Cultural Plants	Significance
African oak (Afzelia Africana) Ecosystem-Guinea Savannah	A spiritually powerful tree. It is believed that forest fairies (spirits live inside this tree). Wood use for carvings, drums and building materials. Leaves are used to feed livestock in the dry season.
Baobab (Adansonia digitata) Ecosystem-Guinea Savannah	Believed to be a mystical tree with spirits congregating on them at night. Fruits are used to make flour for porridge, sweet drink. Leaves are used in vegetable soups
Hibiscus (Hibiscus asper) Ecosystem-Floodplain	Leaves eaten or boiled into groundnut soup or as a substitute for tamarind in a common local dish “tuo zafi”.

	Water from boiled Hibiscus leaves is used as treatment for spitting-cobra poison that enters the eyes.
Monkeybread (Piliostigma thonningii) Ecosystem-Guinea Savannah, Riverine Forest & floodplain	The leaves are pounded and soaked, then the water is used to make "tuo zafi" or mixed with flour to make porridge.
Mututi (Pterocarpus santalinoides) Ecosystem-Guinea Savannah	Strong, termite resistant wood used for building xylophones & tool handles. Leaves are feed to domestic animals & wood used to make charcoal as it burns very hot for a long time.
Tamarind (Tamarindus indica) Ecosystem-Guinea Savannah	Pods are soaked in water to improve flavour of food or medicine. Used as a preservative to prolong lifespan of "tuo zafi" for an extra 2-3 days.
Medicinal plants	**Significance**
African laburnum (cassia sieberiana) Ecosystem-Riverine Forest	Roots are used for treatment of stomach problems or hernia.
African Peach (Sarcocephalus latifolius) Ecosystem-Guinea Savannah, Riverine Forest	Roots are used to alleviate stomach problems or hernia. Fruits are eaten by humans & wildlife.
Buttercup tree (Cochlospermum planchonii) Ecosystem-Guinea Savannah	Used to treat serious stomach problems, poisoning or yellow fever. Roots also used as a yellow dye.
False Abura (Mitragyna inermis) Ecosystem-Floodplain & Riverine Forest	Root and small stems used for treatment of malaria. Bark of tree is used for treatment of burns.
Neem (Azadirachta indica) Ecosystem-Guinea Savannah	Fruit eaten to relieve stomach problems. Boiled leaves drank like tea to relieve fever. Seeds used as insect repellent or as an organic pesticide on farm crops.
Violet tree (Securidaca longepedunculata) Ecosystem-Guinea Savannah	Roots are boiled and used to massage injured areas of dislocated or broken bones.
Wild custard Apple (Annona senegalensis) Ecosystem-Guinea Savannah	Used to alleviate pain and swelling from wasp & bee stings.
Wildlife plants	
African Ebony (Diospyros mespiliformis) Ecosystem-Guinea Savannah, Riverine Forest	
Lannea (lannea acida) Ecosystem-Guinea Savannah, Floodplain	
Economic Plants	**Significance**
African Locust bean Tree (Parkia biglobosa) Ecosystem-Guinea Savannah	Seeds are a popular spice. The pods are used to create paints for houses and burnt ashes are used to make soap. Traditional leaders protect the tree because of its value
Kapok (Ceiba pentandra) Ecosystem-Guinea Savannah, Riverine Forest	Used to make fillings for pillows and mattresses, life jackets etc.

Mango (mangifera indica) Ecosystem-Guinea Savannah, Floodplain	Fruit is harvested extensively in the dry season and sold in markets.
Grewia carpinifolia Ecosystem-Guinea Savannah	Plant is added to Pito, the local millet beer
Shea (Vitellaria paradoxa) Ecosystem-Guinea Savannah	A significant portion of local income is derived from selling shea nut and home processed butter. Trees are under the protection of the chiefs & should not be cut down
Cashew Ecosystem-Guinea Savannah	Grown in plantations and represent significant income from selling and exporting the nuts.

4.3.2 Fauna

4.3.2.1 Mammals, birds and reptiles

Tables 4-5 present the list of some of the animal species found in the study zone, their frequency and their preferred zones. In Ghana, the biological diversity is more noteworthy, and among the roughly 60 species identified, approximately 35 are considered vulnerable or threatened.

The vegetation of the project corridor provides a suitable habitat for a diverse range of fauna. A description of the fauna in the project area was, therefore, undertaken. The objective was to assess the potential fauna diversity of the area by preparing a check list of fauna species, and their relative abundance to form the baseline data for any future monitoring that may take place and also to determine if there are any species of conservation significance (including their habitat).

However, direct observation on patrol, as well as information from local hunters indicates that the following animals are present in the study zone: Loxodonta Africana (elephant), Kobus defassa, (Water buck), Hippotragus equines (roan antelope), Potamochoerus porcus (bush pig) Lepus carpensis (hare), Heliosciurus spp., Funiscium spp, (tree squirrels) and Cricetonys gambianus (giant rats), Pythin sebae, Francolinus spp. (bush fowls), Falconidae (hawks, falcons, kites).

Table 4-5: Threatened animal species in Ghana

	Scientific Name	**Common name/Status**
Reptiles	Crocodylus cataphractus	African Slender-snouted Crocodile (I)
	Crocodylus niloticus	Nile Crocodile
	Osteolaemus	West African Crocodile (I)
	Tetraspis Lepidochelys Olivacea	Olive Ridley Sea Turtle (T)
	Chelonia mydas	Green Turtle (T)
	Eretmochelys imbricata	Hawksbill Sea Turtle (T)
	Dermochelys coriacea	Leathery Turtle (T)
Birds	Agelastes meleagrides	White-breasted Guineafowl (T)
	Scotopelia ussheri Rufous	Fishing Owl (T)
	Campephaga lobata	Western Wattled Cuckooshrike (V)
	Criniger olivaceus	Yellow-bearded Greenbul (V)
	Bleda eximia	Green-tailed Bristlebill (V)

	Picathartes gymnocephalus	Bald Crow, Grey-necked Rockfowl (V)
Mammals	Cercopithecus Diana roloway	Roloway Monkey (V)
	Colobus badius waldroni	Miss Waldron's Red Colobus (T)
	Cercocebus torquatus	White-collared Mangabey (V)
	Colobus verus	Green Colobus (T)
	Colobus polykomos	Ursine Guereza (V)
	Pan troglodytes)	Chimpanzee (V
Even-toed Ungulates	Hylochoerus meinertzhageni	Forest Hog (DI)
	Tragelaphus euryceros	Bongo (DI)
	Cephalophus dorsalis	Bay Duiker (DI)
	Cephalophus ogilbyi Ogilby's	Duiker (V)
	Cephalophus silvicultor	Yellow-backed Duiker (DI)
	Gazella rufifrons	Red-fronted Gazelle (DI)
	Hyemoschus aquaticus	Water Chevrotain (DI)
	Choeropsis liberiensis	Pygmy Hippopotamus (V)
	Damaliscus korrigum	Topi (DI)
Sirenia	Trichechus senegalensis	West African Manatee (V)
	Delphinus capensis	Long-beaked Common Dolphin
	Globicephala macrorhynchus	Short-finned Pilot Whale
	Grampus griseus Risso's	Dolphin
	Lagenodelphis hosei	Fraser's Dolphin
	Peponocephala electra	Melon-headed Whale
	Pseudorca crassidens	False Killer Whale
	Stenella clymene	Clymene Dolphin
	Stenella frontalis	Atlantic Spotted Dolphin
	Scientific Name	Common name/Status
	Tursiops truncatus	Bottle-nosed Dolphin
	Stenella longirostris	Spinner Dolphin
	Orcinus orca	Killer Whale, Orca, Grampus
	Trichechus senegalensis	West African Manatee
Proboscids	Loxodonta africana	African Elephant (V)
	Idiurus zenkeri	Pygmy Scaly-tailed Flying Squirrel (V)
	Protoxerus stangeri	African Giant Squirrel (T)
	Anomalurus peli	Pel's Flying Squirrel (V)
	Anomalurus beecrofti	Beecroft's Scaly-tailed Squirrel (V)
Carnivores	Genetta johnstoni	Johnston's Genet
	Poiana richardsoni	African Linsang (DI)
	Panthera leo	Lion (V)
	Panthera pardus	Leopard (V)
	Leptailurus serval	Serval (T)
	Profelis aurata	African Golden Cat (T)
	Caracal caracal	Desert Lynx, Caracal (T)
	Crocuta crocuta)	Spotted Hyena (T
	Lycaon pictus	African Wild Dog (T)

	Canis adustus	Side-striped Jackal (T)
Pholidota	Manis gigantean	Giant Pangolin (T)
	Manis tricuspis	Tree Pangolin (V)
	Orycteropus afer	Aardvark (T)

