ROAD DEVELOPMENT AGENCY

Republic of Zambia

Ministry of Works and Supply

E2174
v1

ENVIRONMENTAL IMPACT STATEMENT

for the

Construction of a Bridge at Chiawa Crossing on the Kafue River

First Submission APRIL 2007
Revised Final Submission MAY 2009

Sheladia Associates Inc. USA

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ABBREVIATIONS

ADB	African Development Bank
AU	African Union
CBR	Californian Bearing Ratio
CG	Consultative Group
COMESA	Common Market of Eastern and Southern Africa
DRC	Democratic Republic of Congo
EC	European Commission
ECA	Economic Commission for Africa
ECZ	Environmental Council of Zambia
EDF	European Development Fund
EDRP	Emergency Drought Relief Programme
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management and Monitoring Plan
EMU	Environmental Management Unit Road Development Agency
EPPCA	Environmental Protection and Pollution Control Act
ESA	Estimated Standard Axles
FESATA	Federation of East and Southern African Transporters Association
GDP	Gross Domestic Product
GRZ	Government of the Republic of Zambia
GVM	Gross Vehicle Mass
HIPC	Heavily Indebted Poor Countries
HMS	Highway Management System
IMF	International Monetary Fund
m^2	Square Meter
m^3	Cubic Meter
MCT	Ministry of Communications and Transport
MCTI	Ministry of Commerce, Trade and Industry
MWS	Ministry of Works and Supply
NCC	National Council for Construction
NCS	National Conservation Strategy
NGO	Non-governmental Organisation
NHCC	National Heritage Conservation Commission
NRFA	National Road Fund Act
PMS	Pavement Management System
PRE	Provincial Road Engineer
PRSP	Poverty Reduction Strategy Programme
PSCAP	Public Sector Capacity Building Project
RDA	Road Development Agency
ROADSIP	Road Sector Investment Programme
SACU	Southern African Customs Union
SADC	South African Development Community
SATCC	Southern Africa Transport and Communications Commission
TAZARA	Tanzania Zambia Railways
VOC	Vehicle Operating Costs
WB	World Bank
WID	Women in Development
ZAWA	Zambia Wildlife Authority
ZESCO	Zambia Electricity Supply Corporation
ZRA	Zambia Revenue Authority

EXECUTIVE SUMMARY

Introduction

The Government of the Republic of Zambia has initiated techno-economic studies for detailed engineering design for the construction of the bridge at Kafue River crossing to Chiawa. As part of its efforts to achieve sustainable growth, the Government of the Republic of Zambia (GRZ) is putting great emphasis on the rehabilitation/ construction of the country's highway infrastructure, including bridges, in order to ensure accessibility to communities and services. Thus, it is desirous that a bridge should be erected over the Kafue River at the site of the present Chiawa Pontoon. It is hoped that this will alleviate the suffering of the rural people by ensuring quicker access for the transportation of agricultural inputs and produce and access to health, school, markets and other social amenities.

The Government of Zambia considers the construction of a bridge at Kafue River crossing as an important element of the communication and as a vital link in Zambia's internal road communication providing quicker access between the Chiawa region and Lusaka town. The construction of the bridge will bring sustainable development in the area, as new agricultural developments will be facilitated. There will be a reduction in travel time and operational costs of the vehicles and rural industries will open, thereby leading to an increase in employment opportunities.

GRZ considers that a bridge over the Kafue at Chiawa crossing is a priority link that would improve **access for tourism, agriculture and amenities**. The existing pontoon is in a poor condition, has limited capacity and working hours and acts as a **bottleneck** to the movement of people and goods. The pontoon plays a vital role in access to markets and to the Lower Zambezi National Park which has seen an increase in tourism activity in recent years.

General Characteristics of the Area

The Lower Zambezi area enjoys a tropical continental type of climate and the average annual rainfall is 800mm on the plateau and 400mm in the valley. The project is situated in the **Kafue catchment area**, which is a major contributor to the Zambezi catchment and the bridge site is close to the confluence with the Zambezi River and approximately 11km east of Chirundu, which is near the border with Zimbabwe.

Results of Surveys

A topographical survey of the approach roads and river sections was carried out and **permanent benchmarks** were erected. Geological information was collected and **trial pits** were dug on either side of the pontoon crossing. Samples from the pits were tested and analysed. Pontoon records were examined and a **traffic survey** was carried out. Institutional and Maintenance developments in recent years have been positive and three Acts have been enacted which outline the roles of the prime agencies in the road sector. A route location study was conducted and concluded that the **existing location** of the pontoon represented the most ideal route for the bridge for a number of reasons.

Hydrological Analysis

Various formulae were used to determine the catchment areas, rainfall intensity and likely river flows however it is apparent that the historical flood levels are due entirely to the backing up of water during the opening of the **gates in Kariba Dam**. Flood levels are therefore based on levels achieved during the opening of the dam gates. Catchwater drains, check walls and stone pitching will be required on the approaches to the bridge and we have recommended the use of grass embankments and gabion baskets to mitigate the **effects of scour and erosion**.

Foundation Analysis

Test pits were formed and standard penetration tests were carried out however **drilling of the river bed will be required** during the detailed design phase. From the results of the laboratory tests the alluvial soils are not suitable to found on, nor will they be appropriate in their present state, for use as

fill material to road approaches. Both abutments to the proposed bridge at the current pontoon crossing site shall necessarily be founded on piled foundations. No accurate information is available for pier founding solutions within the river bed, however it is likely that **piled foundations** will be required. The design of pile caps shall depend on the final founding solution, also taking into account the apparently constant high water level and likely movement of the river bed due to constant and strong river flows. Abutments will require **gabion protection** against bank erosion**.** Exploratory drilling, DCP/SPT testing, combined wherever possible with sample recovery will be required to establish the general stratigraphic level, engineering properties and profile of the river bed and the resulting depth of founding of the piled foundations in a likely combination of vertical and raked piles.

Proposed Bridge Construction and Dimensions
The basic bridge data and principal quantities are as follows:

Bridge span:	240 metres
Number of traffic lanes	2
Width of Bridge:	10 metres (comprising 7.3m width of carriageway, 2 x 1m (footpath) and 2 x 0.35 (upstand)
No. of piers:	**8**
Span between piers:	**25 metres**
No. of abutments:	**2**
Design speed:	**80km/hr**

Construction Quantities and Cost Estimates
Our estimate of the total cost of the works is **US$5,007,288** ie approximately five million US Dollars. This figure includes for improvements of 2km only of approach roads on each side of the bridge (approx US$287,600) and does not include the cost of **consultancy** (estimated at 10% for detailed design and supervision ie US$500,000). The cost of exploratory drilling and testing has been assumed to be a part of the detailed design.

The approximate breakdown of the principal quantities is as follows:

Preliminary and General Items	24%
Foundations, Piling and Substructures	26%
Steelwork	24%
Approach Roadworks	7%
Piers, Deckslab and Drainage	19%

Quantities for the foundations, piling and substructures may vary depending on the outcome of an exploration and drilling programme to be conducted at the specific detailed design stage for the foundations.

Methodology and Baseline Information
Baseline data was collected through field appraisal, discussion with relevant agencies and institutions in the concerned districts and consultation with local communities and individuals in the project area. The proposed design of the various components of the bridge project was studied and discussed with the members of the Project team. The results were compiled and analysed to enable the preparation of this report.

Scoping Exercise for the Preliminary Environmental Impacts Assessment
The Environmental Protection and Pollution Control Act provides for the protection of the environment through provisions on natural resource management as well as for pollution control under the powers of the Environment Council. Impacts from the bridge construction are likely to be from landscape, ecology, planning and policies, socio-economy, traffic and transport, archaeology and cultural heritage, hydrology and water quality, air quality, noise and dust.

The construction of the bridge will present challenges in terms of maintaining environmental quality. For example, construction of the bridge will involve the digging of borrow pits, there will be changes in the landscape from construction wastes, river siltation, etc. These impacts pose challenges to the environment at and around the site.

Potential Impacts and Mitigating Measures
The major negative environmental impacts have been indentified as follows:

Biophysical Impacts:
- Increased air pollution from vehicle emissions (Hydrocarborns, carborn dioxide, carbon monoxide) due to increased traffic.
- Increased noise nuisance both during construction and operation phases
- Damage from construction activities including digging of borrow pits and development of the camping site for construction workers. This damage can be mitigated by proper planning and restoration measures..
- Disfigurement to the landscape from construction wastes and burrow pits
- River siltation from eroded soil and silt from incresed run-off due to disturbance of sub-soil structure
- Oil and gasoline spills from construction equipment and plant maintenance activities
- Littering domestic refuse and sewarage waste from construction camps
- Increased particulate matter (diesel) and dust.

Socio-economic Impacts:
- Increased access to cheaper goods from neighboring countries
- General improvement in local livelihoods due to synergistic impacts of positive effects of the project, such as increased commercial traffice to and from Lusaka
- Increase in revenue to local authorities and institutions from communications, land rates, licences and personal levy
- Changed human settlement patterns due to increased population who may be attracted to the area
- Creation of employement opportunities during the construction phase
- Increased trade opportunities in the community due to increased population
- Faster movements of people and goods on the new bridge

Environmental Management and Monitoring Plan
An Environmental Management and Monitoring Plan covering the design, tendering, construction and operational phases has been elaborated. The plan comprises elements to be incorporated in the detailed design of the project and also in the Tender Documents. The responsibilities of the EMU, the Contractor and of the various public authorities are clearly defined.

The broad objective of an **Environmental Management Plan** will be to ensure that the various environmental protection measures identified during the planning phase are implemented during the construction phase, so that environmental degradation and pollution resulting from construction activities is minimised.

The aim of a **monitoring plan** is to provide a cost-effective approach to monitoring the contractor's environmental performance. Baseline data must be collected during the EIA to provide a basis for future monitoring. The monitoring requirements will be identified in the Mitigation plan.

Environmental monitoring and enforcement are stated along with the output from such monitoring activities. Monitoring responsibilities are specified for the responsible authorities, EMU and the Contractor.

Conclusions and Recommendations

The findings from the study indicate that the socio-economic benefits of the new bridge to the communities in the project area of influence outweigh the "no-development" scenario. The project is therefore being recommended for implementation provided that the recommended mitigating measures with the implementation of the Impact Mitigation Plan and Environmental Monitoring Plan are undertaken.

1. INTRODUCTION

1.1. Project Background

The Government of the Republic of Zambia (GRZ) has initiated the detailed engineering design for the construction of the bridge at Kafue River crossing to Chiawa. As part of its efforts to achieve sustainable growth, the GRZ is putting emphasis on the rehabilitation/ construction of the country's highway infrastructure, including bridges, in order to ensure accessibility to communities and services. Thus, it is desirous that a bridge should be erected over the Kafue River at the site of the present Chiawa Pontoon. It is hoped that this will alleviate the suffering of the rural people by ensuring easier and faster access for transportation of agricultural inputs and produce and access to health, school, markets and other social amenities.

The Government of Zambia considers the construction of a bridge at Kafue River crossing as a vital link in Zambia's internal road communication providing quicker access between the Chiawa region and Lusaka town. The construction of the bridge will bring development in the area, as new agricultural developments will be facilitated. There will be a reduction in travel time and operational costs of the vehicles and rural industries will open, thereby leading to an increase in employment opportunities.

The Project comprises the replacement by reinforcement concrete or composite steel bridge of the Chiawa pontoon, operated by RDA, situated on the D482 road on Kafue River. This pontoon provides a short and vital link between the Chiawa region and Lusaka town. In addition, vital commercial and industrial transport depends on this pontoon. The pontoon loading capacity is 20 tonnes and the average daily traffic (ADT) is in the ranges of 50-100 vehicles per day. The width of the river crossing is 250 metres and the site is located in fairly rolling terrain.

ASCO (Z) Ltd was awarded the contract to carry out this consultancy on 2nd February 2005. The title of the consulting services is "Feasibility Study and Preliminary Engineering Designs for Construction of a Bridge at Chiawa Crossing on the Kafue River". It is a 6-month consultancy that includes a document review, site surveys and soil investigation, traffic survey, bridge reconnaissance, preliminary engineering analysis, cost estimates, economic evaluation and preliminary environmental impact assessment. Comments from the RDA were received on the draft in August 2005 and this document represents the final study report.

1.2. Contact Details

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Lusaka

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1.3. Transport Infrastructure

Zambia's population of approximately 10.28 million and territory of 750,000km^2 is served by a transport infrastructure consisting of a road network of approximately 37,000 km of gazetted roads and 30,671 km of un-gazetted roads classified under feeder, national parks and estate roads. Under the Transport Policy Document of 2002, the Road Development Agency (RDA) is responsible for construction and maintenance for all roads throughout Zambia. There is a rail network of approximately 1,655 km (exclusive of the inter-mine rail network in the Copperbelt), four

international airports (Lusaka, Ndola, Mfuwe and Livingstone), several airstrips and one inland port (Mpulungu).

1.4. Objectives and Scope of the EIA

To determine the environmental implications of the bridge construction at Chiawa, an Environmental Impact Assessment (EIA) must be undertaken in accord with the Environmental Protection and Pollution Control Act (Environmental Impact Assessment) Regulations of 1997. Under the 1997 Regulations, the main objectives of an EIA are to examine impacts on ecological units and ecological processes of the project area including impacts on physical, biological, socio-economic and cultural environment and to provide mitigation measures for identified impacts.

The Ministry of Works and Supply through RDA has engaged consultants to carry *Detailed Engineering Designs and Preparation of Tender Documents for Construction of a Bridge at Chiawa Crossing on the Kafue River*, which also incorporates an environmental impact assessment. The EIA is to assess the impacts from bridge construction and evaluate the alternative. The existing Chiawa pontoon is considered as the status quo, or the "No option alternative", in case construction of a new bridge does not take place.

The scope of the EIA study is outlined in the Scoping Report and Terms of Reference (January 2006) as reviewed, commented and approved by the Environmental Council of Zambia. The output from the EIA is includes this Environmental Impact Statement (EIS) and Environmental Management and Monitoring Plan (EMP).

1.5. Study Approach and Methodology

The EIA process involved the following steps:

Review of the existing environmental information and legislation
This included review of the Environmental Protection and Pollution Control Act and its subsidiary legislation and other relevant Acts and international conventions.

Initial environmental survey along the proposed road corridor
This task involved collecting data along the project areas and identifying areas requiring detailed investigations, which include sensitive areas.

Scoping
The scoping exercise included consultative meetings and discussions with relevant government institutions at national, provincial and district level, local communities, Headmen, representatives from NGO's and community based organisations and residents from communities along the project area. Letters stating the objectives of the project and requesting local participation and consultation in the process were also distributed. Responses from the consultations and discussions provided the relevant background information and helped identify major environmental concerns of the communities along the road for the detailed EIA process.

Identification of the magnitude and significance of the principal impacts
Impacts were evaluated in terms of magnitude and significance. There are four groupings of impacts on the environment that have been evaluated for the duration of the project namely:
Physical environment
Biological environment
Socio-economic environment
Cultural environment

These impacts may be positive (beneficial) or negative (adverse) and have been classified as low, moderate or high to the extent their effects can be described quantitatively in terms of environmental costs and benefits. Effects may be direct or indirect, short term, intermediate or long term.

The impacts were assessed for each stage of the project:

- Pre-Construction (Design) Phase
- Construction Phase
- Operational Phase

It is important that the likely impacts are defined and evaluated at an early stage of the planning process. This was done through scoping the specific impacts and their implications which are pertinent to the project so that alternatives can then be investigated and changes can be incorporated at the design stage. Other measures have also been identified which can be taken into account during design and construction phases that would enhance the environmental quality of the project.

Identification of appropriate mitigation measures and/or design changes to eliminate or reduce the identified impacts

Mitigation measures have been considered to reduce the effect of the development on the surrounding environment. Wherever possible recommendations will be made to mitigate against impacts on the physical, biological, socio-economic environment and cultural environment.

Formulation of an environmental management and monitoring plan

This report includes a plan for monitoring and implementation of mitigation measures during construction and operation. Mitigation plans should be included in the **tender document** to form part of the overall construction contract.