Source: National Biodiversity Strategy for Ghana, 2002, pp 14-15

Legend: T-threatened; I-indeterminate; V-vulnerable; DI-data insufficient

4.3.2.2 Aquatic fauna

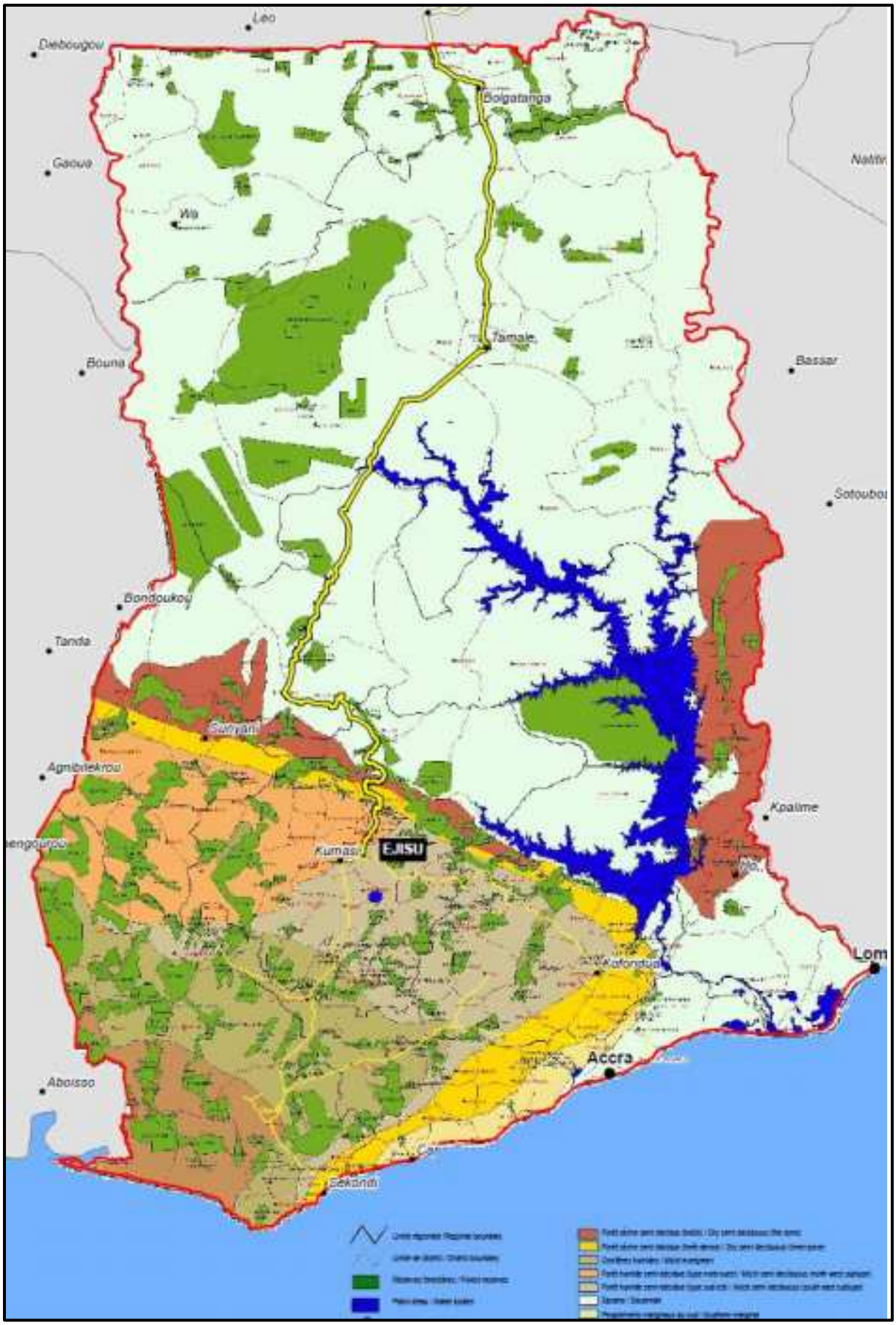
The aquatic ecosystem the Black Volta /White Volta river waterways are used for fishing by the residents along its meandering path and it usually peaks during the wet seasons when productivity in these rivers are high. Tools used in these fishing expeditions include Cast net and hand dug boats.

It is estimated that approximately 124 species of fish inhabit these waters. Species currently fished include oysters, tilapia or African perch, Tilapia zilli (white tilapia), Chlomido tilapia guntheri (redfish), Chryischthys nigroditatus (catfish), Sardinella aurita (round sardinella) and Sarotherodangalilaeus (mango tilapia). The Black/White Volta River is also a migratory stop for Paleoarctic and Afro-tropic species.

4.3.3 Protected spaces

4.3.3.1 Parks and protected spaces

Gambaga Scarp forest reserve lies near the study zone, other valued spaces, which are not, however, threatened by the project, are to be found neighbouring region i.e. The migration corridor for elephants which move each year from Togo toward the Kabo-Tambi Park in Burkina Faso, passing through the northeast part of Ghana. This space is not yet protected officially, but the numerous studies of which it has been the subject, and the interest accorded to it by the scientific community, are a testimony to its importance. (See Map 4-6 and Map 4-7). These are briefly described below for information only.



Map 4.4: Ghana Forest Reserves

➡ **Gambaga Scarp East Forest Reserve**

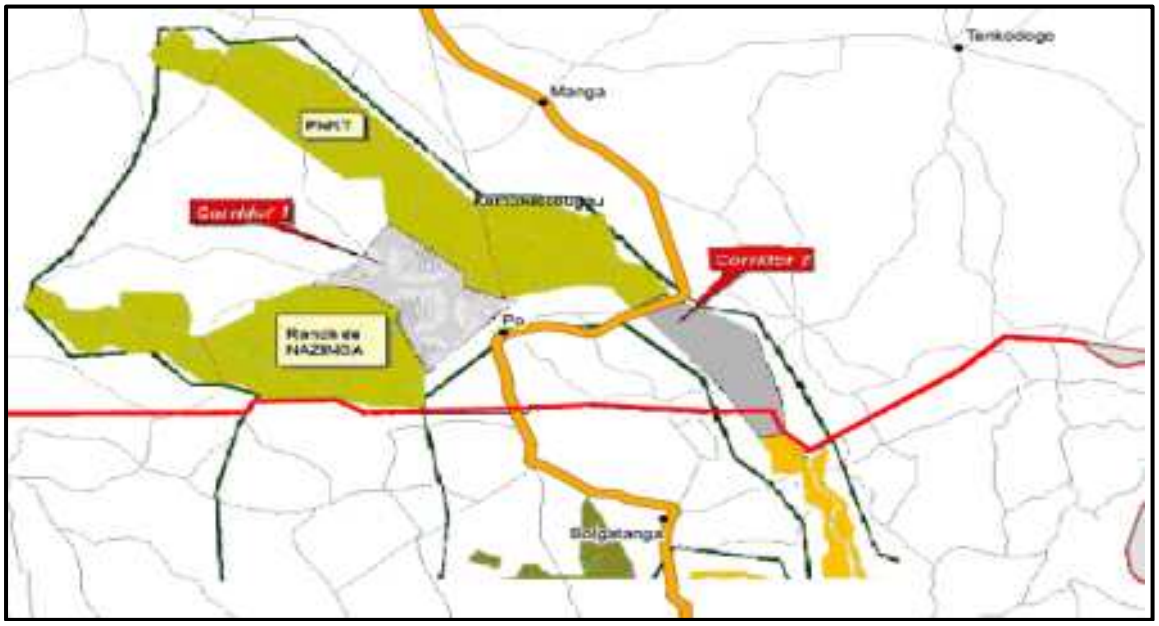
The Gambaga Scarp forest reserve was established in 1953 in order to protect the Gambaga escarpment and the aquifer-replenishing zones of the Volta River's hydrographical network. It occupies an area of approximately 127 km2 in the Mamprusi district, which is located in the northeast portion of Ghana. The dominant plant species in this forest reserve are: Parkia filicoidea, Detarim senegelensis, Daniella oliveri, Crosopteryx febrifuga and Gardenio spp. Also found there are several medicinal plants such as: Kayasenegalensis, Hannoa nudulata, Nauclea latifolia, Calotropis procera and Tacea lecon topetaloides. Other products taken from the forest include: straw for basketry (elephant grass), shea nuts, and wood for heating, meat and honey. The reserve is frequented by several species of rodents, the patas monkey and antelopes.

➡ **Elephant Migration Corridor**

Studies undertaken recently by the Association Amnistie pour l'Éléphant or AAPE (elephant amnesty association) and the Bureau géographique du Burkina Faso (the geographic office) revealed the existence of regular cross-border movement of elephants along the Nazinon from Ghana to Parc national Tambi-Kaboré or PNTK (Tambi-Kaboré national park) in Burkina Faso. The elephants also trek from Bolgatanga to Bole in search of shelter (forest) and water.

Itinerant agriculture being the most usual practice in this zone, the elephant migration corridors are gradually colonized, which has the effect of placing the elephants in competition with livestock and people for use of resources. Elephant movements began well before the 1960s, but riverside populations did not experience notable damage until after 1995.

It is therefore deemed imperative that all users of natural resources, as well as managers of the environment, undertake concerted action in order to reduce the threats that weigh on this species' survival. Elephant conservation, to be sustainable, must be undertaken through socioeconomic development of the zone, especially through tourist development focusing on the species. It is only at this cost that the populations will find it beneficial to protect the elephant.



Map 4.5: Elephants' Migration Corridor

4.4 The Human Environment

4.4.1 Public Concerns and Social Data

A study of the social impacts of the Bolgatanga-Bawku-Pulmakom road project was undertaken by Delin Consult in parallel with this environmental study. The document includes in particular a description of the social demographic profile of the population that will potentially be affected by the project. The reader is invited to refer to this document in order to understand the concerns of the public, and for any data of a social nature dealing with, in particular, demographics, employment sectors and average salaries, education, healthcare, public services and social organization.

The texts presented below deal more with the political and administrative structures, major categories of soil usage and systems of exploitation: agriculture, livestock breeding, forestry, pastoral agro-sylvan activities, transportation, mining and tourism. The final section deals with archaeological resources in the study zone.

4.4.2 Political and Administrative Structures

The sectors traversed by the study zone are mostly occupied by the main ethnic groups in the region; Mamprusi, the Dagomba, Mole-Dagbon, Grusi, Mande-Busanga and Gurma. Among the Mole-Dagbon, the Nabdam, Kusasi, Nankani/Gurense and Builsa are significant. The significant other subgroups are the Kassena among the Grusi, the Busanga among the Mande-Busanga and the Bimoba among the Gurma. The country is divided into 10 administrative regions, each with its capital. The capital of the Upper East region is Bolgatanga. The regional picture however changes, depending on the base district of the ethnic groups. The Nabdam who form 30.5 percent of the region's population, make up 94.2 percent of the population of Bongo and 83.8 percent of the population of Bolgatanga. The Builsa, who constitute 7.6 percent of the region's population, make up 84.1 percent of the population of Builsa. The Kassena and the nankani, who make up 15.7 percent of the region's population, together make up 88.3 percent of the population of Kassena-Nankana.

The Kusasis make up 22.6 percent of the region's total population, but they make up about 75 percent of the population of Bawku West and 47.6 percent of the population of Bawku East. The Busanga also make up about 6 percent of the region's population and are mostly in Bawku East (15.4%) and Bawku West (7.8%).

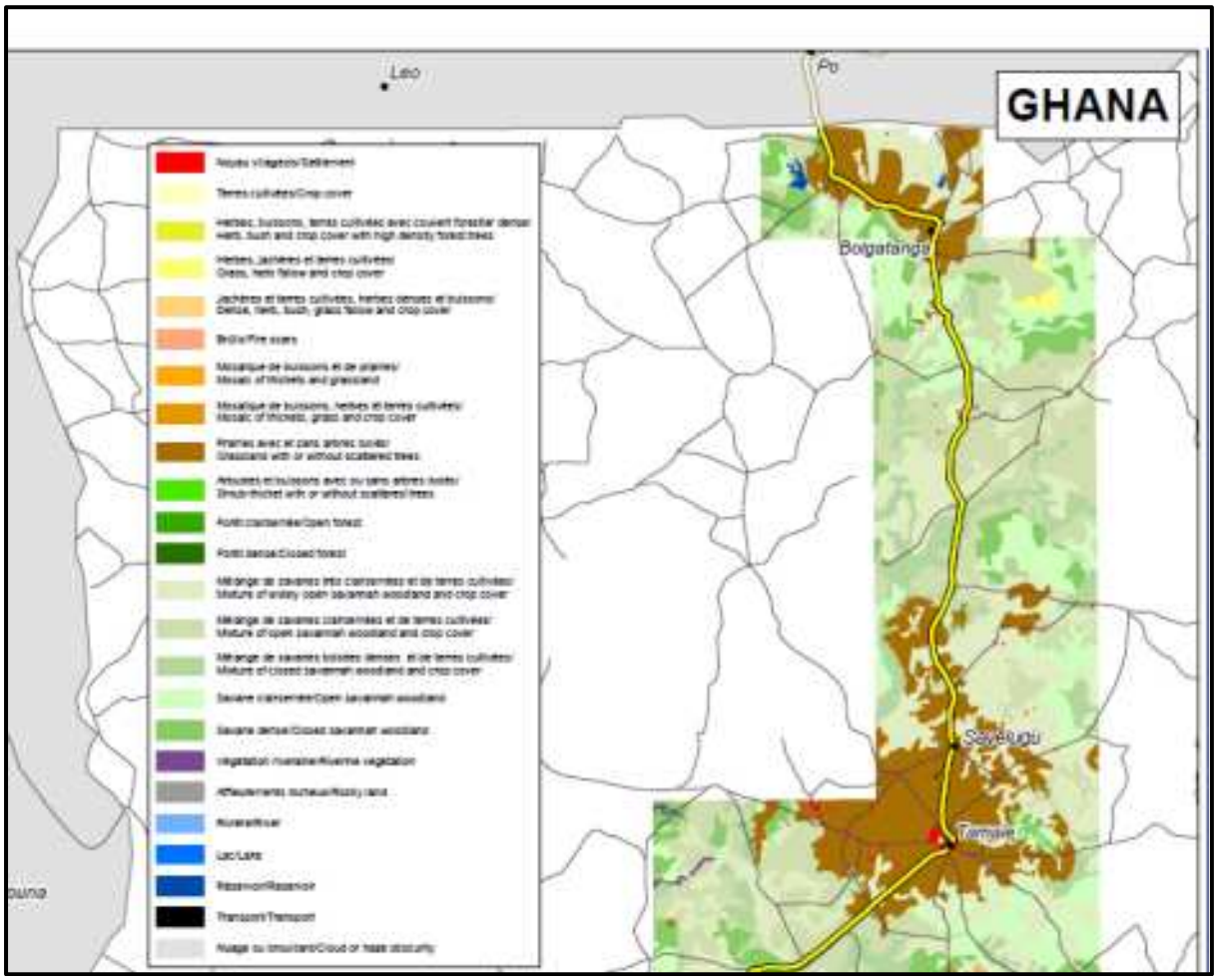
The Mamprusi comprise only 1.8 percent of the region's population. They are thinly spread in the districts. The highest concentration is in the Bawku East district where they comprise 3.7 percent of the population. However, the two adjacent districts in the Northern region, which are located to the South of Bawku East and Bawku West, are mostly Mamprusi.

Bawku East is the most mixed district in terms of ethnic groups. Only the Kusasi and the Busanga constitute more than ten percent of the population. The two ethnic groups account for 63 percent of the population. The remaining 37 percent is made up of over thirty other ethnic groups, including the Bimoba and the Mamprusi. The socio-cultural problems that can arise as a result of the ethnic diversity of Bawku East often manifested in the many ethnic conflicts in the district.

4.4.3 Major categories of soil use

Based on the information on soil use as collected by the Centre for Remote Sensing and Geographic Information Services (CERSGIS) at the University of Ghana, it has been possible to prepare a portrait of the principal types of occupation of the lands in the study zone and to calculate their area and the proportion that each of them occupies compared to the total area. Recall that the study zone extends over a distance of 1 km on either side of the reference axis located in the centre of the existing road corridor.

The route also traverses agricultural areas along a significant portion of its path. These and the grasslands represent almost 80% of the total area, while forested zones amount to approximately 10% of this area. If you can picture the areas obstructed by clouds and fog when the satellite photo was taken, other forms of soil use occupy only about 15% of the total area (see Map 4-10 and Table 4-8).



Map 4.6: Study Area Landuse in the Upper East Region

Table 4-8: Area of land occupation in the study zone

Type of Occupation	Area (ha)	%
Cultivated land	408.90	0.28%
Grasses, fallow and cultivated land	1.71	0.00%
Fallow and cultivated land, dense grasses and bushes	20,836.69	14.13%
Grasses, bushes, cultivated land with dense forest cover	7,516.54	5.10%
Mosaic of bushes, grasses and cultivated land	130.36	0.09%
Mix of dense wooded savannah and cultivated land	8,208.30	5.57%
Mix of sparse savannah and cultivated land	22,139.61	15.01%
Dense forest	1,861.81	1.26%
Sparse forest	827.74	0.56%
Dense savannah	8,933.89	6.06%
Sparse savannah	3,839.79	2.60%
Grasslands with and without isolated trees	31,307.28	21.23%
Shoreline vegetation	1,128.75	0.77%
Village centre	4,599.53	3.12%
River	86.21	0.06%
Reservoir	513.79	0.35%
Cloud or fog	9,495.99	6.44%
Total	147,470.01	100.00%

4.4.4 Agriculture

The sector employs approximately 70% of the rural manpower, represents 45% of the Gross National Product and meets 90% of the nation's food requirements. However, soil degrades rapidly under the combined effects of natural and manmade factors. In these zones, subsistence agriculture is the predominant practice and the farmers do not manage to reconstitute the nutritional elements of the soil. Map 4-7 presents the distribution of principal agricultural cultivation in Ghana. In the northern part of the country, in the sector crossed by the study zone, millet cultivation dominates.

Map 4.7: Commercial Crops in Ghana

4.4.5 Livestock Breeding

In Ghana, cattle breeding dominates, but is not sufficient to supply the population, which has to import 60% of the beef consumed. The country's principal centres of production are located in the northern and south-eastern areas. In the north, livestock is considered a sign of wealth and social status. Breeders attach more importance to the number of head than to the quality of the animals, which leads to over-consumption of forage and destruction of the ecosystems. This traditional activity also faces numerous other problems, such as the absence of water in the dry season, diseases and insect pests.

Cattle breeding is practised on an intensive commercial basis in the south-eastern part of the country (see Map 4-8). However, the bulk of the production comes from the north and is transported on foot to Kumasi and Accra. The movement of the herds over great distances in regions infested by the tsetse fly and other insect pests constitutes a significant problem for regions livestock breeders, who are currently exploring other avenues such as transportation by truck, or by boat on the Volta reservoir.

Map 4.8: Cattle Areas

4.4.6 Forestry activities

The forest in the study zone plays a vital role in the region's economic life. Wood is used for domestic purposes for cooking and heating and as a construction material. It can also be observe that predominant plant species are Anogeisus, Ceiba, Ross Wood, Teak, Neem Tree and the Acacia.

4.4.7 Road Transportation

In the study zone about 13% of the road networks are paved and usable all year round. The road networks in the northern region are less well served compared to the southern part of the country.

Several problems afflict road transportation in the study zone. Repeated increases in gasoline prices have sent transportation costs soaring. The size of the study zone and the scarcity of communication routes create a situation in which the northern part of the country is isolated from the rest and the rare communication routes that enable access to the area are over-used, especially for trucking. The roads are in poor shape and difficult to maintain. They constitute a public danger and a constant threat to users (see photos 4-12 to 4-13).