1.6. Environmental Impact Assessment Team

The Environmental Impact Assessment team is comprised of:

Will KNOWLAND	Senior Associate & EIA Co-ordinator
Jacob CHISHIBA	Environmental Management Specialist
Gillan SIMFUKWE	Process and Waste Management Specialist
Lewis TUMBAMA	Socio-economist
Belon KUNDA	Natural Resources Specialist
Mwimba NKOSHA	Research Assistant

2. POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

2.1. Environmental Policy Framework and Strategy

2.1.1 National Conservation Strategy

The National Conservation Strategy (NCS) is the forerunner to environmental legislation in Zambia. The NCS was adopted by the Government of Zambia in 1985 and led to the enactment of the Environmental Protection and Pollution Control Act in 1990 and provided for the establishment of the Environmental Council of Zambia (ECZ) which became operational in 1991. The NCS provided guidance for the sustainable development of Zambia through the use and conservation of natural resources within a centrally planned and controlled economy. However in 1992, the National Environmental Action Plan (NEAP) process was established to update the NCS, to meet the demands of an economy undergoing liberalisation and to update technical information.

2.1.2 National Environmental Action Plan (NEAP)

The National Environmental Action Plan (NEAP) was published in 1992. By the year 1999, at the turn of the century, Zambia was signatory to at least 22 International Instruments concerned with environmental protection, and some 33 Acts of Parliament concerning Legislation and Regulations on environmental protection and management of natural resources.

2.2. Environmental Legislative Framework

2.2.1 Environmental Protection and Pollution Control Act, Chapter 204

The Environmental Protection and Pollution Control Act (EPPCA), Cap 204, Part IV to VII sets the role of ECZ in setting environmental quality standards for waste, water, air, pesticides and toxic substances, noise, ionising radiation and natural resources conservation. In 1997 an amendment to the EPPCA established the Environmental Impact Assessment Regulations, Statutory Instrument No. 28 of 1997 for conducting and review of Environmental Impact Assessment of certain projects such as this one on road rehabilitation.

The Environmental Council of Zambia being a Statutory body is mandated to enforce the provisions of the EPPCA on natural resource management and pollution control for the protection of the environment.

2.2.2. EIA Legislative Requirements

This Environmental Impact Statement was prepared in accordance with the legal framework on Environmental Management enshrined in the Environmental Protection and Pollution Control Act, Cap 204 of the Laws of Zambia and its subsidiary legislation, the Environmental Impact Assessment Regulations S.I. No. 28 of 1997.

Specifically, Section 3(1) of the EIA Regulations states that, “a developer shall not implement a project for which a project brief or environmental impact statement is required under these Regulations, unless the project brief or the environmental impact statement has been concluded in accordance with these regulations and the Environmental Council of Zambia has issued a decision letter.”

The contents of an Environmental Impact Statement are to include the following elements:

- A description of the project;
- A description of the site;

- A description of the raw material inputs, technology, processes, products and by-products;
- A description of the site surrounding environment;
- A description of the environmental effects;
- A description of the socio-economic impacts;
- Impact Management Plan

The proposed project is outlined under the Environmental Impact Assessment Regulations S.I. No. 28 of 1997, Second Schedule (Regulations (7)(2)) Section 2(a) under the heading Transportation: Therefore the EIA process was conducted in line with the provisions of these EIA Regulations.

2.3. Road Sector Policy and Institutional Framework

The National Road Fund Act No 13 of 2002 defines the functions of the National Road Fund Agency, thereby dissolving and replacing the National Roads Board.

One of the activities of NRB in 2002 was to set up a National Task force to prepare the fifth draft of the bankable document for the Road Sector Investment Programme, (ROADSIP II). This document outlines the status and proposes interventions in the following areas:

- Trunk, Main and District Roads
- Feeder Roads
- Tourist Roads
- Urban Roads
- Community Roads
- Pontoons and Bridges
- Rural Travel and Transport

ROADSIP was designed as a 10-year programme (1998-2007) with an original estimated budget of US$860 million. The principal objectives of the programme include:

- Improvement in the condition of a core network of roads
- Strengthening of the management of the road sector
- Creating employment opportunities
- Improving road safety
- Improving environmental management
- Improving rural transport services
- Improving community roads

The original planning horizons have now entered ROADSIP II, which has a planning horizon to 2012.

The RDA, Local Authorities, Zambia Wildlife Authority and Ministry of Agriculture and Co-operatives are designated Highway authorities. Institutions with direct responsibilities for road management are:

- The RDA in the Ministry of Works and Supply is responsible for management of inter-territorial main roads (T-roads), territorial main roads (M-Roads) and District Roads with prefix D (D-roads).

- The Local Authorities under the auspices of the Ministry of Local Government and Housing are in charge of management of district roads with prefix RD (RD-roads), rural roads (R-roads) and Branch roads B-roads).

- Zambia Wildlife Authority under the auspices of the Ministry of Tourism, Environment and Natural Resources is responsible for management of roads situated within the boundaries of National Parks and Tourist areas as per section 41 and 42 of the National Parks and Wildlife Act of 1991, as well as management of certain Branch roads (B-roads) and Estate roads (E-roads).

- The Ministry of Agriculture and Co-operatives takes care of a limited network of roads leading to mainly agricultural camps, Farmers Training Institutes.

- The Ministry of Finance and National Planning is responsible for among other things budgeting and planning.

2.4. Road Sector Legislative Framework

Important institutional changes have taken place in response to the recent passing of three Parliamentary Acts, of which the Public Roads Act, 2002, and the National Road Fund Act, 2002, is of direct relevance to road maintenance.

2.4.1 Public Road Act No. 12 0f 2002

The Public Road Act No. 12 of 2002 established the Road Development Agency (RDA) to plan, manage and co-ordinate the road network in the country. The RDA assumed the responsibilities of the Roads Department in respect of primary roads, and those of the Department of Infrastructure and Support Services in respect of urban and feeder roads. Besides organising maintenance of the existing network, and planning for its future development, it has full responsibility for axle load control, including the power to stop all vehicles with a gross load exceeding 6.5 tonnes at the designated weighbridge stations.

The RDA is directed by a board of 15 part-time members, including the Director of the Road Transport and Safety Agency, the Director of the National Road Fund Agency (both ex-officio and without voting rights), and 13 other voting members appointed by the Minister, of whom seven represent interested government ministries and a further five represent non-governmental stakeholders in the road network. The board shall appoint a Director as Chief Executive Officer, who shall also act as Secretary to the Agency. It shall also report as determined by the Minister to the Committee of Ministers on Road Maintenance Initiative.

2.4.2 Road Traffic Act No. 11 of 2002

The Road Traffic Act No. 11 of 2002 established and defined the functions of the Road Transport and Safety Agency to replace the National Roads Safety Council. The new act repealed the National Roads Safety Council Act and parts V to XIV, First Schedule, Second Schedule and Third Schedule of the Roads and Road Traffic Act.

2.4.3 National Road Fund Act No. 13 of 2002

The National Road Fund Act No. 13 of 2002 established a National Road Fund Agency (NRFA), whose primary functions include management of the Road Fund; the making of recommendations to the Minister on the fuel levy and other road user charges; the allocation of resources for construction, maintenance and rehabilitation of roads; and the allocation of resources for traffic and road safety management. NRFA has in principle assumed the previous responsibilities of the National Roads Board.

2.5. Other Acts Reviewed Relevant to the Road Rehabilitation Project

The Acts below have also been reviewed in order to ensure that the project complies with other relevant existing laws that have a bearing on environmental management.

2.5.1 National Parks and Wildlife Act, Chapter 201

The National Parks and Wildlife Act provides for the establishment, control and management of National Parks and Game Management Areas. Under this Act is a schedule of Protected animal species.

2.5.2 Town and Country Planning Act, Chapter 283

The Town and Country Planning Act, came into force in 1962 and provides for the control, use and change of land use zones and reservations for various purposes, eg. siting of work sites. It also provides for the compensation of those affected by planning decisions and regulated development subdivisions.

The bridge construction project will be undertaken in accordance with the approved land use plans as provided for under the Town and Country Planning Act.

2.5.3 Forest Act, Chapter 199

The Forest Act, passed in 1974, provides for the establishment and management of National and Local forests, conservation and protection of forest and trees, and licensing and sale of forest products. The Act prohibits the felling, collecting or injuring of forest products in protected forest areas or forest reserves, unless a license has been obtained to do so. It also prohibits excavation, construction, and operation of machinery within the forest reserves or protected areas.

Forest reserves currently cover approximately 10% of the country and are intended for the conservation and development of forest resources, as well as providing protection to watersheds.

The Act also provides for the protection of 6 tree species nationally whether in a protected area or outside it. These are as follows:

Entandrophragma caudatum	Mountain Mahogany
Khaya nyasica	Red Mahogany
Pterocarpus angolensis	African Teak
Afzelia quanzensis	Pod Mahogany
Faurea saligna	Beechwood
Baikiaea plurijuga	Teak

During biological/ecological investigations protected tree species have been found in the project area along the approach road corridor. During civil works, these species will be addressed in accordance with the measures outlined in the management plan in this report.

2.5.4 Water Act, Chapter 198

The Water Act provides for the control, ownership and use of public and private water excluding that of Zambezi, Luapula and Luangwa Rivers which border with other countries. Public water use is controlled by the Water Board through the allocation of water rights which are granted following investigation, advertisement and, where necessary, permission from the chief.

The Act also establishes the pollution of public water as an offence, although the Water Pollution Control Regulations are established by the EPPCA.

The project will comply with the provisions of the Act by ensuring that storm water disposal structures intended to control runoffs from the road into the aquatic environment (both surface and groundwater) are part of the overall detailed designs for bridge construction.

2.5.5 National Heritage Conservation Commission Act

The National Heritage and Conservation Act established the National Heritage Conservation Commission (NHCC), which is responsible for the conservation of ancient, cultural and natural heritage, relics and objects of aesthetic, historical, prehistoric, archaeological or scientific interest by preservation, restoration, rehabilitation, reconstruction, adaptive use and good management. The Commission also provides regulations for archaeological excavation and export of relics.

If a development is unable to proceed without affecting an item of heritage, permission must be sought from the NHCC as outlined in Sections 35 and 36 of the National Heritage Conservation Commission Act.

During the engineering surveys and detailed EIA investigations items of heritage have been found in some areas but their location is far away from the project site thus the impact is considered insignificant.

2.5.6 The Land Act of 1995

The Land Act of 1995 was enacted to quarantee peoples' right to land while enhancing development. The Act recognises the holding of land under customary tenure and the Chief's role has been legally recognised, such that land cannot be converted or alienated without approval of the chief.

The developer worked closely with the local community and has obtained consent from Chiefs, Headmen, Area Councillors and local authorities of Chiawa and Chirundu Communities during the EIA process and will continue to do so during final bridge construction works.

2.5.7 The Lands Acquisition Act No. 2 of 1970

Land acquisition is governed by the Lands Acquisition Act No. 2 of 1970. The Act sets out regulations for compulsory acquisition of land and property and compensation for such acquisition. The president (his designated and authorized person) may acquire any property in the interest of the Republic. Notice shall be given in person not less than two months in advance and shall be gazetted. Compensation for acquired property, losses and damages shall be paid as may be agreed or, finally determined by the National Assembly in case agreement on compensation is not reached within six weeks after publication in the Gazette. Any disputes except for disputes related to the amount of compensation may be instituted for court proceedings. The Act also provides for compensation to be granted by allocation of new land to the property owner.

The Act instituted a Compensation Advisory Board to advise the Minister of Lands in assessment of compensation payable under the Act. The functions of the Board have been delegated to various committees. Various forms to be used in proceedings of property acquisition are prescribed in the statutory Instrument No. 60 of 1970.

The developer will confine the construction works to the site and within the road reserve area i.e. 30m from the centre of the road to either side of the road to minimise impacts in the immediate environment.

2.5.8 Mines and Minerals Act, Chapter 32

The Mines and Minerals Act Cap 32 of 1976 regulates activities relating to mines and minerals operations including quarrying and provides for regulations for environmental protection during prospecting and mining activities and rehabilitation of the areas mined.

Further, the Ministry of Transport and Communications, Environmental guidelines Section 7.6 (2) states that:

"Contractors shall obtain licenses from the Ministry of Mines to operate borrow areas" and 7.10 (6) states that "Contractors shall obtain mining licenses for quarrying".

In this project quarrying for gravel material will be carried out and rehabilitation of the quarries created in the process will be carried out based on the mitigation measures outlined in this document and in the subsequent Environmental Project Brief for a new borrow pit.

2.5.9 Roads and Traffic Control Act, Chapter 464

The Roads and Traffic Control Act, provides for the control of traffic, and for the regulation of storm water disposal structures.

In this bridge project, requirements for storm water disposal structures along the access road as provided for under this Act are part of the overall designs for road rehabilitation.

2.5.10 Local Government Act, Chapter 281

The Local Government Act allows the Council to implement environmental protection and natural resources management functions which include prevention of pollution of water supplies and undertaking of mining operations.

For instance, the Act would support the location and restorations of borrow pit sites, subject to approval by the relevant Government Departments and Local Communities in the areas in which they are located.

Location and siting of camps and borrow pits will be undertaken with consultations and consent from the local community and approval from relevant Government Departments. In the case of opening a new borrow pit this will require approval from the Environmental Council of Zambia by way of undertaking an Environmental Project Brief.

2.5.11 Public Health Act, Chapter 295

The Public Health Act empowers a Council to prevent diseases and pollution dangerous to human health and to any water supply for domestic use.

The project will ensure that measures to prevent diseases and pollution dangerous to human health and to any water supply are taken into account through the provision of a road drainage control system.

2.5.12 Factories Act, Chapter 441

The Factories Act provides a framework for the setting of regulations to ensure the safety, health and welfare of persons employed on construction work sites and in factories. The Act is applicable during bridge construction and road rehabilitation works.

The project will ensure that the safety, health and welfare measures and facilities of workers during bridge construction and road rehabilitationworks will be in accordance with the provisions of the Factories Act.

2.5.13 Petroleum Act, Chapter 439

The areas of the Petroleum Act of relevance to this project are regulations for the conveyance and storage of petroleum, inflammable oil and liquids e. g. paraffin.

Where petroleum products shall be transported to or stored on site this shall be done in compliance with the provisions of the Petroleum Act.

2.5.14 Energy Regulation Act, Chapter 436

This Act allows for the establishment of procedures for the transportation, handling and storage of fuels to minimize negative environmental impacts.

Where fuels shall be transported to, handled or stored on site this shall be done in compliance with the provisions of the Energy Regulation Act.

2.6. International and Regional Conventions

Zambia is a signatory to a number of international and regional conventions, the ones which are related to the environment and applicable to the project are:

- Convention on Wetlands of International Importance especially as a Waterfowl Habitat
- Convention on the Protection of World Cultural and Natural Heritage
- Convention on International Trade in Endangered Species of Wild Flora and Fauna
- United Nations Framework Convention on Climate Change
- Convention on Biological Diversity
- United Nations Convention to Combat Desertification

The project site will be managed as proposed in this Environmental Management Plan.

2.7. World Bank Safeguards

Funds for the Chiawa Bridge Project are being provided by the Roads II Project Loan, through the International Development Association (IDA), of the World Bank. World Bank lending is guided by a set of Operational Policies that have been developed to assure that potentially adverse environmental and social consequences are identified, minimized, and mitigated. These are known as the "Safeguard Policies." The Bank Safeguards have been applied, collectively, since 1999 to all projects and must be addressed, wherever relevant, during the project preparation and approval process.

Since 1991, Environmental Assessment (EA) has been a required component in design of all projects proposed for Bank financing. The Bank uses EA to ensure that projects will be environmentally and socially sound and sustainable; to inform decision makers of the nature of environmental and social risks associated with the project; to increase participation of stakeholders, including potentially affected persons and communities; and to increase transparency of project decisions.

Table 1 World Bank Safeguards – Operational Policies and Bank Procedures

Environmental Assessment (OP/BP 4.01)
Natural Habitats (OP/BP 4.04)
Pest Management (OP 4.09)
Cultural Property (OP 4.11)
Involuntary Resettlement (OP/BP 4.12)
Indigenous Peoples (OP 4.20)
Forestry (OP 4.36)
Safety of Dams (OP/BP 4.37)
Projects in International Waterways (OP/BP 7.50)
Projects in Disputed Areas (OP/BP 7.60)
Disclosure of Operational Information (BP 17.50)
OP = Operational Policy; BP = Bank Procedure

The breadth, depth, and type of analysis depend on the nature, scale, and potential environmental impact of the project. Early on in a project's design, Bank staff make a preliminary determination as to which of several assessment categories should be applied. The principal category designations are A and B.

Category A Projects are likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. EA for a Category A project examines the project's potential negative and positive environmental impacts, compares them with those of feasible alternatives (including the "without project" situation), and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. The borrower is responsible for preparing a report, normally an EIA (or a suitably comprehensive regional or sectoral EA) that includes an Environmental Management Plan (EMP).

Category B Projects are likely to have fewer and less extensive adverse environmental impacts on human populations or environmentally important areas, including wetlands, forests, grasslands, and other natural habitats, than are projects under Category A. These impacts are generally site specific; few if any of them are irreversible; and in most cases mitigatory measures can be designed more readily than for Category A projects. The scope for EA of Category B projects varies from project to project, but it is generally narrower than that of Category A projects. Like Category A, it examines the project's potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance.

The Roads II Loan Agreement underwent a full EIA, which was reviewed and approved by the World Bank, and is publicly available. This current EIA for the Chiawa Bridge Project finds no indication that the activity will pose any additional impacts beyond those already anticipated for the overall Roads II project. In fact, if the Chiawa Bridge Project was a stand-alone project, under World Bank criteria it would appear to qualify as a Category B project.

3. PROJECT DESCRIPTION AND ITS ACTIVITIES

3.1. Nature and Purpose of Project

The Government of the Republic of Zambia (GRZ), as part of the Second Phase of its Second Road Sector Investment Programme (ROADSIP, Phase II) is implementing the Essential Bridge Rehabilitation Project (EBRP). One component of the EBRP is construction of a new bridge over the Kafue River at Chiawa, where a pontoon ferry is currently operating. A feasibility study showed reasonable economic justification for the proposed works, and the detailed design study – of which this environmental assessment is a part -- was undertaken in 2006.

The site is located 11 km from Chirundu on D482, the Chiawa Road. Refer to Figure 2 on the Map below for the project site location. This road provides the main linkage between the Lower Zambezi and Lusaka provinces and supports tourism and agricultural transport locally and between the two provinces.

Figure 1: The Project Site, with Existing Ferry in Operation

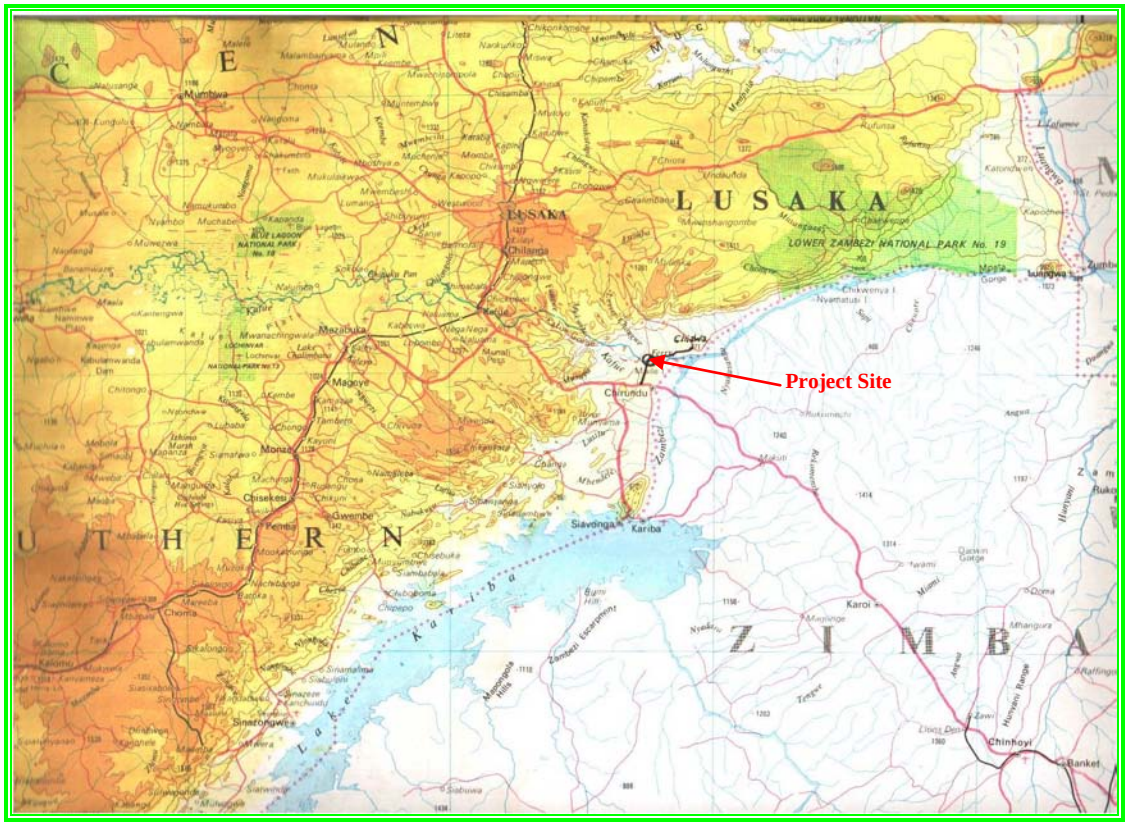
3.1.1 The Existing Chiawa Ferry

In 2006, a new diesel powered engine pontoon boat was put into operation. But the ferry can operate only during daylight, so movement of traffic is restricted to 12 hours per day.

The economy of the area is mainly agricultural and the ferry provides access to markets for farm produce. Also, the Lower Zambezi National Park is only 40 km away, and there is an active and growing tourist market that makes continued use of the crossing. There are several tourist lodges located along the banks of the Zambezi, mostly in the Game Management Area located in Chiawa.

The existing ferry is also used both for traveling to and from the region's towns and to access schools and hospitals that are located on the Chirundu side of the river.[1] In the morning and evening, the pontoon is heavily used by children and parents accessing both of these.

Figure 2: Map Showing Project Site Location



3.1.2 The Proposed Chiawa Bridge

The bridge, which would be dual carriage, with pedestrian walkway, would span 240m across the Kafue River. Refer to Figure 3 which shows the diagram/engineering drawing of the bridge.

The deck structure for the bridge and approach viaducts would be supported on reinforced concrete piers. Foundations for the river piers would be concrete spread footings or large diameter piles and pile caps.

Table 2: Bridge Data

Bridge Span:	240m
Number of traffic lanes:	2
Width of Bridge:	10 m ▪ 7.3m width of carriageway ▪ 2 footpaths of 1m (footpath) ▪ upstands of 0.35m
No. of Piers:	8
Span between piers:	25m
No. of Abutments:	2
Design speed:	80km/h

[1] Material for this section is excerpted from the Feasibility Study.

During the feasibility study, selection of the route took into consideration technical, economical matters and environmental aspects. These included:

- Effects of environmental aspects including social environmental aspects.
- Technical aspects of bridge design, construction method and project cost.
- Natural conditions in the study area
- Relationship with the future development plans of the region
- Existing facilities conditions, and
- Economic aspects.

Further guiding the feasibility study were several guidelines for route selection:

- To preserve the natural environment including social environmental aspects as much as possible.
- To avoid passing through the existing and future community area as much as possible.
- To utilise existing public and private housing or facilities as much as possible.
- To keep compatibility with the future development plans for housing and tourism.

The present location of the pontoon is believed to be the best location for the bridge for the following reasons:

- There will be little or no change in the road alignment necessary.
- It is situated in a straight section of the river and will be perpendicular to the river flow. This situation is preferred when it comes to the use of gabions for river training and erosion control.
- It is on a section of river with well-defined banks and is beyond the disturbing influence of tributaries. This will minimize risks of flooding.
- It also represents the shortest and most economical span available. The necessary land is already owned by the Ministry of Lands and there will be no relocation or land appropriation required. We do not foresee any adverse impact on adjoining land or buildings.
- During construction, the ferry can be moved temporarily to its previous operating site, which is approximately 200m downstream of the current crossing.

3.2. Analysis of Alternative Approaches

Taking the effect of road project on the environment other alternatives were taken into consideration. The purpose was to assess the effects of these alternatives on the environment against expected benefits. The alternatives considered are:

- No-action alternatives
- Construction alternative
- Site Alternatives

3.2.1 No-Action Alternative

"No-Action" for this project would mean keeping the status quo, i.e. leaving the pontoon ferry service as the means to provide a river crossing.

This would mean that crossing would remain a bottleneck for economic and social development of the Southern Province, constraining the development of agricultural production and job opportunities. As already described, the current ferry service only operates during the 12 hours of daylight, and its limited capacity, cost, and time delays all inhibit the growth of trade and commerce in the region.

The status quo is clearly unsatisfactory. Other problems with the current ferry situation are:

- insufficient parking area;
- poor accommodations for the ferry crew staff; and
- the deteriorating condition of the existing approach roads, which are dirt-and gravel surfaced. They are often impassable for saloon cars, and are increasingly difficult for heavily loaded trailer trucks to navigate. These heavy trucks in turn tear up the road surface badly. A comprehensive resurfacing of the roads is required.

The No-action alternative is not recommended.

3.2.2 Construction Alternative

This alternative is to complete construction of the bridge across the Kafue River as planned.

The site at Chiawa is the appropriate location for such a bridge crossing. The existing roads lead directly to it, and the route avoids communities, private holdings, or any protected areas. The ferry crossing itself is at a narrow, straight, and calm section of the river, with suitable soil and surface conditions for a bridge.

Negative impacts on the environment would occur mainly during the construction phase, and will not be major or lasting.

The social and economic benefits of the Construction Alternative are significant, and disadvantages in terms of environmental and social impact are modest. Thus, the Construction Alternative is recommended.

3.2.3 Site Alternative

Two alignments were investigated in the study on the current pontoon operation and another one of about 250m downstream of the current pontoon operation/selected bridge location. The studies found that the downstream location was less favourable from an environmental standpoint for the following reasons:

- It would require no reduction in bridge length
- It would need to open up active new approach road alignments on land currently occupied by private parties on both banks of the river.

Further, findings from the boring investigations carried out on the downstream site showed that the foundation condition was less favourable than on the selected alignment., thus the choice to select the current pontoon operation site.

3.3. Construction Activities

The proposed project may usefully be divided into phases: pre-construction (design), construction and operational. The principal impacts will occur during the construction phase. Construction is expected to take approximately $2^1/_2$ years. A start date for construction has been assumed for 2007.

Construction will involve civil works including the following types of activities:

- Excavation and drilling of the foundations and piles to the abutments and the pier.

- Piled foundations for other piers and abutments would be constructed using conventional augur-boring plant with spoil removed by augur, bucket or grab.

- Reinforced concrete pile caps would be constructed by excavating around the piles supported by sheet piles where necessary. The piles would then be broken down to final size prior to construction of the reinforced concrete pile cap. The works would be dewatered as necessary.

- The construction methodology for the bridge deck would either involve construction insitu or off-site and transported by road.

- Clearing and grubbing the re/aligned sections of the approach roads on both banks of the Kafue River.

- Grading and leveling the approach roads with selected fill.

- Provision of traffic signs and other traffic safety measures.

Other activities related to construction that are considered in this environmental assessment are:

a) Land Requirements

During construction, land would be required to accommodate the construction camp, haul routes and access routes from the road network and to provide working areas around the actual works.

b) Construction Workers Camp

There are likely to be 200-300 workers at any one time. Although some workers will be drawn from local communities, others will be from out of the immediate region. They will need their own temporary quarters, or camp, (about 5 houses, Dormitory units for 50 and 6 sanitary structures) which will bring requirements for water, food, and sanitation, including proper disposal of wastes. The influx of workers, and the wages they will earn, bring potential likelihood of spread of HIV and other communicable diseases. These must be anticipated and provided for.

c) Quarries and Gravel Sites

The gravel sites expected to be used has inspected; they are located off the road to Chiawa going to Zambezi Farm Training Centre. These pits have been used previously and so are considered to be partially exploited and already disturbed. Most of this area appears to be situated on state land. No places for disposal of spoil and construction waste have yet been identified.

d) Drainage

The timing and extent of drainage works would be a function of the construction programme for earthworks and bridge/roadworks.

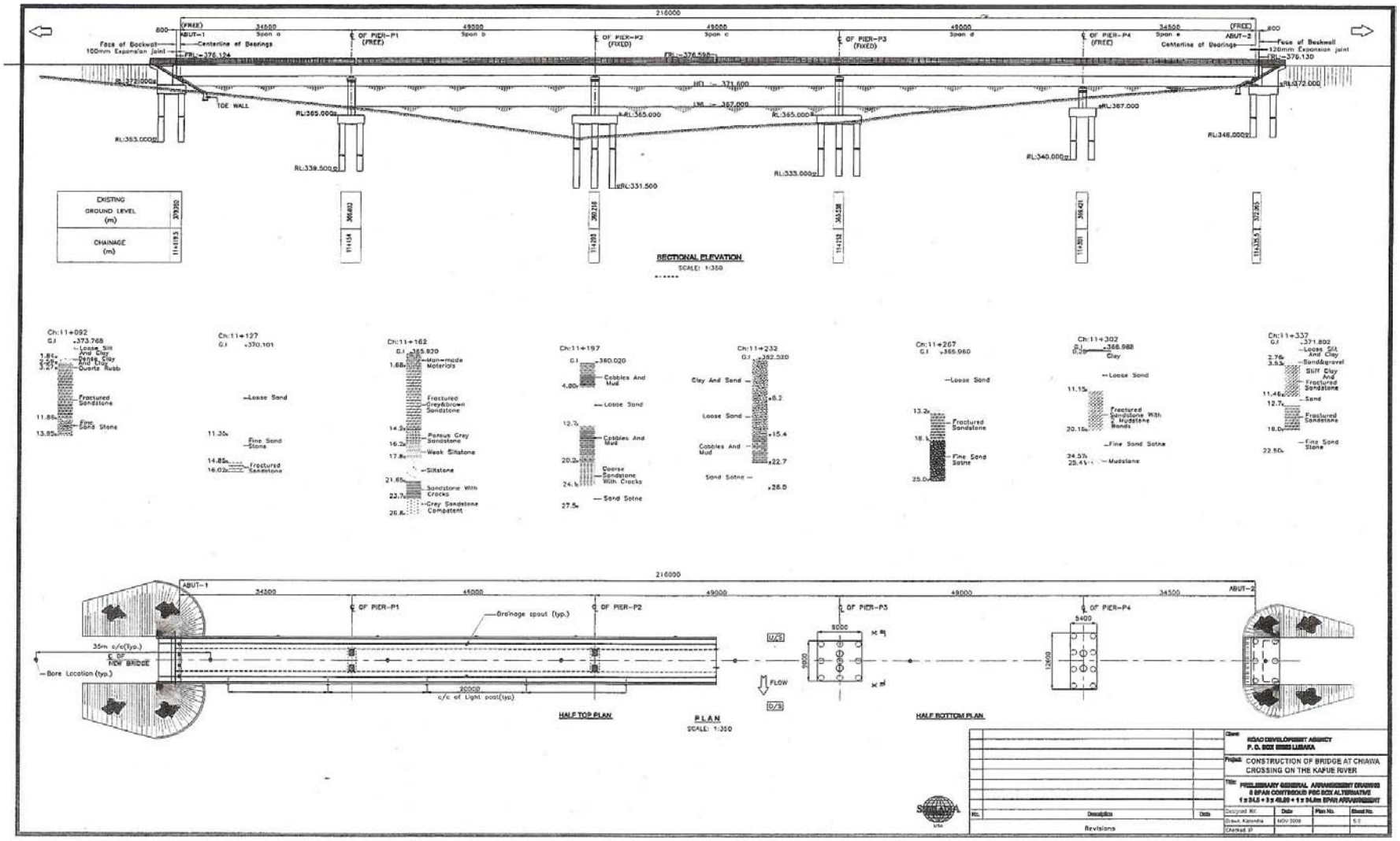
e) Temporary Road Diversion

Bridge construction at Kafue River would require diversion of the present approach road to the temporary ferry location, about 200 m downstream. There will be no relocation of settlements.

f) **Material Handling and Disposal**

Appropriate measures would be adopted for the handling and disposal of contaminated material to meet legal requirements. Storage of hazardous materials on site and disposal will be done in accordance with the Environmental Council of Zambia Regulations on hazardous wastes.

Figure 3: Diagram/Engineering Drawing of the Bridge



4. PHYSICAL ENVIRONMENT OF PROJECT SITE AND ITS SURROUNDINGS

4.1. Soils and Geology

The geology of the Lower Zambezi area comprises a varied suite of rocks of various origins and ages. The youngest rocks are of colluvial materials found in the valley floor. Close to the valley floor are red sandstone, basalt and sandstone all belonging to the Karroo system. A variety of rocks, such as biotite schists, quartzite, meta-quartite, granite gneisses calci-silicate and carbon rocks, distributed widely in the region, were produced by ancient volcanic activities and metamorphism in the region (Barr, 1971).