The major means of transport on the corridor are buses (Metro, Yutong and Imperial), mini buses, and uncountable number of bicycle, tricycle and motor bikes. A discussion with the officer in charge (Bunduri Customs check point), revealed that on an average day; 14 trucks (for imported goods), 14 trucks (for exported goods), 15 passenger buses, 25 passenger urvans and 10 transit trucks can ply the road. According to the officer, the above mentioned is for statutory booked vehicles aside the unbooked ones. Apart from these are uncountable number of motor cycles, bicycles and tricycles.

Photo 4-12: Overturned Tanker Truck near the Study Zone

Photo 4-13: Overturned Truck

4.4.9 Tourism

The study zone possesses several tourist resources, represented by natural sites, cultural sites, conservation zones. The best-known tourist attractions located close to the route in the Bawku district are;

- The Kulungungu Bombsite: This is where the first President of Ghana, Dr. Kwame Nkrumah Survived a grenade attack on 1st August, 1962 when returning from a meeting with his Upper Voltas (now Burkina Faso) colleague, Mourice Yameogo. This site is marked by a burst of Dr. Nkrumah.

- Yarigungu Crocodile Pond: This is a pond in a tributary of the White Volta inhabited by crocodiles. This pond never dries despite the fact that the other parts of the stream dry up during the dry season. The crocodiles can be viewed by attracting them with treads which local boys will provide for a small fee.

- Naa Gbewaa Shrine at Pusiga: This is a spot in the forest near the famous government (now Gbewaa) Teacher Training College, where Naa Gbewaa, the famous chief and ancestor of the Mole-Dagbane group of people is said to have disappeared. One needs to contact the Tindana of Pusiga with cola nuts and a fowl for a sacrifice at the shrine. The area is now fenced and provided with a tourist reception facility by the Ministry of Tourism and Ghana Tourist Board.

- Zawse Hills: It is about ten kilometers north-west of Bawku. It is an ideal place for mountain climbing and par-gliding.

4.4.10 Sites of historical and archaeological interest

In the study area, however, several sites of interest have been identified and documented by Oliver Davies (1970) and members of the staff of the Department of Archaeology at the University of Ghana. Only a few sites have been explored in detail, so the physical extent and chronology of these sites remains inexact and only systematic explorations will reveal their true wealth.

The fragmented information compiled to date reveals that most of the sites have been occupied since the Stone Age (more than 3,000 years) and demonstrate the beginnings of agriculture and livestock breeding in Ghana. Certain places were sites of important commerce and cultural exchange between the Sahara, Niger River delta and forested zones of Ghana since the first millennium BC. Several of these were subsequently abandoned or relocated to escape the violence that characterized the period of the slave trade, or simply from a desire to improve living conditions.

The documentary research conducted as part of this study was not able to obtain specific information on sites of historical and archaeological interest that could potentially be affected by the project in the study area.

However, Cemeteries are mostly found in people's homes since most of them bury their dead in their respective homes. The Bawku prison yard has two big trees of about 80m apart. One is just in front of the prison and the other in the prison yard. According to the officer in charge, the folks use to come and perform some rituals some years back believing it is their god but that ritual is no more these days.

Table 4-11 presents, from north to south, the list of known sites to date as well as the era to which they belong. An asterisk indicates that the site has previously been the subject of certain investigations.

Table 4-11: Sites of historical and archaeological interest in Ghana

Locality	Era
Paga	-
Tongo *	Neolithic
Wungu	-
Nasia	-
Kukobila	-
Disiga	-
Pigu	-
Diari	-
Yapei *	Stone Age
Ntereso *	Neolithic
Fufulsu	-
Buipe *	Stone Age
Yeji *	Stone Age
Gbulumpe	-
Dawadawa	-
Soronoase	-
Kintampo *	Stone Age up to Neolithic
Jema	-
Maasa	-
Techiman *	Iron Age up to 19th Century
Boyasi	Neolithic

5 IMPACT IDENTIFICATION AND EVALUATION

5.1 General Scope of Analysis

An environmental evaluation must identify and mitigate the short- and long-term impact of a project. An environmental impact may be positive or negative, depending on whether it enhances or degrades existing conditions of an environmental component.

In addition to describing the project environment, preparing an environmental evaluation also involves performing the following steps:

- Identifying environmental consequences by determining interactions between potential sources of impact, and sensitive environmental components

- Evaluating the importance of consequences observed

Based on the results of the environmental evaluation, a management and monitoring program, including recommendations to mitigate negative environmental consequences and defining monitoring and follow-up activities, could be prepared.

This would depend on whether the authorities judge it appropriate to proceed with the project. If the residual impact predicted is too great, the project may not proceed as planned.

5.2 Potential Sources of Impact

Based on the description of the project as well as associated construction and operating activities examined in earlier chapters, the principle sources of environmental consequences related to the proposed construction of the Bolgatanga-Bawku-Pulmakom road project were identified. They can be divided into two major categories. Consequences associated with:

- The location and construction of the road
- The mode of construction
- The mode of operation

5.2.1 Location and Construction of the Road

The construction of the road infrastructure will result in a loss of land and productivity of the natural areas they cross. The construction will also require the creation of cuts and fills that will involve moving material, creating borrow pits and using disposal sites if excess materials are generated by the work. Land denuded becomes susceptible to erosion while areas subject to intensive use become compacted and impermeable.

Building a linear infrastructure also changes drainage. Waterways crossed must be deviated away from the road to prevent the water from coming into contact and creating erosion problems. Poorly designed works can also create areas where water accumulates, providing shelter for insect pests.

5.2.2 The Mode of Construction

Soil and water quality: The construction will also require the creation of cuts and fills that will involve moving material, creating borrow pits and using disposal sites if excess materials are generated by the work. Land denuded becomes susceptible to erosion while areas subject to intensive use become compacted and impermeable.

Loosened soil and debris of concrete materials will be exposed to erosion by wind and storm run-offs. The storm run-off could transport and deposit the sediments or silt material into nearby surface water bodies along the proposed road.

Building a linear infrastructure also changes drainage. Waterways crossed must be cross drained to prevent the water from coming into contact with the road and creating erosion problems. Poorly designed works can also create areas where water accumulates, providing shelter for insect pests.

Three types of lubricants are used: motor oils added to combustion engines; heavy oils used to lubricate gearboxes, axles and drive shafts; and hydraulic oils that allow hydraulic gears to function. During construction, parts of the vehicles may leak, and oils and grease may end up on the ground, threatening both surface and ground water. Disposal of used oil and solvents can also lead to problems.

In maintenance yards used by the contractors in their camp site, acid solutions used to clean parts can also contaminate the environment if they are not properly neutralized prior to disposal. Camp site, where large quantities of fuel are transferred from a reservoir to the vehicles or a Tanker truck, are also a threat to surface water. Their number should be limited, and they should be paved and equipped with recovery gutters in case of spillage.

The impact of sediment deposits and spillage into the water bodies is significant and has long term effect on aquatic life. The water bodies support a variety of aquatic life including fish and bottom organisms (benthic organisms).

Air and noise quality: The type of fuel used by construction machinery and vehicular movements can also become a source of soil and air pollution. The main pollutants generated by diesel fuel are: carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), sulphur dioxide (SO2) and particulate matter. The pollution load generated by the diesel engine will depend on the load and speed of the heavy vehicular machines, the combustion method, type of engine, maintenance procedures and quality of fuel used.

The construction activities and traffic generated by operating road link infrastructures generate varying levels of noise and air quality (dust generation from clearing, excavation and transportation of construction materials (sand, stones and fill material)); however, levels vary depending on the density of population and levels of activities along the road network infrastructures.

From an environmental standpoint noise can have physical and psychological effects on people over the long term. Air quality problems can also result in respiratory illnesses on the population along the road network.

Waste and sanitation: Construction waste and construction spoils generated at the site will need to be disposed of at an approved site to avoid environmental problems. These wastes could create aesthetic nuisance at the project sites and their immediate environs.

Furthermore, inappropriate disposal of general waste (i.e. food waste, etc.) at the sites by construction workers will create unsanitary conditions at the area. Finally inappropriate defecation and urinating by the

construction workers may create unhygienic condition and increase sanitation problem in the affected communities.

Traffic Nuisance: The construction would involve partial closure of some sections of the road to traffic. This means temporary diversions will be necessary and this may lead to increase in traffic times along the link roads.

Landscape/Aesthetics: Excavated materials, as well as demolished structures at the project sites, if not properly disposed could negatively affect the scenery and beauty of the sites where the projects are to be undertaken. More importantly along some section of the road avenue trees which contribute immensely to the beauty of the communities apart from serving as vegetative cover maybe lost during the construction stage.

CLIMATE CHANGE: The proposed road network design will incorporate various considerations aimed at adapting to climate change especially to extreme events such as droughts and floods in the project area: (i) selection of appropriate type of pavement; (ii) proper design of drainage facilities incorporating the existing natural drainage in the catchment; (iii) proper level of road embankment; (iv) provision of dugouts and boreholes where appropriate.

5.2.3 The Mode of Operation

The type of fuel used by vehicles using the road infrastructure as well as grease can also become a source of soil and air pollution. The main pollutants generated by diesel fuel are: carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), sulphur dioxide (SO_2) and particulate matter. The pollution load generated by the diesel engine will depend on the load and speed of the vehicles, the combustion method, type of engine, maintenance procedures and quality of fuel used.

During operation, oils and grease from vehicle parts may leak end up on the ground, threatening both surface and ground water.

The construction activities and traffic generated by operating road infrastructures generate varying levels of noise; Levels vary depending on the location of infrastructures and levels of activities. Over the long term, noise can have physical and psychological effects on people.

5.3 Sensitive environmental components

The description of the environment in the preceding chapter identified sensitive components. These were grouped into three major categories:

- Physical environment: soil, water and air
- Biological environment: flora, fauna and protected areas
- Human environment: land use, communities and countryside.