In the Musensenshi valley are found some isolated intrusive rocks as biotite granite, gabbro, tractolite and derived ampibolite. The varying collection of rocks formed by volcanic intrusions and metamorphism mostly during the pre-Cambrian period give the mineral wealth characteristic of Lower Zambezi region. Gold was once mined in the Chakwenga valley while a number of other gemstones such as garnet, aquamarine and tourmaline are believed to exist in the Chakwenga and Musensenshi river valleys. Both of these river valleys are situated in Lusaka Province east of Chirundu.

Soil and geological information was obtained from the Department of Geological Survey entitled 'The Geology of the Leopards Hill Area – Explanation of Degree Sheet 1528, SE Quarter, 1966. Trial pits and soil tests were undertaken by sub-contract to Wade Adams, Kitwe. (Refer to Appendix II – Soils Report).

Laboratory tests carried out on samples recovered from the trial pits indicated that the top 5 metres of the alluvial soils at the approaches are:

- Clays, silts and gravels mixed in varying proportions, non-plastic or PI between 5.2 to 10.2.
- Low CBR values ranging from 3 to 7
- Existing alluvial soils are compressible and contain layers which appear to have collapsing characteristics.
- Rocks or residual horizons from the Karroo system are evident in some places. (surface occurring samples only collected)

From the results of the laboratory tests the alluvial soils are not suitable to found on. The same alluvial materials are not suitable as fill material for road construction, in view of their variability and generally low strength.

Alluvium must also be removed from within the road embankment, to depth and extent as determined from the final bridge and road design configurations, and replaced with higher strength soils.

Refer to Appendix II – Soils Report for details of test results.

Weathered rock of the underlying Karroo system has been observed at two locations:

a) On the Chiawa bank of the present Pontoon site, but only at the top of the ridge.

b) At the downstream disused pontoon site, but only on the Chirundu bank approach. (Photographs and rock samples only collected).

The proposed bridge site is underlain by alluvial soils extending to a depth of at least 5 metres, as summarised in the soil profile logs made from information obtained from trial pits TP1 and TP2.

The nature of the alluvium on both sides of the bank is characterised by silty sands, silty clays, gravelly silts.

Generally the above-mentioned soils are expected to be moderately to highly compressible and therefore cannot be considered as suitable founding horizons for a structure such as the proposed bridge. Above is also in view of the highly variable nature of the alluvial soils as evident in the trial pits, and furthermore in view of apparent collapsing soil horizons which occur at depth.

Fig 1 provides a sectional view of the soil profiles as deduced from the test pits. No test pits could be carried out within the riverbed itself due to permanently high water levels, and strong current.

The alluvial soils are underlain by Karroo System geology comprised of grits, arkose, ferruginous and conglomerate grit, mudstones, argillaceous sandstones, conglomerate etc. (Report 21 of geological survey of Zambia).

At the present pontoon site, the underlying Karroo System formations appear at surface at the cut face at the top of rise of the Chiawa bank. In this location the formation is evident by its original bedding and jointing. The dip of the system appears to be towards the river.

The Karroo system could not be clearly identified on the Chirundu bank, of the present Pontoon site, which is overlain by a thick layer of alluvium (TP1, at least 5 metres).

The Karroo System is visible on the downstream, old, presently abandoned Chirundu bank ferry approach. The Karroo System, in this location, appears to dip towards the river, apparently in an opposite sense to that evident at the top of rise of the Chiawa bank approach of the present pontoon site.

In summary, the alluvial soils overlie the Karroo System, but with variable thickness, which can only be determined by further geotechnical surveys including exploratory drillings and possibly seismic surveys.

4.2. Climate

In general, Zambia enjoys an enviably pleasant climate. Temperatures are remarkably moderate and this is mainly due to altitude. The rainfall is not heavy and floods are rare. Winds are generally light and damage to life and property due to high winds is practically unknown. Three seasons are experienced as follows:

i) The Rainy Season, which lasts from November to April, the temperature range is 12 degrees to 32 degrees celsius, humidity varies from 66% to 96%,the usual rainfall range is 500 to 1500mm, however up to 600mm has been recorded in a single month.

ii) The cool-dry season, which lasts from September to November, the temperature range 1 degree to 29 degrees Celsius, humidity varies from 32% to 67%.

There is the trend that rainfall is higher in the North, 1400mm and lower in the South, 700mm and the average for Chirundu is 800mm. The temperature depends on altitude and does not vary significantly across Zambia. Some parameters taken from the Lusaka Meterological station are as follows:

Table 3: Climate Factors in Lusaka Province

Altitude (ELM)	Annual Rainfall (mm)	Annual Temperature (°C)			Annual evaporation (mm)	Annual Evapo-Transpiration (mm)	
		Mean	Max	Min		Actual	Potential
1213	848	20.7	31.3	8.7	2104	733	1591

The Lower Zambezi area experiences a tropical continental type of climate with three distinct seasons i.e. hot rainy season from late November to April; a cool-dry season, from May to August; and a hot-dry season, from September to early November.

Rainfall amounts and temperatures vary between the valley and plateau areas due to differences in altitude. Mean *Annual rainfall on the plateau is about 800mm and that of the valley is 400mm or less. There are no rain-gauges in the Lower Zambezi National Park to accurately record rainfall, however, records exist from the nearest weather stations at Luangwa, Katondwe Mission in Runfunsa and Kasisi Mission. The Lower Zamb*ezi National Park is situated in an area prone to drought and records show that 61% of the time Luangwa in the valley experiences drought while 58% of the time Kasisi Mission on the plateau experiences drought (Sichingabula, 1994). The mean annual temperatures in the valley range from 19.1°c in June to 30°c in October while mean annual temperature on the plateau ranges from 12.5°c in June to 25^0C in October.

4.3. Hydrology

The Chiawa bridge cuts across the Lower Kafue River Basin and terminates into the Zambezi River Basin. From data presented in the National Water Resources Master Plan (Volume 1, C-10), it is possible to calculate the size of the Kafue River's catchment between the Kafue Gorge Dam and the Chiawa crossing. The catchment areas are presented as follows:

- Catchment area at Kafue Gorge Dam – 153,826m^2
- Catchment Area at Confluence with Zambezi – 156,995m^2

The approximate catchment area between these two sites is therefore estimated at 3,200Km^2.

There are two main river systems in Zambia, namely the Zambezi River and the Zaire (Congo) River. The Zambezi River system covers three quarters of the country and can be divided into three smaller systems, the Zambezi, the Kafue and Luangwa Rivers. The project bridge is in the Kafue catchment area.

The Kafue River originates at the eastern end of the Zambezi – Zaire watershed in the Copperbelt Province, and flows in a south-easterly direction to a point near Kitwe. It then turns southwards or south-westwards and flows into the Itezhi-tezhi dam reservoir. Afterwards it turns eastwards and travels across the Kafue flats and into the Kafue gorge dam reservoir. From the hydropower station, it flows through the steep Kafue gorge before joining the Zambezi river near Chirundu. The density of tributaries is high in the northern parts of the basin, and becomes lower in the southern part of the basin.

The Kafue River is a major tributary accounting for 27% of the Zambezi River basin. The point of confluence is located about 176km up river from where the Zambezi flows into Mozambique. The River is 1,310 km long. The difference in elevation measures 990m, and the average riverbed slope is 1/1320. As a major tributary, Lunga River having its basin (24,000 km^2) in North Western province joins the flow 130km upstream from the Kafue Hook Bridge, which is situated in Central Province. The Kafue flats are an almost completely flat area, extending over 320km from the Itezhi-tezhi dam to the area near Kafue town. The Kafue river flows across the flats, exhibiting repeated meandering. The difference in elevation of this area is only 10 to 15m, and the average riverbed slope is 1/20,000 – 30,000, representing an almost flat profile. The area between the Kafue gorge dam located about 20km downstream from Kafue town to the Zambezi river is a series of gorges over a distance of

64km, and the river drops through a height of 570m at an average riverbed slope of I = 1/110. It should be noted that the Itezhi-tezhi dam has no function of flood control, but actually its large-scale reservoir capacity works on flood mitigation for the downstream area of Kafue flats. Similarly, Kafue Gorge dam acts as a flood control for the river downstream towards Chirundu.

4.4. Precipitation

An isohyetal map was prepared and is based on a 40-year period October 1964 to September 2004. (ref. Figure 4-2-1). In Zambia, 90% of the rainfall is concentrated in the rainy season from November to March. In particular, the months of December and January have 40-50% of annual rainfall. There is almost no rain from April to September.

From an examination of the map, it can be seen that the isohyetal lines are almost parallel from west to east and veer northwards in Northern Province. The average for the Chirundu area is 800mm.

4.5. Runoff

Runoff is comprised of surface flow and subsurface flow and is supplied by precipitation. The main factors affecting the quantity of runoff in Southern Province are climate and drainage basin characteristics. The climatic characteristics are:

- Precipitation-intensity, duration, time distribution, seasonal distribution, recurrence interval, soil moisture and direction of storm movement.
- Other characteristics, which are not very relevant in Zambia include temperature, wind, humidity, atmospheric pressure and solar radiation.

The drainage-basin characteristics are:

- Topographic – size, shape, slope, elevation, general location, land-use and cover, rivers and lakes, artificial drainage and chemicals.
- Geologic – soil type, permeability, etc.

4.5.1 Method of Runoff Determination

The highest known flood level has been determined by local observation. According to the pontoon operators and members of the local community, the highest levels have been experienced in the past when the Kariba floodgates have been opened on the Zambezi, which has a backing up effect on the Kafue near Chiawa. During these times the pontoon operators move to the high-level anchors in order to continue operations. Operations have never been halted due to flooding.

The Kariba Dam will have a major impact on flood peaks at the site. Due to its huge storage capacity of 1.85×10^{11} m3 significant flood attenuation will take place and flood peaks downstream of the dam will depend on the operation of the six gated spillways of the dam. Each of the 6 spillways has a capacity of 1,574.2m3/s giving a combined total of 9,445.2m3/s. When the Kafue river flood magnitudes are compared with the volume that may be released from the Dam, albeit on the River Zambezi, it should be clear that the floods released from the dam will play a dominant role in establishing the maximum floods at the Chiawa Bridge site, with the floods being generated from the catchment below Itezhi-tezhi dam being of secondary importance.

In our preliminary designs, we have allowed a five-metre clearance from this highest known flood level to allow for the passage of regular or occasional river craft and any floating debris at times of flood. Boating is a very popular pastime, both by the locals who rely on fishing as their livelihood, and increasingly for tourism purposes. Many travellers to the Lower Zambezi National Park arrive at Gwabi Lodge (approximately 2km from the Chiawa Crossing) and are taken to the various riverside lodges by boat. These are generally small craft (seating a maximum of 20 people) and many have a shaded canopy.

The hydrological adequacy of the new bridge structure has been checked as follows:

a) Using the Lloyd Williams Formula

$P = 0.268\ CA\ I$

Where P = discharge in m^3/s
C = discharge coefficient
A = area in Km^2
I = average rainfall intensity in mm/hr

i) Discharge Coefficient C
C can be estimated by assuming factors relating to soil, slope and protection, summing the total, adding one to the result for areas less than 25 Km^2 and dividing by 10.

ii) Catchment Area in Km^2, A
The Catchment area has been assessed from 1:50,000 contour maps upstream of the proposed Chiawa bridge.

iii) Rainfall Intensity in mm/hr, I
I, the rainfall intensity, depends on T, the time of concentration, which in turn depends on the area, its slope and shape.

$T(hrs) = 0.7\ 5 \times \sqrt{A2L}$ Bransby Williams Formula)
SD

Where L = length of longest axis in kilometres
S = slope per cent
D = diameter in kilometres of a CIRCLE of equivalent area

Knowing the time of concentration, the point intensity I of rainfall once in C years can be found from the formula:

$$i = \frac{}{T + 0.5}\ a$$

$$a = \frac{32 \log (CD) + 50}{845}$$

D = average annual rainfall in mm

The point intensity I is then corrected for the average intensity of rainfall for the area by substituting in the first formula and thus obtaining the discharge in m^3/s.

Note that the Rational method has a number of limitations. One assumption is that rainfall is of uniform intensity throughout the area during the time of concentration. This does not recognise that many features that affect rainfall may be substantially different over the area of the basin. This and other assumptions become particularly

susceptible to error as the size of the drainage area increases. It is generally considered unsuitable for areas greater than 25 Km². In these cases the ORSTOM method provides a more realistic assessment of flow.

b) Using the ORSTOM Method

From the contoured Ordinance sheets, we can assume a nominal size of the catchment area to be 600 Km^2. This is considered too large for the Rational Method. The Orstom method, based on an empirical formula is favoured, however, for comparison purposes both the Orstom and Rational methods have been used.

A = 600 Km2

S = 2%

D = 27.6

L = 20

$T = 0.7 \times 5\sqrt{A2L} = 0.7\sqrt{6002 \times 20}$

$SD \qquad 0.2 \times 27.6$

$= 0.7 \times 16.71 = 11.7$ hrs

50 year cycle and average rainfall of 1000mm

$a = 32\log CD + 50 = 32 \log 50 \times 1000 + 50 = 106.7$

$845 \qquad 845$

$i = \frac{106.7}{11.7 + 0.5} = 8.75$mm/hr

$I = i \times 0.6 = 8.75 \times 0.6 = 5.25$mm/hr

Reduction Coefficient = 82%

Runoff Coefficient = 37%

$Q = IA = 5.25 \times 0.82 \times 0.37 \times 600 \times 10^3 = 1001220 m^3/hr$

$= 278 m^3/s$

Allowing 5 metre minimum clearance, the area of available waterway is therefore = 800m² which is sufficient to pass the volume of water anticipated in a 50 year storm. Embankments should be protected with a form of gabion and erosion on side slopes should be repaired and seeded with grass. Trees will also be planted in these locations for environmental considerations. The waterways upstream and downstream of the bridge should be cleared of all overgrowth and debris. We recommend the use of gabion protection for embankments and riverbed protection.

4.6. Water Quality

The main water body is the Kafue River. This river is the major transporter of industrial liquid waste and is also the source for drinking water. However, river silts, debris, erosion, industrial effluents negatively impact on the river water quality. These issues as well as spillage from petrol, chemical and storage sites will need to be mitigated during construction and operational phases of the project.

4.6.1 JICA Surveys of the Kafue River

During the 1990 to 1994 JICA Surveys, the Kafue River was the most sampled stream with 57 samples being taken from 11 stations. To assist the analysis of the quality records and because of the different hydrologic characteristics, the Kafue was divided into three sections, upper (essentially the Copperbelt stations), middle (downstream from the Copperbelt to downstream of Itezhi Tezhi dam) and lower (from Itezhi Tezhi to the Zambezi). The focus on water quality will be on the lower Kafue since this is the area where the project influence is likely to be felt.

According to JICA Surveys, the general welcome features in the lower Kafue were as follows: low dissolved oxygen while salinity, chloride, iron and turbidity (median value of 4 NTU's but high in the wet season) were all generally good.

Specifically the water quality upstream and downstream the project site are tabulated in Table 4.

Table 4: Water Quality Upstream and Downstream of Project Site

Kafue River	pH	EC uS/cm	Col	Turb NTU	T °C	Cl^- mg/l	NO^{3-} Mg/l	$CaCO_3$ Mg/l	Fe Mg/l	NO_2^- Mg/l
Kafue Gordge Dam u/s Pool (U/S of Project Site)	9.0	233	<5	1.5	25.0	4.8	1.0	61	0.05	nil
Kafue Gordge Dam d/s Pool (U/S of Project Site)	8.8	249	<5	1.5	25.0	4.0	1.0	68	0.05	0.00
100m upstream Zambezi Junction (D/S of Project Site)	7.1	229	<5	2.8	30.1	9.0	nd	61	0.05	0.02

Source: Ministry of Energy & Water Development, Water Master Plan, 1995
u/s: Upstream
d/s: Down stream
nd: not detected

4.7. Air quality

The air quality in the project area is generally good, except occasionally in vicinity and at the time of mechanical or vehicular activity. Around Chirundu township the air is heavily affected by emissions from trucks that are hauling goods using the road connecting Zambia and Zimbabwe. After Chirundu going towards Chiawa the air quality tends to be generally of good quality.

The pontoon currently be used to ferry people at the project site is using diesel as fuel and does contribute to hydrocarbons, fine particulates, and carbon dioxide as air pollutants; ferry passengers and workers are potentially subject to these polutants while the ferry is operating. When conditions are dry, the time vehicles using the gravel road tend to emit dust particles of various sizes.