5.4 Sensitive Receptors along the Road Corridor

Receptor	Specific Location	Description	Flora/Fauna	Uses
Pusiga forest reserve	Pusiga	The reserve stretches from Terago village towards the Naa Gbewa shrine to the residence of the Gbewa College of education tutors. This forest has always been known as the upper Tamne	Animals: Monkeys, rabbits, snakes and domestic animals from people's homes Tree : Neem trees, acacia , teak, dawadawa trees	Tourist attraction for the visitors of Naa Gbewa shrine, medicinal plants, domestic source of fuel. Hunting goes on even though it is banned.
The Kobori forest reserve	Kobori	This reserve extend to Bazua	Animals: antelope, elephant, squirrel, bush pig, grasscutter, hyenas, kangaroo, buffalos and most of the monkey family types such as chimpanzee and various types of birds Trees Anogeisus, Ceiba, Ross wood, Teak, Neem tree and the Acacia	Domestic source of fuel, medicinal plants
Basonde reserve	Basonde	This is located in Basonde	-do-	-do-
Nangodi-Zebila mountain	Nangodi	This mountain stretches from Nangodi through Zebila and Bawku		It is used for hiking which is a good tourist attraction.
Zaagu maountains	Zaagu	The mountain stretches from Zawse to Gbase		Not having any defined use at the moment.
Nangodi-Tilli reserve	Nangodi	The reserve stretches from Nangodi to Tilli. In this reserve, you could see animals such as the elephant passing during the rainy season	-do-	Tourist attraction and source of domestic fuel.
Zawse forest	Kpalugu	The forest stretches for Kpalugu to a nearby village called 44	Animals: only domestic animals from homes.	Domestic animals feed in the forest and also as a source of domestic fuel.
Sugudi forest reserve	Sugudi	The forest is found on the left hand side of the community where	Rabbits and domestic animals from people's homes.	For firewood, charcoal and domestic animals go there to feed.

		the police check point is located		
Forest reserve at Catholic spiritual renewal centre	Kongo	This is plantation intentionally planted left and right hand side of the road by father Rogers (Minister in charge) for the purposes of maintaining the beauty of the environment	Domestic animals	To beautify the environment.
Zongu forest	Timbiku	The forest stretches to the nearby market called the Zongu Naaba market.	Birds, rabbits and domestic animals	Domestic animals go there to feed,
Asoka dam	Kpalugu	This dam is located 15m from the existing road	Tilapia electric fish and mud fish,	Used for fishing, to feed domestic animals and for domestic chores
Gheaburi pond	Kongo	This pond is located 1km from Kongo town	Fishing	Irrigation during the dry season
Red Volta river	Tilli	This river has the bridge that the Ghana Highway Authority constructed in 1981	Tilapia, mudfish, electric fish	Fishing which is done 1km away from the bridge
Saka dam	Saka	The dam is located just beside Yikurugu, Saka and Ankpaliga afforestation project	Mudfish and the tilapia	Mainly for irrigation, fishing and domestic purposes
Zuabolga river	Terago	This river is locate 300m from Terago	Tilapia and crocodile believed to be a god that comes out every Friday	Fishing and domestic uses.
Kodorko river	Kodorko	This is the river runs through the Kodorko bridge	Crocodile	No fishing is done in the river due to the crocodile.
Zeketbogo dam	Mandago	Located 10m from the existing road	It has no fish	To feed domestic animals and building mud houses.
Mauri river	Timbiku	The river is located 200m from the existing road.	Mudfish and tilapia	Fishing, domestic purposes and drinking by domestic animals.

5.4.1 Degree of impact

Although environmental consequences cannot be qualified in absolute terms, the changes and trends resulting from the project can be examined and predicted. The potential effects are described according to their degree of significance, as described below.

- Negligible Effect (○):

A negligible effect is barely perceptible. It affects a population, entity or specific group of individuals in a localized area and/or for a short period of time. It has the same effect as a series of small random changes associated with natural changes that have no measurable impact on a population, an environmental component or a group as a whole.

- Insignificant Effect (⌂):

An insignificant effect has one or more of the following characteristics:

- It affects a limited space
- It is temporary or of limited duration (e.g., only during construction)
- Its recurrent effect lasts only for a short period during or after implementation of the project
- It is not permanent, which means that when the source of the impact disappears, the integrity of the social/environmental components returns

- Significant Effect (●):

A significant effect has one or more of the following characteristics:

- It is widespread
- It permanently contravenes environmental legislation, regulations, standards or objectives
- It reduces biodiversity
- It results in the disappearance of important productive habitats
- It permanently changes the characteristics of a community or services delivered to people, land use or ways land is occupied
- It leads to the disappearance of archaeological and/or heritage resources

5.5 Potential Impact Matrix

Table 5-1 shows the potential impact matrix of the Bolgatanga-Bawku-Pulmakom Road project. It illustrates the potential sources of impact associated with the project and the various environmental components described earlier.

Table 5-1: Potential Impact Matrix

Environmental components			Sources of impact: Construction								Operation	
DEGREE OF IMPACT ○ Negligible effect ⌂ Insignificant effect ● Significant effect ⊕ Positive effect			Acquisition of rights	Clearing	Access construction	Excavation and levelling	Construction of link roads	Traffic and use of machinery	Cut and fill management	Management of road accidents	Presence and use of road	Management of road accidents
Physical environment	Soil	Structure and stability		⌂	⌂	⌂	⌂	⌂	⌂			
		Quality								⌂		⌂
	Water	Quality of surface and ground water		⌂	⌂	⌂	⌂	⌂	⌂	⌂	⌂	⌂
		Runoff and infiltration		○	⌂	●		●	⌂			
	Air	Quality		●	●	●	●	●	●		○	
		Noise		●	●	●	●	●	●		○	
Biological environment	Flora and fauna	Protected spaces		⌂	⌂	⌂	⌂		⌂			
		Species and habitat		⌂	⌂	⌂	⌂	⌂	⌂	⌂	⌂	⌂
Human environment	Land use	Built environment	●									
		Agricultural land and irrigated surroundings	⌂									
		Tourist sites									⊕	
		Archaeological features, sacred groves and tombs				●			●			
	Infrastructure	Roads and traffic		●	●	●	●	●	●		⊕	
		Public networks		●		●	●		●			
	Population	Lifestyle	●								⊕	
		Local and regional economy		⊕	⊕	⊕	⊕	⊕	⊕		⊕	
		Public health and safety		●	●	●	●	●	●	●	⊕	●

6 ENVIRONMENTAL MANAGEMENT AND MONITORING MEASURES

6.1 Prevention, mitigation and optimisation measures

Table 6-1 provides a description of the environmental impacts the Bolgatanga-Bawku-Pulmakom Road link is expected to have. The initial potential impacts identified in Section 5 as well as their level of importance are described at the left. This table also provides, as general and specific recommendations, a series of mitigation and optimisation measures intended to reduce the significance of the negative environmental impacts and provide a framework for the monitoring and follow-up activities during the subsequent phases of the project.

The measures presented are based, on the one hand, on current environmental assessment practices and, on the other hand, on specific recommendations formulated by the political and social stakeholders met in Upper East Region during the course of missions to collect data.

Finally, the level of importance of the residual impacts, namely those remaining after the application of the recommended measures, is indicated at the right of the table. These residual impacts will be used to determine the environmental feasibility of the project.

Key to table below:

○ Negligible effect

⌂ Insignificant effect

● Significant effect

⊕ Positive effect

Table 6-1: Prevention, Mitigation and Optimisation Measures

Potential Impact		Prevention, mitigation and optimisation measures	Importance of Residual Impacts
Importance	**Description**		
⌂ ⌂	In the urban environment, the development of the road links will perturb the **current built environment** and the **subdivided zones** in certain localities. Clearing of the land, construction of access roads, excavation and levelling work, construction and use of machinery and management of cuttings and waste material may cause **soil erosion and destabilization** in the sensitive sectors.	• Optimise the route in cooperation with the local authorities. • Submit the route plan to the local authorities so as to make sure it respects government guidelines concerning land use. • Explore the possibility of providing financial compensation for the communities that will have to change their zoning and subdivision plans in order to include the road link routes. • Avoid, as much as possible, zones susceptible to erosion and unstable soils. • If new access roads must be built, the contour lines must be respected. • Mark the work sites and minimize the movement of machinery. • Direct the surface run-off and drainage waters so that they go around sectors where the soil is susceptible to erosion. If they cannot be diverted, implement protective measures (berm, diversion channels). • Use the existing borrow pits and quarries. • Once the work has been completed, level the ground and close the accesses to the temporary roads located near bodies of water (ponds, rivers, swamps).	○ ○
⌂ to ●	Most of the construction activities will entail the use, handling and storage of dangerous materials such as fuel, oils and solvents. With these operations there is a risk that **the soil, surface water and groundwater may be contaminated** in the event of leaks or spills.	• Prohibit the filling of transportation vehicles and machinery within less than 30 metres of streams. • Take all the precautions possible when filling transportation vehicles and machinery so as to prevent spills. • Avoid storing machinery on areas other than those defined as essential for the work. Identify the limits of these areas clearly. • Keep the transportation vehicles and machinery in good working condition so as to avoid leaks of oil, fuel or any other pollutant, and minimize gas emissions and noise. • secure the areas where dangerous materials are stored with devices to protect against accidental spills. • Develop and implement an emergency plan for handling accidental spills of dangerous products. Post a list of the names and telephone numbers of the people in charge and the alert structure where it can be seen by the workers. • Avoid accumulating of all types of waste outside or on the work site; send waste to the waste disposal sites provided for this purpose.	○
⌂ to ●	The construction activities and more specifically the land clearing activities and the excavation work may modify the **drainage and infiltration** patterns of the surface water during the rainy season.	• Avoid obstructing streams/rivers and remove all waste that blocks the normal flow of surface water. • Avoid doing work in zones that are subject to flooding in the rainy season. • Limit the number of roads and restrict the movement of machinery to the work areas and at the marked accesses. Maintain the access roads and the work areas on a regular basis to prevent the formation of ruts, ridges and mounds that could hamper the natural flow. • Direct surface and drainage waters so that they bypass the sectors where the soils are susceptible to erosion. If they cannot be diverted, implement protective measures (berm, diversion channels).	○