The advent of a new bridge may be expected to result in increased traffic emission which may result in increased gaseous emissions; but the affect on air quality should still be very localized and minor.

Dust during rehabilitation and construction work may pose dust problems and this will need to be mitigated.

5. BIOLOGICAL ENVIRONMENT

5.1. Flora and Fauna

Classification of Vegetation

The classification of vegetation along the road transect is in accordance with that of Edmund's classification of Vegetation types for Zambia, 1976. This is in line with the Chakanga De Barker classification of their Woodland Resources Management of 1984.

The broad classification of the vegetation types adopted is as follows:

a) Dry Deciduous Woodland

This is a *Dalbergia-Combretum* shrub-scrambler thicket dominated by *Dalbergia spp* and *Combretum spp.* The common associated scrambler taxa include *Acacia ataxacantha* (Mugowa konoto T), *Capparis tomentosa* (Chimwese T) and *Grewa flavescens.*

There are also spots of emergents of this woodland that include *Adansonia digitata* (Mubuyu, T), *Berchemia discolor (*Mwii T), *Boscia angustifolia* (Muyusa T).

b) Riparian Woodland

This consists of a narrow band of forest along the rivers and streams. The taxa *Bridelia micrantha* (Musangu sangu T), *Ficus capensis* (Mukuyu, T), *Mimusops zeyheri* (Mukulanjoni T) *Syzygium guineense* (Katope, T) form the outer riparin fringe along most streams that traverse the Lusaka Chirundu transect.

The commoner shrubs and smaller trees include *Acalypha ornata, Azazna garkeana* (Munego, T), *Bauhinia tomentosa* (Mupondopondo T) and *Markhamia obtusifolia* (Mupetakwale, T).

c) Miombo Woodland

This woodland is dominated by *Braschystegia-Julbernardia species*. It covers most of the hills along the transect. There is frequently a catenal sequence found; miombo at the crests of the ridges and down the slopes. This is gradually replaced by the mopane and at the bottom of the slope is found a narrow belt of thicket fringing seasonal water courses.

Braschystegialongifolia and Julbernardia globiflora are the usual dominants. The commoner canopy associates are *Braschystegia spiciformis, Burkea africana, Parinari curatelifolia and Monotes africana.*

The commoner shrubs and small trees include *Bauhinia petersiana, Diplorhynchus condylocarpon, Psuedolachynostilis maprouneifolia.* On the lowest scarp slopes and on many of the ridges and kojes in the valley miombo occurs in admixture with munga woodland. *Braschystegia boehmii* and *Combretum spp* are dominant associated with *Markhamia acuminata* in the upper and characteristic hilly species such as the paper barked *Bridelia mollis, Commiphora spp, Sterculia quinqueloba.*

d) Munga Woodland

This woodland, characterised by Acacias, Combretums and Terminalias, occurs on some of the deepest and most fertile soils along the transect. The associated species include *Acacia tortilis, A. sieberana, Adansonia digitata, Sclerocarya caffra* (Marula) and *Tamarindus indica.*

e) Mopane Woodland

The canopy of this woodland is almost exclusively dominated by the principal taxa of *Colophosermum mopane*. However, occasionally, Adansonia digitata, Afzelia quanzensis were seen in the canopy cover. The woodland commonly carry a considerable undergrowth of such shrubs and small trees as *Combretum spp* and *Dalbergia melanoxylon*.

f) Terminaria

These occur on the more level to gently sloping sandstone slopes with understorey species typical of miombo woodland but dominated by such species as *Diospros mesipiliformis* and *Sclelocarya caffra*. Low termite mounds occur here and there in scrub mopane and munga woodlands. The dominants are from the surrounding woodland.

g) Grassland

- **Dambo grassland**

The vegetation is a moderately dense mat of grasses, sedges and herbs. The cushion-like perennial grasses occur in bunches with *Loudetia simplex* as the characteristic taxon associated with *Aristida, Leersia hexandra* (Rice relative) and *Eragrotis spp*.

- **Riverine grassland**

This occur as a narrow belt of *Hyparrhenia* grasses, principally, *H. cymbaria, H. filipendula* and *H. rufa* associated with *Bracharia* and *Setaria* grasses. *Panicum spp* and *Acrocerns macrum* are common in wetter parts.

h) Trees Outside Forests

These may be referred to as trees and tree environments on land not defined as forest or other wooded land. They include trees planted along roadsides and backyards.

The road is flanked by a relatively good spectacle of planted exotic tree and shrub species notably *Eucalyptus ssp, Bouganivillea, Tricalia emetica, Vitex trifoliate, Gmelina aborea, Toona cilliata, Senna siamea, Callistermoni viminallis, Mangifera indica, Vitex trifoliata.* The Munga woodland then flanks the road up to Kafue.

5.1.2 Vegetation

The vegetation types around the project area are strongly tied to the nature of topography, lithology and soil characteristics on which they occur. The rainfall regimes and underground water discharged from surrounding areas do modify the structure of the vegetation and its floristic composition. Large areas along this road are covered by stunted woodland and secondary thicket formations. The vegetation observed around the study area are basically of five distinct woodland types namely Mopane, Munga, Riparian and dry deciduous woodlands.

On the way to the project site the road passes a big baobab (*Adansonia digitata*) standing on the right hand side of the road (see Figure 1). This tree could be several hundreds of years old and has significant socio-cultural value and should be protected during road rehabilitation.

Figure 4: Baobab alongside the road to the project site

The fruit pulp makes a refreshing drink when dissolved in water or it can be used to make porridge-its Vitamin C content is one of the highest known in a natural fruit (FD, 1995).

5.1.3 Fauna

There are a number of rare and endangered animals in the project area with a sizeable population of most monkeys. Further on towards Chiawa across the Kafue River is a Game Management Area (GMA). Wild life such as antelope species, as well as elephant (*Loxodanta africana*), baboon (*Papio cynocephalus*), hippopotomus, crocodiles and several other species are being observed. Although these animals are mostly found on the side of Zimbabwe Game Park, elephants and other large vertebrates may use the bridge as well into the Chirundu area.

Figure 5: Vegetation around the project Site

Source: Consultant's survey

6. SOCIO-ECONOMIC ENVIRONMENT

6.1. Demographic Profile

According to the 2000 census of population and housing, Chirundu has a population of 9,576, 49.13 percent male and 50.87 percent female (4,704 and 4,871, respectively).

The Chirundu-Chiawa Bridge will be an important part of the regional and international road network. The existing ferry plays a vital role both in the movement of traffic and people between Lusaka and Chirundu, and is an economic artery for the SADC region. From a social perspective the ferry performs a vital function for the local population to access health and education facilities located in Chirundu, and at certain times of the day, particularly in the morning and evening the pontoon is heavily used by children and parents accessing both of these.

6.2. Current Land-use and Settlements

The land-use around the project site is charaterised by agricultural activity and forest areas. Though woodland is still the predominant type of vegetation around the project site, however the project area is covered by stunted woodland and secondary thicket formations. Some of these forests are now degraded, particularly in the vicinity of the project site. Farming and animal husbandry have significantly altered the visual impression of the original vegetation and the land-use around the project site is now mainly crop farming mixed with forests.

-

An estimated 3,000 people live in the Chirundu area. These comprise government and police officials and their families, whose work is linked to the border post together with a host of people involved in the service industry. The Government is taking measures to upgrade Chirundu. Alongside the recent completion of a new bridge, the Government is undertaking housing and infrastructure, such as a water and sewerage scheme.

Figure 6: Structures on the Project Site belonging to Ministry of Works and Supply which may require Physical Relocation

Figure 4 above refers to the structures belonging to Ministry of Works and Supply, Engineering Services Company (ESCO) which will be relocated to allow the construction of the approach road. ESCO is the company that is currently operating the pontoon on the Kafue River crossing.

6.3. Health

The challenges of HIV/AIDS for Zambia are serious. AIDS threatens the country's efforts to build capacity because it strikes the educated and skilled as well as the uneducated. The long periods of illness of the skilled personnel in employment has translated into a severe loss in economic productivity. The relationship between HIV/AIDS and economic growth is increasingly being recognized.

6.4. Economic Activities

Agriculture and tourism are the two key sectors of the local economy. In respect of agriculture the 'Economic Report, 2002' of the Ministry of Finance and National Planning (MFNP) noted that 'Government encouraged production of winter maize (on irrigated land). In this regard a total of 1,500 hectares was cultivated, mainly in Chiawa and Sinazongwe'. This 'contributed to improving the food security situation'.

For the tourist sector it is useful to give some national data as background. Total international tourist arrivals, as shown in the 'Economic Report, 2002' of MFNP on the basis of data from the Ministry of Tourism, Environment and National Resources (MTENR), rose from 362,000 in 1998 to 556,000 in 2002. Nearly half of these, however, were business visitors, and others were visiting friends and relatives. The number stating 'Holiday' as their purpose of visit rose from 86,000 in 1998 to 150,000 in 2002, at an average annual growth rate of just under 15 per cent.

The numbers of domestic and international tourists visiting Zambia's most famous destinations during the years 2003/2004 are shown in Table 5.

Table 5: International and Domestic Tourist Arrivals in Zambia, 2003/04

	International		Domestic	
	2003	**2004**	**2003**	**2004**
Mosi oa Tunya	19,712	12,635	3,785	5,127
Lower Zambezi	3,631	4,606	782	1,453
South Luangwa	13,827	17,853	5,901	6,076
Kafue	2,619	1,853	1,193	1,930
Lochinvar	162	224	228	197
Other parks	437	1,650	263	374
Totals	40,388	38,821	12,152	15,157

Source: MFNP

Lower Zambezi National Park is shown as the third most popular destination for international tourists, and the fourth for domestic tourists. It accounted for 8.4 per cent of all tourists in 2003, and for 11.2 per cent in 2004. Total tourist numbers for Lower Zambezi showed a 37 per cent increase in 2004 over the previous year, as against one of just under 3 per cent for the whole country.

Within the Lower Zambezi area, there are stated by MTENR to be 11 lodges with a total bed capacity of about 130, and also 13 camps with bed capacity of about 240; capacity details are not available for all establishments. There are also five campsites. The lodges are reported to be generally open for only about six months a year, through the dry season (May to November). During the rainy season road access is often impossible, and even during the dry season the condition of the road and delays at the pontoon mean that tourists prefer to travel in and out by boat. Detailed statistics on bed occupancy and average length of stay are not available, but the above statistics suggest that occupancy is quite low, even during the dry season when the lodges are open. Occupancy could no doubt be improved if road access were improved.

Construction of the bridge is expected to generate substantial additional activities in the large-scale farming and tourism sections. At present further development of these sectors is constrained by the bottleneck at the Kafue crossing, and the expansions will not take place if the bridge is not constructed. It is appropriate in these circumstances to adopt a methodology which measures induced economic activity, and places a value on the additional national income which can be attributed to the project.

6.4.1 Agriculture

Since there are several commercial farmers in the area, it seems reasonable to assume that at least an additional 30,000 tonnes of crops could be produced if the bridge were constructed. It is further assumed that the new cropping areas would first come into production in the third year following construction of the bridge, that is 2011; that in this year 10,000 tonnes of new crops would be produced; and that this additional production would build up steadily over the next eight years to reach 30,000 tonnes by 2019, thereafter remaining constant.

Farmgate prices for the various crops were quoted by CHC Commodities Ltd. as follows:

- Maize US$ 170 per tonne
- Wheat US$ 320 per tonne
- Soya US$ 312.50 per tonne
- Bananas US$ 187.50 per tonne.

With maize likely to be the dominant crop, it appears reasonable to project an average crop price of US$ 200 per tonne, giving an additional crop value of US$ 2.0 million in 2011, rising to US$ 6.0 million by 2019.

These crop values will considerably overstate net value added by the new cropping activities to the Zambian economy. Assessment of this value must take into account the costs of necessary inputs including land preparation, irrigation, fertilisers, harvesting, on-farm storage and transport to market. Value added may amount perhaps on average to only 10 to 15 per cent of sale values.

However, economic multiplier effects will certainly also result from the additional incomes earned in the new activities. Although little precise information is available on multiplier values for Zambia, it seems reasonable to assume that the appropriate multiplier for large-scale agriculture in the Chiawa area could be at least in the range 1.4 to 1.8.

As a fairly conservative estimate, it seems reasonable to assume that value added for the new cropping activity could be 12.5 per cent of farmgate prices, to which should be applied a multiplier of 1.6, giving a full benefit value equivalent to 20 per cent of farmgate prices. Hence projected economic benefits arising from additional farming activities may be estimated as shown in Table 6.

Table 6: Projected Values of Agricultural Activity Induced by Bridge Construction

	2011	2015	2019	2020-2035
Forecast crop production volume ('000 tonnes)	10.0	20.0	30.0	30.0
Assumed average crop value (US$ / tonne)	200	200	200	200
Forecast crop production value (US$ '000)	2,000	4,000	6,000	6,000
Value added at 20 % of crop value (US$ '000)	400	800	1,200	1,200

Source: ASCO's estimates

6.4.2 Tourism

As shown in Section 6.4.1 and Table 6, the Ministry of Tourism recorded arrivals in the Lower Zambezi area as 3,631 international and 782 domestic tourists in 2003, rising to 4,606 international and 1,453 domestic tourists in 2004. Due to apparent inconsistencies in statistical coverage, it is not possible to give a clear long-term growth rate for Zambian tourism, but it has already been shown in Section 11.2.2 that 'international tourist arrivals' rose between 1998 and 2002 at 11 per cent per annum, while numbers of these arrivals giving 'holiday' as their purpose of travel rose at nearly 15 per cent per annum.

A significant proportion of tourists visiting the Lower Zambezi lodges and camps are reported to travel in by air or by boat. The lack of easy road access must certainly inhibit some potential tourists from visiting the area. It is considered a reasonable assumption that perhaps 30 per cent more tourists might do so if the bridge were constructed. Of these it is considered realistic to assume that half will be new tourists, while half will have merely transferred from another tourist area in Zambia. Thus the net increase in Zambian tourists will be 15 per cent of the numbers who would visit the Lower Zambezi without the bridge. It is assumed that this level will be reached in the third year after bridge completion, that is in 2011, with earlier intermediate figures of 5 per cent in 2009 and 10 per cent in 2010.

On the basis of total tourist numbers (international and domestic) for the Lower Zambezi of 4,413 in 2003 and 6,059 in 2004, together with assumed sector growth of at least 10 per cent per annum, arrivals without the bridge may be forecast as 10,000 in 2009. Beyond this year it

is further assumed that the sector will grow at 8 per cent per annum up to 2015, and at 6 per cent thereafter. Hence additional numbers of tourists attributable to the bridge may be calculated for selected years as follows:

2009	0.05 x 10,000	=	500
2010	0.10 x 10,800	=	1,080
2011	0.15 x 11,664	=	1,750
2015	0.15 x 15,869	=	2,380
2019	0.15 x 20,034	=	3,005.

From 2019 the number of additional tourists attributed to the new bridge will be conservatively maintained at 3,005 per annum.

Tourist earnings per head cannot clearly be established on the basis of available data. For instance the tourism chapter (Section 4.6) of the Ministry of Finance's 'Economic Report 2002' shows 'tourist earnings' at US$ 145.3 million in 2002, and 'international tourist arrivals' at 556,043, without making it clear whether these earnings came form all these tourists, or only from certain groups, such as those on holiday (150,451) or 'visiting friends and relatives' (82,592).

Nevertheless it is considered a realistic estimate that expenditures per head by tourists visiting the Lower Zambezi area will be around US$ 250 per head.

As with the farming activity discussed in the previous sub-section, net value added to the Zambian economy will be only a fraction of total tourist expenditure, with the added complication that a proportion of earnings may be expatriated. Hence the value added could be as low as 10 per cent of gross tourist expenditure, or just US$ 25 per head. However, there will again be multiplier effects on the local economy, though in this case a rather lower value of, say, 1.4 may be appropriate, giving a net benefit value equivalent to 14 per cent of US$ 250, or US$ 35 per head.

Hence projected economic benefits arising from additional tourist activities may be estimated as shown in Table 7.

Table 7: Projected Values of Induced Tourist Activity Due to Bridge Construction

	2009	2010	2011	2015	2019	2020–2039
Forecast additional tourist numbers (net)	500	1,080	1,750	2,380	3,005	3,005
Assumed expenditure per head (US$)	250	250	250	250	250	250
Forecast additional tourist expenditure (US$ '000)	125.0	270.0	437.5	595.0	751.3	751.3
Value added at 14 % of expenditure (US$ '000)	17.5	37.8	61.3	83.3	105.2	105.2

Source: ASCO's estimates

6.5. Current Transport Situation

6.5.1 Present Traffic

Traffic data was gathered from the pontoon operator. These covered operations during daylight hours (0600-1800), and were extracted for three five-day periods in March, June and September 2004. In accordance with established Zambian practice for road traffic counts, the

counts were taken for three weekdays and two weekend days (Wednesday to Sunday inclusive). Details of vehicles carried on the 15 days are given in Table 8.

These flows are broadly consistent with those observed by the Consultant in early April 2005, when the pontoon was found to be in constant use throughout the day, making approximately one return trip each hour, with each crossing generally carrying one to three vehicles, but having no room for other vehicles if a large truck had to be carried.

The variations in total truck flows between June (average 2.2 per day), September (10.6 per day) and March (14.6 per day) reflect reported variations in the agricultural year. However, the reported distribution between rigid trucks of two to three axles and multi-axle semi-trailers is not in accordance with the Consultant's observations, and appears to require adjustment. In April 2005 it was seen that roughly 50 per cent of trucks crossing the river were of two or three axles, while 50 per cent were six-axle semi-trailers. A 50/50 split on this basis has been assumed in dividing up the total of 137 trucks recorded on the 15 sample days.

Table 8: Numbers of Vehicles Using Kafue Pontoon on Sample Days in 2004

		Cars	Other Light Vehicles	Buses	Trucks Rigid (2/3 axles)	S/Trailers & Others	Totals
Wed	March 24	0	7	0	13	1	21
Thurs	March 25	0	5	0	16	2	23
Fri	March 26	2	20	0	6	0	28
Sat	March 27	2	12	0	12	1	27
Sun	March 28	0	17	0	16	6	39
Totals	**March 24–28**	**4**	**61**	**0**	**63**	**10**	**138**
Wed	June 2	2	33	1	2	0	38
Thurs	June 3	3	19	0	4	0	26
Fri	June 4	2	20	1	1	0	24
Sat	June 5	2	14	0	1	0	17
Sun	June 6	1	22	0	3	0	26
Totals	**June 2–6**	**10**	**108**	**2**	**11**	**0**	**131**
Wed	Sept 8	0	28	0	15	0	43
Thurs	Sept 9	1	19	0	3	0	23
Fri	Sept 10	1	25	0	11	0	37
Sat	Sept 11	4	38	0	12	0	54
Sun	Sept 12	3	29	3	9	3	47
Totals	**Sept 8–12**	**9**	**139**	**3**	**50**	**3**	**204**
Grand Totals (15 days)		**23**	**308**	**5**	**124**	**13**	**473**

Source: Kafue pontoon records

Hence average daily traffic flows on weekdays (Wednesday to Friday) and weekends (Saturdays and Sundays) may be classified over the 15 days of records as follows:

	Weekdays (9 days)	Weekends (6 days)
Cars	1.22	2.00
Light commercial vehicles [1]	19.56	22.00
Buses	0.22	0.50
Trucks, rigid (2/3 axles)	4.11	5.25
Trucks, semi-trailers (4-6 axles)	4.11	5.25
Totals	**29.22**	**35.00**

Note: 1: Including both passenger and goods vehicles

By adding five times the weekday flows to twice the weekend flows, estimates of average weekly flows and hence of average daily flows may be derived as shown below:

	Average Weekly Flows	Average Daily Flows
Cars	10.11	1.44
Light commercial vehicles	141.78	20.25
Buses	2.11	0.30
Trucks, rigid (2/3 axles)	31.06	4.44
Trucks, semi-trailers (4-6 axles)	31.06	4.44
Totals	**216.12**	**30.87**

A further adjustment must be made in respect of the length of the working day. The data shown in Table 7 are taken from pontoon records covering the normal working day from 0600 to 1800. In practice it became clear from observation and discussion with users that the pontoon often continues work after 1800, and that in the busiest months it may work as late as 2200. Over the whole year it is assumed that vehicles carried outside normal hours will be equivalent to 15 per cent of traffic carried between 0600 and 1800. Hence the following estimates may now be made of current annual average daily traffic levels in 2004:

Cars	1.66
Light commercial vehicles	23.29
Buses	0.35
Trucks, rigid (2/3 axles)	5.10
Trucks, semi-trailers (4-6 axles)	5.10
Total average daily flow	**35.50**

With rounding of these individual figures and allowance for a small traffic increase of say 3 per cent between 2004 and 2005, the following working estimates may be made of average current traffic flows for 2005:

Cars	2
Light commercial vehicles	24
Buses	0
Trucks, rigid (2/3 axles)	5
Trucks, semi-trailers (4-6 axles)	5
Total average daily flow	**36**

6.5.2 Future Traffic

The above estimate of 36 vehicles per day (vpd) may be considered as the existing or 'normal' traffic flow for 2005. Traffic demand is likely to increase in future as the economy grows in general, and as agricultural activities in the Chiawa area expand in particular.

If the bridge is constructed, capacity of the crossing will be greatly increased and it will be possible for all traffic demand to be satisfied over the full benefit period of the economic analysis (2009-38). On the other hand, if the crossing remains as a pontoon, constraints on demand will worsen..

Traffic growth may generally be related to economic growth through elasticities of demand. The elasticity for a defined vehicle group relates the expected percentage increase in traffic to the expected percentage increase in economic activity. Experience in Zambia and in other countries in sub-Saharan Africa suggests that typically the elasticity of demand for passenger vehicles may be in the range 1.1 to 1.3, while that for goods vehicles may be closer to 1.0. If these elasticities are applied to an economic growth rate of 3.5 per cent per annum, then it

may be estimated that passenger vehicle flow will increase at about 4.0 per cent per annum, while goods vehicle flow will increase at 3.5 per cent per annum.

Construction of the bridge is expected to be completed in 2008 with benefits being enjoyed from 2009. If it is not constructed, then it is assumed that the above rates of traffic growth can be accommodated only over the first ten benefit years, up to 2018. Thereafter it will be impossible to accommodate additional traffic on the pontoon. Hence normal traffic forecasts, of vehicles which will move whether the bridge is constructed or not, may be summarized as in Table 9. These are given in terms of Annual Average Daily Traffic (AADT). After 2020 traffic will remain at the same level, as the capacity of the crossing will have been reached.

Table 9: Normal Traffic Forecasts, 2005-20

(AADT)	2005	2009	2010	2015	2018	2020
Cars	2.0	2.3	2.4	3.0	3.3	3.3
Light commercial vehicles	24.0	28.1	29.2	35.5	40.0	40.0
Buses	0.0	0.0	0.0	0.0	0.0	0.0
Trucks, rigid (2/3 axles)	5.0	5.7	5.9	7.1	7.8	7.8
Trucks, semi-trailers (4-6 axles) 5.0	5.7	5.9	7.1	7.8	7.8	
Totals	**36.0**	**41.8**	**43.4**	**52.7**	**58.9**	**58.9**

Source: ASCO forecasts

If the bridge is constructed, it is to be expected that considerable additional traffic will be generated. Although vehicle running costs will not be reduced, there will be substantial time savings of 30 to 60 minutes per crossing, which will have impact on vehicle operating costs, passenger time costs and cargo time costs.

It is necessary to divide such generated traffic into specific and non-specific components. Specific generated traffic will be associated with additional economic activity in the large-scale farming and tourism sectors. Such traffic will not be quantified, since an induced economic activity methodology will be used to evaluate the associated benefits. These farming and tourism activities may be associated with perhaps 30 per cent of the present light vehicle traffic using the ferry (cars and LCV's), and with most of the trucks.

For the remaining non-specific traffic a traditional traffic approach will be employed in the calculation of benefits. In order to avoid double-counting of benefits, this approach will be applied to 70 per cent of light vehicles only. For this traffic, experience in Zambia and other African countries suggests that generated traffic could amount to around 10 per cent of normal traffic in 2008, rising to 20 per cent by 2010 and remaining at that level in succeeding years. Hence the non-specific generated traffic proportions to be applied to normal traffic forecasts for cars and LCV's will be 7 per cent in 2008, rising to 14 per cent by 2010 and in subsequent years.

7. CULTURAL ENVIRONMENT

7.1. Cultural Resources

7.1.1 Archaeological, Cultural and Historical Sites

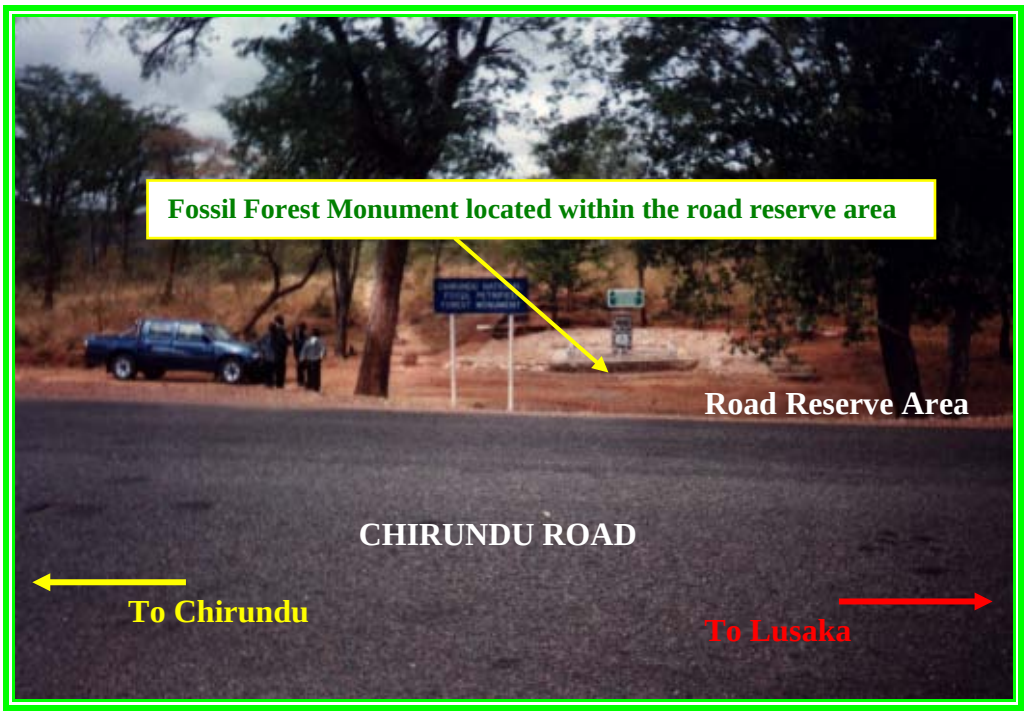
The road passing the proposed bridge project joins the Lusaka-Chirundu Road. On the Lusaka-Chirundu road corridor lies an item of heritage, the fossil forest site. The site is known as Chirundu National Petrified Forest Monument and is found in the area of Chief Sikongo in Siavonga District. It is located south of the Lusaka-Chirundu Road, 21 km from Chirundu border at the corner of the access road to Lake Kariba. It lies at approximately latitude 16 degrees 2 minutes South, longitude 28 degrees 40 minutes East. Mopane woodland is the main vegetation type on site and in the immediate surrounding areas.

Figure 7: Chirundu National Fossil Petrified Forest Monument

The site together with those outside the declared site enjoy equal protection status under the National Heritage Conservation Commission Act, Cap 173 of the Laws of Zambia and should be protected under any circumstances during road rehabilitation works. The National Heritage Conservation Commission is the custodian of Zambia's unique heritage, which include fossils.

The Chirundu Fossil Forest is a place in Zambia where conifer-like trees were growing about 150 million years ago during the time the Karroo system was being formed.

Figure 8: Location of Chirundu Road and the National Forest Petrified Monument



The wood was slowly preserved by silica replacement of the cellulose and the trunks remain as fossils. Although the site lies within the Lusaka-Chirundu road reserve area, the site was declared a national monument to protect the unique geological features (fossilized), which are found there, and to present them as samples of the type of fossils that are found in the Chirundu area.

Disturbance in this area should be reduced to the absolute minimum. This means construction of diversion roads, location of campsites, crusher and asphalt plants and extraction of materials should as far as possible be avoided.

8. POTENTIAL ENVIRONMENTAL IMPACTS

8.1. Initial Scoping with Public Consultation

8.1.1 Approach and Methodology

The method adopted for community consultations was open discussions with the relevant local institutions at provincial and district level, Headmen, representatives from NGO's and community based organisations and residents from communities living in the project area.

Letters stating the objectives of the project and requesting local participation and consultation in the process were also distributed.

Responses from the consultations and interviews provided the relevant background information and helped identify major environmental concerns of the communities along the road for preparation of this environmental impact statement.

8.1.2 Key Presentations, Questions and Concerns from the Community Consultative Meetings

Following meetings with the stakeholders and the review of questionnaires, ASCO has therefore prepared Terms of Reference for the EIA exercise contained in the Scoping Report (January 2006) reviewed, commented and approved by the Environmental Council of Zambia.

These discussions were centred on:

- The road and its surroundings (land-use, natural resources, water, etc.)
- The most important features (market places, gathering sites, schools, clinics, quarries, borrow pits, access and feeder roads, etc.)
- Sensitive areas (protected areas, graveyards, historical sites, etc.)
- Where should construction materials be taken from/or not taken from?
- Employment opportunities
- Road accidents and where are the black spots?
- Benefits (increased trade and transport) and inconveniences (illegal timber trade, poaching, increased traffic)
- Positive or negative experiences with other contractors

Following the environmental surveys and consultative meetings with stakeholders, the key environmental issues of concern have been referred to in this chapter and the mitigation measures are to be incorporated into the detailed design.

Impacts from the bridge construction are likely to be from:

- Landscape – topography, vegetation, historic features, material finishes
- Ecology – Loss of bush habitat, disturbance due to noise, plant movements and human presence during construction, pollution
- Planning and Policies – Land use, promotion of economic/social policies
- Socio-economy – demand for labour, influx of labour, activity of prostitutes, increase pressure on medical and educational facilities
- Traffic and Transport – Construction traffic movements, air pollution, noise and dust, risk to safety
- Amenity and Tourism – Visual intrusion, air pollution, noise and dust
- Archaeology and Cultural Heritage – known and unknown archaeological remains and structures of historical importance

- Hydrology and Water Quality – Pollution during construction
- Air Quality, Noise and Dust – Operation of construction plant, movement of vehicles on site and access roads, creation of dust through excavation, blasting and vehicle movements.

There are other issues related to Chirundu's high growth rate due to the business generated by the activities at the border post. These include:

Health – Current health problems in Chirundu are AIDS, with a large number of prostitutes living on the Chiawa side of town, and cholera, which can be prevalent during the rainy season from December to March. Malaria is also particularly prevalent during the rainy season.

Education – There is a shortage of schools in the area. There is provision for another secondary and primary school, although lack of funds may prevent such developments in the near future.

Road Safety – There are many accidents brought on primarily to the lack of control of the freight traffic and the poor condition of the roads.

Other services – There is one hotel and one motel in Chirundu, a small market and a number of licensed premises in Chirundu.

Tourism – The Gwabi lodge is situated a short distance from the proposed bridge site on the Kafue River and is used by canoe parties to gain access to the Lower Zambezi National Park.

Fisheries – The Zambezi supports an important subsistence and tourist industry and fish farm enterprises. There are over 120 species of fish occurring within the Chirundu reach of the Zambezi. The tigerfish is a main attraction for sport fishing and Safari groups practice a sustainable catch and release policy.

Noise and Air Quality – Dust is the major source of air pollution, and only the main road to Lusaka has a tarmac surface.

8.2. Likely Impacts of the Bridge Construction

Following the scoping exercise, the consultant does not consider there to be considerable environmental problems in the preliminary design results, however, there are some environmental problems and issues during the construction stage which will need great attention.

Many of these impacts will arise not only at the construction site but also at quarries, gravel sites and materials' storage areas serving the project. In addition, adverse environmental and socio-cultural impacts will occur during construction as a result of air pollution and soil contamination from asphalt plants, dust, noise from construction equipment; fuel and oil spills, trash and garbage; and the presence of non-resident labour forces.

8.3. Impacts on Land and Soil

Construction Phase

In this phase dust raised from gravel access roads by haulage trucks while transporting laterite, stone aggregate, cement, lime, petroleum products and other chemicals may change the soil structure. This impact is considered insignificant.

Soil contamination will be caused by leakages from the asphalt plant operations, poor handling of petroleum products such as oil and fuel spillage during dispensing as well as improper disposal of used oils, hydraulic fluids, toxic and empty oil containers.