		• Avoid accumulating all types of waste outside or on the work site; send waste to the waste disposal sites provided for this purpose (agreed with GHA and the district assemblies	
● ⌂	The construction activities and the operation of the borrow pit will entail the use of noisy machinery and tools and produce dust and exhaust gasses that may modify the **quality of the air** and ambient **noise levels**, affecting the residents' quality of life. Once it is in operation, the road links will also be a source of **noise** and **air pollution.** The construction of the road links will result in a **loss of vegetation cover**. Afterwards, during the operating phase, maintenance activities will hamper the expansion of vegetation species.	• During construction, maintain transportation vehicles and machinery in good working condition so as to minimize gas emissions. • Use dust control measures (e.g. watering of exposed surfaces twice daily) and cover vehicles transporting materials to sites with tarpaulins. • In inhabited areas, inform the residents concerned about the schedules for bothersome work and implement adequate measures to reduce the effects. • Avoid undertaking noisy activities outside normal work hours. • Use existing quarries and borrow pits. Reduce the number of borrows to a minimum. •Consult the public and pay particular attention to the species valued by the public. •Do not do anything in settings where the growth of vegetation does not hamper the construction or maintenance of the road links. •During the work, protect the trees kept along the border of the right-of-way •Encourage the re-growth of vegetation at the end of the work and sow the bare areas with indigenous species (herbaceous shrubs and plants).	○ ○
⌂	It is possible that the development of the road links will perturb **certain aquatic and land habitats.**	•Respect a protective perimeter of at least 30 metres around the following sensitive zones. - shores of rivers, ponds and streams; marshes and swamps - important fauna habitats; - water supply wells; - slopes that are steep and sensitive to erosion; •Avoid blocking streams and remove any debris that could hamper the normal flow of surface water. •In order to prevent possible spills, prohibit the filling of transportation vehicles and machinery near streams.	○
⌂	The construction site could also interfere with the practice of **traditional activities**.	•Do the work so as to have as little impact as possible on the existing cultures and cultural practices. •Preferably choose zones with less agricultural value for storing materials. The space chosen must be minimal and its borders must be marked.	○
⊕	The link roads will improve access to several well-known **tourist sites.**	•Positive effect: no mitigation measure proposed	⊕
●	Certain **archaeological ruins**, **sacred groves** and **tombs** could be destroyed during the excavation and construction work or during the operation of the borrow pits.	Submit the route for the road link to the traditional local leaders and representatives of the archaeological departments at University of Ghana Legon (Ghana), so that they can identify and mark off the sites with archaeological, cultural and religious potential. • Protect the sites identified. • If work is planned near these sites, establish a protective perimeter. • If work is planned within a perimeter of archaeological interest, undertake archaeological digs prior to the work and promote the study and development of ruins. • If fortuitous archaeological discoveries are made during the work, suspend all activities and inform the appropriate government authorities. • If work is planned within a sacred grove or cemetery, contact the religious authorities and respect traditional rites for moving remains and sacrifice sites.	○

●	The presence of construction vehicles will increase **traffic** along the roads used.	•Identify, with the contractor, the roads to be used by trucks to access the work site and insist that they be respected. •Avoid parking machinery or storing construction materials along public roads.	○
⌂ to ●	The development of the road links could conflict with certain **public infrastructures** such as power and telephone distribution systems and telecommunications antennas.	•Coordinate the work with the distribution agencies. •Notify the public in advance about any cut in services.	○
●	The development of the road links will perturb the **lifestyle** of the population in the event of lost areas, which could affect the profitability of operations or entail relocation.	•Design and implement an information and communication strategy with those directly affected by the project, taking into consideration local dialects and the high illiteracy rate, all in keeping with the directives of Ghana and other important, international funders. •Early in the process, inform the population affected so as to clearly explain the project and dissipate fears and concerns, particularly with respect to relocation and compensation. •Before starting the work, provide compensation for those actually using the sites within the ROW, in keeping with the terms established by law and the directives of the funding body and other large international funders. •Offer technical assistance to owners who must be moved.	○
⊕	During construction, the road links project will improve the **regional economy** through the hiring of local people and the purchase of goods and services. Once the road links are in operation, it will also play an important role in the economy, by improving **commercial exchanges** and **incomes**, by supporting the development of the internal trade in the communities and by relieving the isolation of the municipality from the region.	•Encourage workers living near the work site to get involved. •Inasmuch as possible, break the work down into units so as to encourage the participation of small local contractors. •Explore the possibility of building stores near the stations and making them available to communities so as to stimulate the creation of new commercial activities and increase public revenues. •Set up training sessions intended to improve the management abilities of small business for income generating activities. • Improve access to micro-credit.	⊕
●	The work site and the traffic generated by the construction vehicles and machinery could be harmful to the **health** and **safety** of the workers and the population during the construction work. However, once operational, the infrastructure will help to improve the **safety** of travellers and goods and reduce the number of accidents caused by trucks on the bad roads.	•Inform the workers about the dangers inherent in the work. •Make the public aware of the dangers involved in the road construction. •Use construction machinery and equipment that is suitable for the specific conditions of the site and are equipped with back-up signals. •Identify, in cooperation with the contractor, the roads to be used by trucks to reach the work site and see that they are respected. •Mark the roads to the work site with signs indicating the presence of a work site.	⊕

6.2 Residual effects

The application of the prevention, mitigation and optimisation measures proposed in Table 6-1 will serve to reduce the scope of the expected impacts to such an extent that the residual effects of the Bolgatanga-Bawku-Pulmakon road link will be insignificant or negligible. The principal residual effects expected are:

- The modification of the built environment in the communities the road link crosses through: loss of homes, loss of subdivided areas
- The loss of agricultural areas: zones that are cultivated, irrigated, planted, etc.
- The crossing through of Forest Reserve in the Upper East
- Disturbance of public services: power transmission lines, telephone networks, telecommunications antennas
- Potential destruction of archaeological ruins
- Disturbance of sacred groves and tombs

It is important to note, however, that some of the impacts expected could be eliminated during the route optimisation work that will take place during the development of detailed plans. This applies specifically to the last two impacts concerning the possible destruction of archaeological remains and the disturbance of sacred groves and tombs
The project will also have positive effects on the environment. The most significant include:

- A reduction in traffic accidents on the highway connecting Bolgatanga-Bawku-Pulmakom and the increased safety of passengers and goods
- The creation of employment during the construction and operating phases
- Improved access to certain renowned tourist sites such as the Kulungungu Bombsite, Naa Gbewaa Shrine at Pusiga, Yarigungu Crocodile Pond and Zawse hills

6.3 Environmental monitoring measures

The implementation of an environmental monitoring programme adapted for the environment through which the road link will cross as well as the project will ensure the concrete application of proposed mitigation measures. The programme may take on various forms, depending on the stage of the project.

6.3.1 Study stage

The study stage includes developing construction plans and drafting the tender documents. Environmental monitoring will ensure that all the environmental standards, directives and measures included in the environmental impact study as well as all of the requirements formulated by the parties consulted and accepted by the national agencies concerned with environmental issues are integrated in the plans and specifications as well as all other contractual documents pertaining to the project.

6.3.2 Preconstruction stage

During the preparatory work, namely the topographical and technical surveys, geotechnical campaign, clearing of the land and construction of roads, environmental monitoring will involve the application of all environmental measures, requirements, standards and other prescriptions specified in the contractual

documents pertaining to the project. Responsibility for this will be assumed, on appointment of an environmental manager who will be responsible for ensuring that all environmental measures are applied.

6.3.3 Construction stage

During the construction work, the contract administrator, inspectors and on-site representatives of the environmental manager will see that the commitments made by the company with respect to protecting and enhancing the environment will be respected. At the end of the work, the responsible authorities shall also make sure that the work to restore the sites is completed. Finally, the environmental manager will conduct an environmental assessment of the work and draft a report on the environmental monitoring to be submitted to the authorities.

6.3.4 Operation and maintenance stage

After the road is put into operation, the responsible authorities must make sure that the directives concerning the maintenance of rights-of-way are respected and that the intervention is effective, as well as ensure the protection of fragile zones.

6.4 Environmental monitoring measures

Since the feared impacts will occur principally during the construction phase and since, during the operating phase, few impacts will persist, no particular environmental monitoring measures are recommended for this phase. It should be noted, however, that during the information gathering tours that provided an opportunity to meet with local and regional authorities it became obvious that noise emissions are of particular concern. Therefore, it is recommended that, once the construction has been completed, the sound climate generated by the operation of the road link should be monitored so as to ensure the effectiveness of the mitigation measures implemented as part of the project and to ensure that the noise standards specified in the country are respected.