Within the construction phase some activities involving site installation, stock piles preparation, quarrying, construction of detours, access roads, plant park sites and drainage excavation will cause soil destabilisation. Soil compaction by plant machinery and vehicles movement will lead to reduced groundwater yields.

Operational Phase

Abandoned excess laterite and stone aggregate littered around stock pile areas after construction is completed change the soil structure in the surrounding areas. Similarly devegetated areas resulting from post excavation and grading works including drainage channels enhance soil erosion on discharge areas.

8.4. Impacts on Vegetation

Construction Phase

The vegetation to be affected most is that which is confined to the river edge cliff and along the approach road reserve and also where gravel pits will be established.

Dust raised from gravel access roads by haulage trucks during the transportation of laterite, stone aggregate, cement, lime, petroleum products and other chemicals including emissions from plant machinery and vehicles hamper normal growth of roadside vegetation. Similarly poor disposal of toxic waste and petroleum products hampers normal growth of vegetation.

Loss of vegetation in this phase is caused by activities related to clearing of sites for installation of works, clearing of the quarry site, preparation of stock pile area, construction of detours, access roads and park sites and the demand for fuelwood by labour force.

Operational Phase

Laterite dust and littered stone aggregate from the excess construction material left after project works will hinder normal vegetation growth around the stockpile areas.

The project is famous for timber trading. Therefore over the life time of the bridge, an indirect impact could be an increase in illegal felling and sale of trees for timber, fuel wood and charcoal along this road caused by improved accessibility.

8.5. Impacts on Wildlife and Wildlife Habitat

Construction Phase

The impacts on wildlife in the project area is considered insignificant as the project is not located in the National Park.

Operational Phase

Impacts on wildlife are considered insignificant, as the project is not located in the National Park. Though there's a possibility of Elephants and monkeys crossing the bridge from the GMA during this stage. This remains insignificant for they can only access the bridge in the absence of the natives of the area – during night time.

8.6. Impacts on Water Quality

Construction Phase

The potential impacts on surface water is associated with the following:

- Changes to quality and flows of surface water due to excavation and drilling of the foundations and piles to the abutments and the pier and fuel leakages that may find its way into the Kafue River.
- Changes in quantity and quality of surface water available for abstractions for public and private water supplies due to piled foundations for other piers and abutments would be constructed using conventional augur-boring plant with spoil removed by augur, bucket or grab.
-
- Changes to hydrodynamic and sediment transport patterns due to reinforced concrete pile caps that would be constructed by excavating around the piles supported by sheet piles where necessary. The piles would be broken down to final size prior to construction of the reinforced concrete pile cap. The works would be dewatered as necessary.
- , and
- Changes to quantities and quality of runoff due to clearing and grubbing the re/aligned sections of the approach roads on both banks of the Kafue River.

Operational Phase

Excess construction material left after construction works may be washed into the water sources and lead to sedimentation of water sources and lowering of the water quality. Erosion of bare areas resulting from excavation and grading works and construction of drainage channels may increase runoff which will lead to sedimentation and increased turbidity in surface water as well as reduced groundwater infiltration.

Further hazardous materials spilled from haulage vehicles and washed into water sources will result in water pollution.

8.7. Impacts on Air Quality

Construction Phase

During construction phase large amounts of soil will be excavated and transported. The machinery used for excavation will generate dust, which can be dispersed by the wind affecting a zone of up to 100m around the excavation.

Emissions to the air in form of exhaust fumes and dust from vehicles and machines including operations from the asphalt plant may cause nuisance to the closest surroundings. Dust raised from gravel access roads by haulage trucks during transportation of materials will also pollute the air of the immediate local environment.

Operational Phase

Impact on air quality in the operational phase is likely to come from increased vehicular traffic flows which proportionately discharge emissions to the air. Also loose soils on cleared areas may be blown off during strong winds and raise dust particulate matter, which may affect the quality of the air.

8.8. Impacts of Noise

Construction Phase

During construction phase heavy machinery will be used for the excavation of soil. The machines are noisy and will cause a certain degree of nuisance to the surrounding environment.

The noise levels of machines and vehicles vary widely and depend on the type of noise generated and level of activity. A front end loader has for instance a power level of 100dB(A)

while a truck will have a power level of 85 dB(A). In the worst case a combined power level of 115 dB(A) will be in place during construction which will result in the 50 dB(A) contour being located at a maximum 250m from the construction site. However since the equipment will never work at exactly the same location the 50 dB(A) contour will be confined to the construction site and within the road reserve area.

Some common impacts of noise nuisance include annoyance, sleep disturbance and interference with communication. Acceptable levels of noise are regarded to be 40 dB(A) during the night and 50 dB(A) during the day. Since construction will take place during the day only the 50 dB(A) level is of importance.

Operational Phase

During operational phase the source of noise is expected to come from increased traffic and heavy vehicles using the rehabilitated road.

8.9. Impacts on Landscape and Aesthetics

Construction Phase

The construction activities that without mitigation would give rise to landscape and visual impacts of the project, over and above those experienced during operation would include the following temporary activities:

- Presence of construction camps, storage and stockpile areas and activities within them;
- Movements of construction machinery, plant and delivery vehicles on the existing road network and temporary haul roads;
- Presence and operation of cranes, large piling and earthmoving equipment, batching plants;
- Presence of construction activities within, above and on either bank of the Luena River;
- Removal or changes to landform, planting or other landscape features in addition to permanent changes identified during operation; and
- Closure of access to open space, footpaths, cycleways etc. as a result of construction activities.

Operational Phase

Abandoned structures, which are left near areas of scenic beauty after construction works, excess construction materials of laterite, stone aggregate and concrete slabs left in areas of scenic beauty reduces the quality scenery.

8.10. Impacts on Land-use and Surrounding Environment

Construction Phase

This section considers the potential direct impacts of the project on existing land uses. Impacts during construction arising from loss or damage of, or benefit to, land or facilities currently used are identified and their resultant effects on the ability to provide for such land uses are evaluated.

The effects of temporary land take are associated with,

- Construction camps,
- Working widths, and
- Haul roads.

Operational Phase

Increased traffic will entail a proportionate increase in exhaust fumes and will have an impact to the immediate surrounding environment.

8.11. Impacts on Socio-economic Environment

Construction Phase

During this phase skilled and unskilled labour will be required. Project areas are characterised by high level of unemployment and low level of skills and employment opportunities will therefore increase the positive benefits for the local people who are in dire need of income for sustenance. Furthermore, indirect opportunities for employment will arise from the provision of services to the construction teams, such as sale of food and beverages. In this sense the construction of the road may have a positive impact on the employment situation in the nearby communities. This impact is considered to be positive.

Operational Phase

Socio-economic benefits provided by bridge construction project will include all-weather reliable bridge crossing, reduced transportation costs, increased access to markets for local produce and products, better access to health care and other social services.

The National/ Regional Economy

Road transport is the dominant form of transport in land locked Zambia. It accounts for the majority of passenger and freight transport (excluding pedestrian transport) and provides the only access to many communities.

From a regional perspective the Chiawa bridge is one of the most important routes connecting Lusaka and Southern Provinces and a gateway to the Zimbabwe.

Thus, Chiawa bridge construction will have a significant positive impact on the economic activities in the region.

8.12. Impacts on Cultural and Historic Sites

Construction Phase

In the project area at about 31km from the project site lies the Chirundu National Fossil Forest Monument on the Lusaka-Chirundu road. The site is protected under the National Heritage Conservation Commission Act. The impact is considered insignificant.

Operational Phase

No additional negative impacts on cultural values are foreseen during operational phase.

8.13. Impacts on Human Settlements

Construction Phase

Physical relocation may occur on the government structures which may be affected by the re-alignment of the approach road. The potential impact is considered insignificant.

Operational Phase

No direct correlation was determined between migration and improved road. No additional negative impacts on human settlements are foreseen during the operational phase.

8.14. Impacts of Quarries and Borrow Pits

Construction Phase

During construction phase, a number of quarries and borrow pits may be opened up. Potential impacts include vegetation clearance and landscape scars resulting from the absence of re-vegetation programmes and poor excavation techniques. Extraction of construction materials from quarries and borrow pits could generate excessive noise caused by blasting, movement of machinery and labourers and thus impact on the nearby communities. Also increased air pollution due to diesel fumes and dust generation resulting from the presence of construction machinery and site clearing activities.

Quarries and borrow pits impact on the visual and aesthetic view. The excavated areas become prone to soil erosion during rain season and can contaminate nearby surface water.

Operational Phase

Quarries and borrow pits left abandoned after construction works could be a potential hazard to ecology and nearby communities. Transmission of diseases, such as malaria and their vector can occur in stagnant water collected in abandoned borrow pits. Malaria that is transmitted by the anopheles mosquito and diarrhoea are both water-related diseases. Thus the potential impact from poor extraction techniques and lack of re-vegetation programmes is considered significant. Further if the quarries and borrow pits are sited nearby communities the pits could become habitats for dangerous creatures such as snakes, which can easily attack unsuspecting children playing in these abandoned quarries and borrow pits.

8.15. Impacts of Road Traffic

Construction Phase

Construction traffic could negatively impact on undisturbed areas adjacent to the proposed route. The construction process could impede momentum of the existing traffic flow and may lead to the use of improvised detours by other motorists, which may compromise the safety of pedestrians if not properly planned.

Operational Phase

The traffic intensity on the complete bridge is likely to increase once the construction is complete and the bridge becomes operational. The additional flow may cause an increased number of accidents on the road. This increase in traffic may cause an increase in the number of accidents. The types of accidents include those involving vehicles, bicycles and pedestrians.

However, improved sight lines and replacement of road furniture will reduce some accidents. Overall, the potential impact of an increase in accidents is considered significant and negative.

8.16. Impacts of Work Accidents

Construction Phase

During the construction phase heavy machinery will be employed. Heavy machines make a lot of noise, cause carbon dioxide emissions and generate dust and may cause accidents among operators if not handled properly. This is likely to have a negative impact on health of the workers. To limit the risk of accidents, safety procedures will be put in place and enforced by the foreman to ensure that vehicles and machinery only drive in designated places by authorised personnel.

Operational Phase

As the bridge project would have completed there will be no workers on site and there will be no more impact from this phase.

8.17. Impacts of Construction Camps

Construction Phase

Construction of camps will require clearance of vegetation and this will result in loss of vegetation around the site. In addition waste will be produced at the camps including sewage and petroleum product waste. The potential impacts are significant and negative.

During construction phase, the construction team will interact with the nearby communities and can cause social upheaval and transmit diseases (STDs, HIV/AIDS) to the communities living along the route. The impact is therefore considered moderate and negative.

Operational Phase

At the end of the construction project, construction camps will either be demolished or handed over to the nearby communities and therefore the potential impact in this phase is considered insignificant.

9. EVALUATION OF ENVIRONMENTAL IMPACTS

Any project affects the environment and community through which it passes. The objective of this section is to predict and to assess these potential impacts of bridge construction and to recommend mitigating measures to be incorporated into the project design.

Issues identified during the course of this assessment are presented in Tables10-15. They have been grouped according to the stage of the project – Design, Construction, or Operation – in which they would be anticipated, and according to their "Significance". The terminology for this grouping and the basic criteria of the assessment, are presented below. The terminology and analysis describe the integrated environmental management procedure used to consider the like issues. Only those issues that merit a "Moderate" or "Serious" significance ranking are included in the tables.

9.1 Type of Impact

This is an appraisal of the type of effect the proposed activity would have on the affected environmental component. Its description should include what is being affected and in what way.

9.1. Direct: An impact that appears immediately as a result of an activity of the project. For example, the loss of forest habitat is a direct impact of logging.

9.2. Indirect: An impact that is related to the project but that arises from an activity of the project at a secondary level. For example, building a new road may cause indirect impacts on the local economy of a village by increasing accessibility to other markets.

9.2 Spatial Extent

The physical and spatial size of the impact. It is a description of whether the impact would occur on a scale described as follows:

- **Site,** the impact could affect the whole or measurable portion of the site. Whether it is limited to the immediate area of the proposed project;

- **Local,** the impact could affect the extended area adjacent to the site perhaps a neighbourhood or small town. Whether it would affect environs up to 15km outside the immediate environment;

- **Regional, t**hat impact could affect the area including the outlying areas of the city, the transport routes and the adjoining towns.

- **National,** the impact could be as far reaching international boundaries.

9.3 Duration

The lifetime of the impact; this is measured in the context of the life-time of the proposed development.

- **Short term,** the impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase.
- **Medium term,** the impact will last for the period of the construction phase, thereafter it will be entirely negated.

- **Long term**, the impact will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter.

- **Permanent**, the only class of impact which will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient.

9.4 Intensity

A description of whether or not the intensity (magnitude) of the impact would be high, medium, low or negligible (no impact). An attempt will be made to quantify the impacts on components of the affected environment will be described as follows: Is the impact destructive, or benign? Does it destroy the impacted environment, alter its functioning, or slightly alter it? These are rated as follows:

- **Low**, where the impact will not have significant influence on the environment, and this will not be required to be significantly accommodated in the project design or implementation; the impact alters the affected environment in such a way that natural processes of functions are not affected in any significant way.

- **Moderate**, where it could have an adverse influence on the environment which would require modification of the project design or alternative implementation schedules; The affected environment is altered, however, function and process continue, albeit in a modified way.

- **High**, where it could have significant influence on the environment but cannot be mitigated or be accommodated by the project environment by introducing alternative mitigation measures such as realignment at a particular stretch or adoption of different design measures. Function or process of the environment is disturbed to the extent where it temporarily or permanently ceases.

- This will be a relative evaluation within the context of all the activities and the other impacts within the framework of the project. Note that some impacts have a high intensity and a short duration with no permanent audio effects.

9.5 Probability

This describes the likelihood of the impacts actually occurring. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows:

- **Unlikely**, the probability of the impact occurring is very low, due to either the circumstances, design or experience.

- **Possible**, the impact could possibly happen, and mitigation planning should be undertaken.

- **Probable**, it is most likely that the impact will occur at some or other stage of the development. Plans must be drawn up before the undertaking of the activity.

- **Definite**, the impact will take place regardless of any prevention plans, and only mitigatory actions or contingency plans can be relied on to contain the effect.

9.6 Determination of Significance

Significance is determined through a synthesis of impact characteristics or combination of effects. Significance is an indication of the importance of the impact in terms of physical extent, intensity and time scale, and therefore indicates the level of mitigation required.

The classes are rated as follows:

- **Negligible**, the impact is not substantial and does not require any mitigatory action.
- **Low**, the impact is of little importance, but may require limited mitigation.
- **Moderate**, the impact is of importance and therefore considered to have mitigation. Mitigation is required to reduce the negative impacts to acceptable levels or positive impacts maximised.
- **High**, the impact is of great importance. Failure to mitigate, with the objective of reducing the impact to acceptable levels, could render the entire development option or entire project proposal unacceptable. Mitigation is therefore essential. Positive impacts should be enhanced as a priority.

From the baseline information assembled in the previous chapter coupled with the information gained during the consultation stage, the expected environmental impacts can be categorised into positive and negative impacts.

In addition, it is important to consider the duration of the impact and at what phase of the project it occurs, i.e. impacts during the rehabilitation phase or impacts over the life of the road (operational phase) and whether the impacts are *direct* (i.e. removal of vegetation) or *indirect* (increased deforestation as a result of the improved road).

The direct impacts would be experienced mainly during the rehabilitation process, and include effects on the physical environment, health and safety of the residents along the road and the construction workers during the rehabilitation phase.

The indirect impacts are primarily socio-economic and extend beyond the project implementation. The indirect impacts include changes in economic activities and long-term changes, such as increased land degradation due to increased settlement and development along the road.

Unlike the direct impacts, which occur in the immediate environment, the indirect impacts would be felt in the adjacent regions.