Cost Estimates

The overall costs of the recommended environmental monitoring measures stand at $100,000. The cost estimates include mitigation measures, sensitization campaigns on health issues, road safety, planting of alignment trees and compensatory activities for rehabilitating social infrastructure as well as measures aimed at building the capacity for monitoring implementation. The implementation costs summary in each phase of the project is presented in the following table:

	Description	**Cost (US$)**
1	Pre-construction Phase	20,000
2	Construction Phase	55,000
3	Operational Phase	25,000
	Total	100,000

7.0 PROPOSED ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan (EMP) acts as an Operational Manual for the project with respect to environmental issues during the implementation and operation of the project. It sets out in practical terms, how the mitigation measures proposed should be implemented. It includes details of the environmental monitoring programme. This chapter, however, presents a summary of the EMP of the proposed project.

7.1 Key Stakeholders

The key stakeholders in the environmental management activities are: GHA and EPA, the Design Consultant, Contractor, Local Authorities and, to some extent, the Public. Responsibilities for implementation of the proposed mitigation measures have been allocated to the various stakeholders as discussed below.

7.2 Key Actions and Responsibilities

A number of possible negative impacts were identified during the environmental and social assessment. Mitigation measures to minimize or eliminate the negative impacts have been proposed for implementation. The key actions required will focus on the following:

Protection of Existing Utilities

Electricity

The project shall be fed with electricity from the National Grid through transformers installed for example at contractor quarry site and distributed by a three (3) phase supply lines or by the Contractor's generating plants.

The Contractor shall ensure that all persons working in such areas are aware of the relatively large distance that high voltage electricity can 'short' to earth when cranes or other large masses of metals are in the vicinity of power lines.

Water

The project site shall be provided with water from the various GWCL. In the event of water supply cut off due to fault on the mains, the project sites and other affected residential areas shall be supplied with water through mobile water tankers from the Contractor's and GWCL mobile water tankers.

Occupational Health and Safety Measures

Measures shall be put in place to reduce the risk of accidents and respiratory diseases. The Contractor shall ensure that as far as practicable, the health, safety and welfare of employees and all other persons on site are secured. Protective clothing and safety equipment shall be provided to all staff and labour engaged on the project, e.g. safety boots, nose masks, gloves, goggles and coveralls.

In addition, First Aid Services shall be provided at the site office to serve as emergency response to accident or ailing victims before being referred to nearby clinics or hospitals when the need arises.

Staff and Labour Issues

The implementation of the project is expected to provide employment opportunities for a lot of the unemployed youth during and after the construction stage as well as help to provide transport opportunities for the people living along the various road corridors.

The contractor shall ensure that conditions of employment for the staff are in accordance with those established in the Collective Agreement between the Association of Building and Civil Contractors of Ghana (ABCCG) and the Construction and Building Materials Workers Union (CBMWU).

Livelihoods

The LVB on behalf of the Ministry of Roads and Highways through the implementing agency, GHA, shall appropriately value and pay adequate compensation for all affected properties during land acquisition stage before work begins on the proposed road corridor.

Measures for Air and Noise Quality

During construction phase, dust and noise pollution will be experienced at various levels. The contractor shall ensure that dust generation is reduced by frequently watering all exposed surfaces. In addition, the contractor shall ensure that all vehicles and equipment on site shall be regularly maintained according to the original manufacturer's specifications and service manuals to reduce particulate emissions and noise pollution.

Traffic Management during Construction

As the road shall be built without closing the existing road there are potential minor negative impacts for the existing traffic, access, and road safety. These can be mitigated by requiring the Contractor to undertake temporary traffic management measures.

The Contractor shall take reasonable precautions to keep all public or private roads clear of any spillage of material from his traffic to the satisfaction of GHA. All such spillage which occurs shall be cleared without delay.

The Contractor shall also provide, erect and maintain on the road corridor and at such positions on the approaches to work areas, traffic control signs necessary for the direction and control of traffic. The signs shall be reflective or adequately illuminated at night in a manner approved by the GHA and kept clean and legible at all times. The Contractor shall reposition, cover or remove signs as required during the progress of the works.

Employment

The Contractor to be selected to execute the works will need to recruit new casual workers and it is proposed that they are encouraged to direct particular effort to taking on people from the vicinity of the construction site..

7.3 Key Responsibilities

7.3.1 Current Environmental Policy of GHA and EPA

Enshrined in the GHA's policy framework are issues regarding the protection of the environment, occupational health and safety. In this policy, the responsibilities and roles of the Authority regarding general and specific situations are clearly indicated. To this effect, the commitment of the GHA to its policy objectives can be summarized in the following statement that: 'the construction and operation of the road project will be undertaken using the best available technological and human resource capacity of the Authority to ensure sustainable development'.

Similarly the Environmental Protection Agency has a mandate which covers monitoring of projects to ensure compliance with approved mitigation measures, quality standards and all other environmental conditions. Table 7.1 summarizes the environmental management responsibilities of the GHA and EPA for the various phases of the project.

Table 7.1: Environmental Management Responsibilities of the GHA and EPA

PROJECT PHASE	NO	RESPONSIBILITIES OF GHA/EPA
Project Preparations	1	Issue necessary environmental permits, instructions and guidelines to be incorporated in the Project Document.
	2	Approve of locations for quarries and borrows pits and plan for their rehabilitation.
	3	Inspect and mark trees along the existing road to be felled
Project Execution	4	Observe the overall environmental performance of the project.
	5	Issue instructions and guidelines for additional mitigation measures to be included during project execution.
	6	Issue interim notes of approval for staged rehabilitation of project areas, e.g. construction sites, borrow pits, campsites.
	7	Conduct awareness raising campaigns on public health as well as on traffic safety.
Demobilisation	8	Issue letter of recognition that all environmental obligations have been appropriately fulfilled

7. 3.2 General Roles and Responsibilities of the Consultant/Engineer

The consultant shall be responsible for supervising and enforcing the Contractor's performance on all environmental provisions that are included in the Contract and may recommend additional mitigation measures for implementation where deemed necessary. He shall assist and support GHA or any other institution responsible for the monitoring of the general environmental impact of the Project. The consultant shall also ensure that road safety education, environmental information and awareness raising campaign is organized for residents along the project road to educate them to be safer road users. Public health and HIV/AIDS awareness-raising programmes in the communities and work camps shall also be included. A summary of the responsibilities of the consultant is presented Table 7.2.

Table 7.2: Environmental and Social Management Responsibilities of The Design Consultant/ Engineer

PROJECT DESIGN	1	The Design Consultant/Engineer shall prevent erosion and other negative impacts by incorporation of suitable measures in the project design.
CONTRACT DOCUMENTS	2	The Design Consultant/Engineer shall incorporate all suitable clauses requiring the contractor to execute his work with due diligence and apply environmentally friendly methods. Such requirements must be accompanied by the necessary methods for monitoring and enforcement. Clauses will be incorporated in the contracts documents.
IMPLEMENTATION	3	The Design Consultant/Engineer will supervise and enforce the contractor's performance on all environmental requirements included in the contract Documents.
	4	The Design Consultant and Engineer will monitor the overall environmental impact of the project and recommend additional mitigation measures for implementation when deemed necessary.
	5	The Design Consultant and Engineer will liaise with the local health, traffic and educational authorities to plan agreed awareness raising campaigns.

7.3.3 General Roles and Responsibilities of the Contractor

The construction method and behaviour of the Contractor and his workforce will determine the extent to which the project could adversely impact on the environment. The basic responsibility of the contractor towards protecting the environment has been defined as such to compel the contractor to take all reasonable steps to protect the environment and avoid damage and nuisance arising as a result of his activities.

The Contractor shall ensure that site managers and foremen are well aware of the potential environmental as well as the relevant health and safety implications of the Project. He shall also ensure that all the relevant staff are well aware of pertinent national safety regulations, sufficiently trained in environmentally friendly construction methods and that these methods are ultimately applied and appropriate measures taken throughout the implementation of the Project.

The Contractor shall be familiar with all pertinent national and local legislation relating to his activities and shall generally take all reasonable steps to adequately secure traffic, road and health safety and to protect the environment on and off the site during construction. He shall prepared and perform his work in such a way to achieve such results as to avoid damage or nuisance to persons, to public property or others resulting from the organization of traffic, from pollution, noise or any other causes arising as a consequence of these methods of operation.

Considering the impact that the project will have on the environment, it is expedient that the Environmental Clauses are specifically defined and incorporated in the contract agreement to enable the Contractor reduce or eliminate the environmental impacts and also to emphasize the importance of environmental protection. He shall inform the Engineer in due time of any unforeseen adverse environmental impacts that may arise. Table 7.3 summarizes the environmental management responsibilities of the contractor.

Table 7.3 Environmental Management Responsibilities of the Contractor

PROJECT PHASE	NO	CONTRACTOR'S RESPONSIBILITIES
Mobilisation	1	Ensure that the headquarters staff as well as site managers and foremen are well informed about all environmental issues of the project.
	2	Ensure that his site managers and foremen know about and understand environmentally friendly construction methods, especially those related to prevention of soil erosion
	3	Maintaining and operating his own and sub-contractor's equipment in accordance with the original manufacturer's specifications and service manuals to control noise, vibrations and emissions. Faulty equipment must be rectified or replaced within 24 hours of being given notice
	4	Properly establish, operate and rehabilitate construction camps
	5	Prepare and submit plans for borrow pit management for approval by the relevant authorities and the Engineer in due time before starting any clearing activity at the site.
	6	Establish a waste management plan covering all types of waste.
	7	Possess adequate relevant knowledge of the rules and regulation for environmental protection in Ghana: • Noise • Air • Tree cutting
Project Execution	8	Fulfil all environmental requirements of the contract documents
	9	Apply environmentally friendly equipment and construction methods
	10	Inform the GHA if any unforeseen negative environmental impact should occur.
	11	Responsible for the occupational health and safety of all persons (workers and visitors) present at his work sites at any time.
	12	Responsible for providing safe passage around or through his work site for all kinds of traffic
	13	Spraying any dusty road touched upon by project activities to sufficiently fulfil the EPA guidelines for ambient air quality.
	14	Possess erosion prevention work plans and promptly re-vegetate all exposed areas.
	15	Provide proper storage facilities for fuel, oil and lubricants and wastes thereof to prevent water pollution.
	16	Responsible for providing potable water to any community whose water source is made unwholesome due to the project activities until the water is made wholesome again
	17	Responsible for not cutting or damaging any trees which have not been marked for felling. Felling/destruction of such trees will involve an automatic fine to be deducted from next payment due. Any tree felled is the property of the Government of Ghana and must be handed over to the Department of Forestry.
	18	Responsible for the management of all type of waste generated from construction activities, camps, quarries and borrow pits. Waste includes that from asphalt plants must be dealt with in such a manner that any kind of water pollution is prevented.

	19	Responsible for immediate elimination of any breeding site of disease vectors resulting from the project activities.
Demobilisation	20	Ensure that all affected project areas have been properly cleaned of waste, graded and re-vegetated

7.3.4 Environmental and Social Management Responsibilities of the Public

The general public has no specific tasks in the environmental management plan. Their role however is very important. The public must express its concerns about the project not only in the preliminary design phase but also wherever it becomes aware of previously unforeseen impacts or that impacts take on a different order of magnitude than expected. The public has an unwritten obligation to inform the authorities and the Supervising Design Consultant/Engineer about such developments as early as possible. The public will also be the target of awareness raising campaigns to mitigate the negative impacts of the project.

Periodic interviews with the beneficiaries of the project will be undertaken by the GHA/EPA to assess their opinions about the effect of implementation of the project. Above all direct field observations by the monitoring team will be undertaken to ensure that the contractors for the project are actually implementing the proposed mitigation measures against the environmental and social effects of the project.

7.3.5 Monitoring Plan

There is the need for the projects to be monitored. This is to ensure that the contractors actually implement the social and environmental measures intended for the anticipated impacts that could result from the project. The GHA supported by other stakeholder such as EPA will monitor the project. The general monitoring responsibilities of stake-holders are summarized Table 7.4.

Table 7.4: Monitoring responsibilities of stakeholders.

PARTY RESPONSIBLE	PARAMETERS TO BE MONITORED	OUTPUT	ACTION TIME FRAME
EPA	- Overall Environmental Performance of the project	Instructions to contractor and GHA	Throughout project life cycle
Department of Forestry	- Impact on vegetation and avenue Trees	Instructions to contractor and GHA	On-going responsibility throughout construction phase.
GHA	- Overall Environmental Performance of the project - Community relations - Payment of appropriate compensation - HIV/AIDS awareness raising Campaigns	Monthly Environmental Reports	Once a month but responsibility runs throughout the project life cycle

PARTY RESPONSIBLE	PARAMETERS TO BE MONITORED	OUTPUT	ACTION TIME FRAME
The Engineer	- Construction methods and material - Environmental management of construction sites - Implementation of mitigation measures for air, water, soil, traffic, occupational health and safety, trees etc. - Environmental management of construction camps - Environmental management of borrow pits and quarries - Contractor's waste management - Staged rehabilitation of impact areas - Environmental performance of contractors equipment -Accidents (traffic, spills, etc.) - Environmental performance of mitigation measures	Monthly Environmental Reports Incident Reports as and when required (spills, accidents and the like).	On-going responsibility throughout construction phase.
The contractor	- Environmental performance of equipment and plants. - Implementation of interim and permanent mitigation measures. - Occupational Health and safety measures - Air quality - Accidents of any kind	- Maintenance records - Accidents Reports - Mitigating actions, e.g. Sprinkling of water, traffic signs, safety barriers	On-going responsibility throughout construction phase.
Traffic Police	- Traffic nuisances - Traffic safety measures - Traffic accidents	Police reports and instructions to contractor and GHA	On-going responsibility throughout construction operational phases
Health Authorities	- Change of frequency of diseases - Occurrence of new disease in the area	Health reports	Upon observation of incidence of diseases

8 CUMULATIVE IMPACTS AND OTHER POTENTIAL EFFECTS

8.2 Cumulative impacts

8.2.1 Principles for evaluating cumulative effects

"Cumulative impacts" refer to the environmental impacts that result from the combination of direct or indirect effects of a project with those of other projects or past, current or future activities or, at the very least, activities which are foreseeable. Environmental Assessment Regulation Act 1999 (LI1652) requires an analysis of the cumulative effects as part of the environmental assessment of projects.

The assessment of cumulative impacts is based on concepts that are slightly different from those used for an assessment of the "direct" effects of a project. For example, the assessment of cumulative effects is conducted over a larger territory than the intervention zone of a project (regional), over a longer period of time, and takes into account interactions with other interventions in the environment—past, present and future. In addition to these differences, the assessment of cumulative impacts is fundamentally the same as the assessment of the "direct" environment impacts and is often based on acknowledged environmental impact assessment practices.
It should be noted that only significant residual effects are considered for the assessment of cumulative effects.

Moreover, only cumulative effects on valued components of the ecosystem (VCE) are assessed, namely the effects on the components that are part of the ecosystem, such as surface water, fauna habitats, valued fauna species and others. The principal stages in a cumulative impact assessment are:

- To determine if the project will have an impact on a VCE
- To determine if the impact adds progressively to the effects of other past, present or future actions
- To determine if the impact of the project, combined with the other effects, could cause an important short- or long-term change to the VCE, following the application of the mitigation measures planned for the project

8.2.2 Report of cumulative effects

Based on the principals for assessing cumulative impacts, it is understood that these effects are determined through the identification of other projects that are likely to take place in the sector and have negative effects on the same elements of the environment.

Following the environmental assessment for the Bolgatanga-Bawku-Pulmakom road link, it appears that the application of the proposed mitigation measures as well as the implementation of a supervision and monitoring programme will reduce the significance of cumulative effects to such an extent that no major residual effect was identified. Therefore, the project will have no cumulative impact.

8.3 Effects that may be caused by defects and accidents

The principal effects that may result from failures and accidents associated with the operation of a road link primarily concern:

- The risk of loss of life following collisions between road vehicles and people and animals along the route or at crossing points
- Damage to and explosions involving tankers could result in injuries and fuel leaks
- The risk of road accidents that could result in loss of life for passengers and people living along the route as well as environmental disasters and material losses

The questions concerning the management of dangerous goods carriers were discussed as part of the environmental assessment of projects and preventive measures specifically concerning the respect of certain minimal distances near sensitive elements of the environment were proposed. The implementation of these recommendations could also be completed by a risk analysis and the implementation of solutions to reduce the threats for people and the environment.

8.3.1 Risk analysis

A risk analysis serves to define and establish a detailed list of dangers related to the product. It includes four steps:

- Determination of the limits of the product
- Identification of the dangerous phenomena
- Estimate of the risk
- Assessment of the risk

Following the risk analysis, which serves to identify and quantify the risks of injury (location, importance and probability), appropriate measures must be implemented, in keeping with the following order of priority to reduce the risks of injuries as much as possible:

- Corrective measures: for example, implementation of warning devices
- Protective measures: for example, using protective barriers to mark off the risk zone

8.3.2 Information for the public and workers

The social impact study for the project will include a series of recommendations concerning public information and consultation concerning the project. It should specifically include a section on the dangers of the construction and operation of a road link for the health and safety of the public and the workers.

The means considered for reaching the target publics could include awareness-raising campaigns for local organisations and individuals, the development of computer and conventional training programmes, and the implementation of advice and aid mechanisms. The implementation of these information and consultation mechanisms should take into account the low literary rates in the rural areas and the need to reach the female population.

9 ENVIRONMENTAL SUMMARY AND TRAINING PLAN

9.1 Environmental Summary

The exercise undertaken to prepare this document made it possible to examine the environmental effects and propose an environmental impact management plan for the Bolgatanga-Bawku-Pulmakom road link project.

The analysis was conducted based on information in existing documents gathered during two field missions to meet with authorities responsible and members of the technical team designing the project. It also takes into account local and international environmental protection requirements.

In light of the results obtained, it appears the project will have no significant environmental impact, provided the protective, mitigating and optimisation measures recommended in this document are heeded.

9.2 Training Plan

As indicated earlier, respect for environmental considerations during the study, preconstruction, construction and post-construction phases of the Bolgatanga-Bawku-Pulmakom road link project will involve the participation of numerous specialists who will have to work in close collaboration to ensure the implementation of the recommendations proposed in this project and its harmonious integration into the environment.

Participants who will play key roles in this process include the authorities of the Ghana Highway Authority as well as environmental advisers in the field, the contract administrator, contractors and their field representatives, labourers called on to perform the work, and the community in general.

The activities that will have to be undertaken will take the form of seminars or simple information campaigns aimed at the targeted participants. Some will involve all participants identified, and others will target only certain groups.

ANNEXURE

ANNEX 1: CONSULTATIONS
ANNEX 2: PICTURES OF SENSITIVE RECEPTORS

ANNEX 1
CONSULTATIONS

ANNEX 2
PICTURES OF SENSITIVE RECEPTORS

Transformer and existing bridge at Kongo, 5m from the road

Solar light at Timbuktu 10m from the road

Starting Point of the Bolga- Bawku Resurfacing by GHA

Mauri Dam at Timbuktu, 200m from Road

The Red Volta Bridge on, Tilli

Grave yard at Kongo, 10M from the road

Afforestation programme at Saka

Cross-Section of the Pusiga Market, 5m from the road

Rock outcrop at Nangodi, close to road

Zebilla Customs Barrier Market near road

Binduri Plantation reserve

Residence of Gbewaa College of Education Tutors, Pusiga