Table 10: Evaluated Impacts: Impacts of Moderate Significance During Design Phase

Impact	Type	Extent	Duration	Intensity	Probability
Quarries and Borrow Pits					
Quarries and borrow pit location may negatively impact important ecological units.	Direct	Site	Medium term	Moderate	Probable
Road Traffic					
Failure to use established routes may result in surveyors' vehicles negatively impacting on the environment.	Direct	Local	Short term	Low	Possible

Table 11: Potential Environmental Impacts of High Significance During Construction Phase

Impacts	Type	Extent	Duration	Intensity	Probability
Vegetation					
Loss of vegetation due to site clearing will reduce habitat and displace fauna species, especially avifauna.	Direct	Local	Medium term	Moderate	Probable
Water Quality					
Water shortage to local community due to over exploitation for project activities.	Direct	Local	Medium term	High	Possible

Table 12: Potential Environmental Impacts of Moderate Significance During Construction Phase

Impact	Type	Extent	Duration	Intensity	Probability
Soil					
Soil contamination due to improper storage of materials, fuels and poor waste oil disposal methods.	Direct	Site	Medium term	Moderate	Probable
Exposed soil is prone to erosion by water or wind.	Direct	Site	Medium term	Moderate	Probable
Stripping and stockpiling of topsoil could lead to erosion and degradation of soil quality.	Direct	Site	Medium term	Moderate	Probable
Soil compaction could result following construction activities.	Direct	Site	Medium term	Moderate	Probable
Vegetation					
Retardation of vegetation growth due to contamination from dust particles and gas emissions.	Direct	Local	Medium term	Low	Unlikely
Wildlife & Habitat					
Disturbance to birds and animals and loss of habitat.	Direct	Site	Long term	Moderate	Possible
Water Quality					
Siltation of water courses due to soil erosion of nearby drains and culverts.	Indirect	Local	Long term	Moderate	Probable
Ground water contamination due to construction of sub-standard campsite pit latrines for workers.	Indirect	Site	Long term	Moderate	Probable
Air Quality					
Air pollution from diesel fumes and dust from excavation and grading as well as site clearing will affect human health, vegetation, and associated fauna	Direct	Local	Short term	Moderate	Probable
Unpleasant odours due to un-maintained toilets and poor waste management.	Direct	Site	Short term	Moderate	Probable
Landscape and Aesthetics					
Disfigurement of the natural landscape and aesthetic view due to construction works.	Direct	Local	Moderate	Moderate	Definite
Land Use					
Construction of temporary detours will disturb the environment within the immediate and surrounding environment.	Direct	Local	Short term	Moderate	Possible
If labour is not recruited from local areas people from far away places may come to settle near the project site in a bid to get employed by the project and this may change land use in the project area.	Indirect	Local	Short term	Moderate	Probable

Table 13: Potential Social Impacts: Social Impacts of Moderate Significance During Construction Phase

Impact	Type	Extent	Duration	Intensity	Probability
Socio-Economic Environment					
Temporary marriages, casual sex relationships and more chances of transmission of sexually transmitted diseases due to interaction of project workers with local communities.	Indirect	Local	Short term	Moderate	Probable
Cultural and Historic Sites					
Dust may disfigure the appearance of the site	Indirect	Site	Short term	Moderate	Probable
Construction of detour next to the site may lead to loss of heritage site. The Chirundu Fossil Forest Monument is located away from the project site.	Direct	Site	Long term	Moderate	Probable
Noise					
Excessive noise from blasting, machinery may disturb nearby communities.	Direct	Local	Medium term	Moderate	Definite
Road Traffic					
Construction traffic could impact on undisturbed areas adjacent to the proposed route.	Indirect	Local	Medium term	Moderate	Probable
Excessive dust from construction works could disturb nearby communities.	Direct	Site	Short term	Low	Probable
Work Accidents					
Lack of safety and health regulations could impact negatively on construction workers.	Direct	Site	Medium	High	Low
Construction Camp					
Improper disposal of waste.	Indirect	Site	Short term	Low	Probable
Interaction of construction workers with nearby communities increases risk of transmission of sexually transmitted diseases.	Indirect	Site	Short term	Moderate	Probable

Table 14: Potential Impacts of Moderate Significance During Operational Phase

Impacts	Type	Extent	Duration	Intensity	Probability
Soils					
Soil erosion near culverts and drainage channels where water velocity could increase.	Indirect	Local	Long term	Moderate	Possible
Soil contamination by waste and spillages of road users and un-maintained vehicles.	Indirect	Local	Long term	Moderate	Possible
Vegetation					
Increased access as a result of the bridge construction could lead to increased deforestation in the Chiawa area.	Indirect	Site	Long term	Low	Possible
Wildlife and Habitat					
Wildlife loss due to accidental killings caused by speeding as a result of increased traffic into Chiawa area.	Indirect	Site	Long term	Moderate	Possible
Disruption to wildlife routes due to quarries and borrow pits left in wildlife areas without rehabilitation.	Direct	Local	Long term	Moderate	Possible
Noise disturbance to wildlife due to increased traffic.	Indirect	Site	Long term	Moderate	Possible
Water Quality					
Sedimentation and increased turbidity in surface water caused by erosion of bare areas and runoffs resulting from excavation and grading works and drainage channels left after construction works.	Indirect	Local	Long term	Moderate	Possible
Air Quality					
Excessive diesel fumes due to un-maintained equipment.	Indirect	Site	Long term	Moderate	Possible
Noise					
Noise and vibration caused by construction machinery, equipment and drilling.	Direct	Site	Short term	Moderate	Probable
Landscape and Aesthetics					
Abandoned construction structures, excess construction materials of laterite, stone aggregate and concrete slabs left in areas of scenic beauty reduces the quality of scenery.	Direct	Site	Moderate	Low	Probable

Table 15: Potential Social Impacts of Moderate Significance During Operational Phase

Impacts	Type	Extent	Duration	Intensity	Probability
Socio-Economic Environment					
Increased road accidents due to increased traffic and speeding on black spots areas.	Indirect	Site	Long term	Moderate	Possible
Un-rehabilitated borrow pits could pose potential hazard to ecological units and residents.	Indirect	Local	Long term	Moderate	Possible

Table 16: Table of Evaluated Impacts: Impacts of Low or Negligible Significance During Operational Phase

Impacts	Type	Extent	Duration	Intensity	Probability
Noise					
Noise from increased traffic.	Indirect	Site	Long term	Low	Possible
Land Use					
Exhaust fumes to the surrounding environment due to increased traffic.	Indirect	Site	Long term	Low	Possible
Road Traffic					
Increased accidents due to increased traffic flow.	Indirect	Site	Long term	Moderate	Possible

10. MITIGATION MEASURES

10.1 Significant Issues and Proposed Mitigation Measures

This section proposes mitigation measures for identified potential impacts as discussed in Chapters 9. Mitigation measures are actions that are intended to avoid, alleviate or reduce environmental impacts on the environment. Mitigation measures form the basis on which the Environmental Management Plan has been formulated. The mitigation measures are set forth to maximise positive impacts and minimise negative impacts as a result of the proposed bridge construction.

Table 17: Mitigation Measures: Design Phase

Impact	Mitigation Measures
Landscape and Aesthetics	
Visual impact of the new bridge could be substantial if designs are not compatible with the slope angles of the surrounding environment.	Development of the designs for the bridge must be compatible with the slope angles of the surrounding environment.
Land-use and Surrounding Environment	
The proposed project might influence migration and settlement patterns if labour requirements are not planned in advance.	Local people with the necessary skills shall be employed for the project works;
	Resettlement of communities in new areas shall be done in consultation with host or existing community.
Cultural and Historic Sites	
The impact on heritage sites is insignificant as there are no heritage sites in the vicinity of the project.	The provisions of the National Heritage Conservation Commission shall apply.
Quarries and Borrow Pits	
Quarries and borrow pit location may negatively impact on important ecological units.	Quarrying shall not be done near surface water sources.
	There shall be no quarrying near Chirundu Fossil Forest Monument.
Road Traffic	
Failure to use established routes might result in surveyors' vehicles negatively impacting on the environment.	Surveyors should not venture too far away from the proposed route in order to avoid impacts on the surrounding environment.
Work Accidents	
Failure of advanced planning of safety requirements	Development of safety procedures and operational manual.
Construction Camps	
Failure of advanced planning of construction camp siting.	Selection of camp siting must be done in consultation with the local authority and local people.

Table 18: Mitigation Measures: Construction Phase

Impact	Mitigation Measures
Land and Soil	
Soil contamination due to improper storage of materials, fuels and poor waste oil disposal methods	Petroleum products dispensing points shall have drip pans.
	Storage of potential pollutants such as fuel, oil and chemicals should be done on sealed surfaces to prevent soil contamination.
	Collection and recycling of used oil & lubricants.
	Petroleum storage tanks shall have bund walls around and shall be high enough to contain any spillage.
Exposed soil is prone to erosion by water or wind.	Limitation of earth moving to dry periods.
	Protection of susceptible soil surface with mulch.
	Protection of drainage channels by stone pitching.
	Installation of sedimentation basins or planting of erodible surfaces as soon as possible.
Stripping and stockpiling of topsoil could lead to erosion and degradation of soil quality.	Exposed soil should be avoided by selective soil stripping.
	Areas requiring less clearing shall be preferred for stock piles. Clearing shall be limited to the site approved by the local authorities.
Soil compaction could result following the construction activities.	Only heavy equipment with pneumatic tyres shall be used on access roads.
Vegetation	
Retardation of vegetation growth due to contamination from dust particles and gas emissions.	Dust control by application of water.
	Haulage trucks shall not exceed the speed limit of 60km per hour.
Loss of vegetation due to site clearing which will lead to loss of habitat and displacement of fauna species, especially avifauna.	Less vegetated areas shall be preferred.
	Careful site planning.
	Implementation of the EIA-EMP mitigation measures.
Wildlife and Wildlife Habitat	
Disturbance to birds and small animals and loss of habitat.	Construction of new bridge and approach road should be confined to the project site.
	Noisy activities to be scheduled to occur within prescribed normal working hours.
Water Quality	
Siltation of water courses due to soil erosion of nearby drains and culverts.	Sides of the drainage shall be planted with grass or stone pitched.
	Drainage systems shall have scour checks.
	Drainage systems shall discharge into settlement basins.
	Silt traps shall be put along drainage systems.
Water shortage to the local community due to over exploitation for rehabilitation works.	Exploitation of water sources for rehabilitation works shall be done with approval by the local authority and with consent from the local community.
Ground water contamination due to construction of sub-standard campsite pit latrines for workers.	Proper siting of pit latrines away from water logged areas.
	Good hygienic standards and proper maintenance of pit latrines.

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Table 18: (Continued) Mitigation Measures: Construction Phase

Air Quality	
Air pollution caused by exhaust fumes and dust from excavators, bull dozers, graders as well as site clearing will affect human, vegetation and also disturb habitats for birds and insects.	Regular maintenance of construction vehicles and equipment in order to reduce emission of exhaust fumes.
	Periodically water down on temporary roads.
Unpleasant odours due to un-maintained toilets and poor waste management.	Cleaning and regular maintenance of toilets to avoid unpleasant odours.
	Waste should be carefully managed to prevent unpleasant odours.
Noise	
Noise and vibration caused by construction machinery, equipment and drilling.	Working hours limited to day light only.
	Enforcement of the Factories Act by the Factories Inspectorate under the Ministry of Labour.
Landscape and Aesthetics	
Disfigurement of the natural landscape and aesthetic view due to construction works.	Development designs which are compatible with the final slope angles of the surrounding environment.
Land-use and Surrounding Environment	
Construction of temporary detours will disturb the environment within the immediate and surrounding environment.	Detours, access roads and equipment park site location shall be done in consultation with local people and take into account the existing land use in settled areas.
If labour is not recruited from local areas people who reside far away places may start to settle near the project site in a bid to get employed by the project.	Local people with the necessary skills shall be employed in the project.
	Resettlement of communities in new areas shall be done in consultation with host or existing community.
Socio-economic Environment	
Temporary marriages, casual sex relationships and more chances of transmission of sexually transmitted diseases due to interaction of project workers with local communities.	There shall be provision of education both to the local community on STDs and HIV/AIDS using aids such as video shows, pamphlets, talks, etc.
Cultural and Historic Sites	
Dust may disfigure the appearance of the site	The provisions of the National Heritage Conservation Commission shall apply.
The impact on heritage sites is insignificant as there are no heritage sites in the vicinity of the project..	The provisions of the National Heritage Conservation Commission shall apply.
Human Settlements	
Although no significant impacts on human settlements are foreseen since construction works will be confined to the project site, re-alignment of the approach road will cause physical relocation of huts belonging to ESCO employees currently operating the pontoon.	Rehabilitation shall be confined to the road reserve area.
	Physical relocation will be done to government huts being used by ESCO employees.
Quarries and Borrow Pits	
Excessive noise from blasting, machinery may disturb nearby communities.	Quarrying shall not be done nearby communities.
	Quarrying shall be done in conformity to the Mine and Minerals Act, No. 31 of 1995.

Continued on next page.

Table 18: (Continued) Mitigation Measures: Construction Phase

Road Traffic	
Construction traffic could impact on undisturbed areas adjacent to the proposed route.	Established routes should be used where possible in order to reduce impacting on undisturbed areas.
	Construction vehicles must use pre-determined access roads as determined in the design phase.
	Allowance should be made for alternative routes for existing road users during construction.
Excessive dust from construction could disturb nearby communities.	Control of dust through watering of dust roads.
Work Accidents	
Lack of enforcement of safety and health regulations could impact negatively on construction workers.	Enforcement of Public health and safety regulations.
Construction Camps	
Loss of vegetation at construction site.	Clearing for camp siting must be limited to the actual site to avoid vegetation loss on a larger scale.
Waste generation at campsite.	Waste disposal to be done at designated sites approved by the local authority and ECZ.
Interaction of construction workers with the nearby communities may lead to transmission of sexually transmitted diseases.	Education provided both to the local community and camp workers on STDs and HIV/AIDS using video shows, pamphlets, talks, etc.
	Local people with the necessary skills shall be employed by the project.

Table 19: Mitigation Measures: Operational Phase

Land and Soil	
Soil erosion near culverts and drainage channels where water velocity could increase.	Soil erosion should be prevented especially near culverts by construction of correctly designed culverts.
	Regular maintenance of culverts & drainage channels.
Soil contamination by waste and spillages of road users and un-maintained vehicles.	ECZ Regulation of waste disposal.
	Law enforcement to ensure that only roadworthy cars that are maintained are on the road.
Vegetation	
Increased access as a result of the new bridge could lead to increased deforestation in the Chiawa area.	Provision of a forest conservation awareness programme to communities in the project area.
Wildlife and Wildlife Habitat	
Wildlife loss due to accidental killings caused by speeding traffic as a result of increased traffic using new bridge.	The project shall have adequate road furniture signs for warning road users of wildlife presence.
Noise disturbance to wildlife due to increased vehicular traffic.	Control of noisy activities on site (local by-laws).
	ECZ Regulation of Noise.
Water Quality	
Sedimentation and increased turbidity in surface water caused by erosion of bare areas and runoffs resulting from excavation and grading works and drainage channels left after construction works.	Excavated soils shall be used for other road works such as shoulder building.
	Sides of drainage channels shall be planted with grass or stone pitched.
	Drainage systems shall have scour checks.

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Table 19: (Continued) Mitigation Measures: Operational Phase

Air Quality	
Excessive diesel fumes due to un-maintained equipment.	Law enforcement to ensure that only road worth cars that are maintained are on the road.
Noise	
Noise from increased traffic.	Enforcement of the EPPC ActSection VIII on Noise.
	Control of noise activities on site (local by-laws).
Landscape and Aesthetics	
Abandoned construction structures, excess construction materials of laterite, stone aggregate and concrete slabs left in areas of scenic beauty reduces the quality of scenery.	Abandoned structure in areas of scenic beauty shall be converted into visitor facility.
Land-use and Surrounding Environment	
Exhaust fumes to the surrounding environment due to increased traffic.	ECZ Regulation on air pollution.
	Adherence to engine maintenance schedules and standards to reduce air pollution.
Socio-economic Environment	
Increased road accidents due to increased vehicular traffic and over speeding in black spots areas.	Provision of adequate warning road signs in black spot areas and speed retarders at pedestrian crossing site.
Human Settlements	
Improved transport through bridge construction enhances accessibility, mobility and economic activities for the communities in the project area.	There shall be no conversion of communal land into state land around the project area.
The new bridge may lead to increased human settlements, changed settlement patterns, increased cultivation and commercial activities along the roads.	There shall be no conversion of communal land into state land around the project area.
The new bridge may lead to increased land values and land resource tenure along the roads,	There shall be no conversion of communal land into state land along the improved roads.
The new bridge may increase risks of road traffic accidents to communities along the road.	Speed limits of 40km per hour shall be observed in settled areas.
	The approach road in settled areas shall have appropriate and adequate pedestrian crossing facilities.
The new bridge may increase traffic volume thus lead to increased health risks to communities along the approach road from vehicle emissions.	Trees shall be planted along the approach roads in settled areas to minimize noise and hazardous emissions.
Noise due to high traffic volumes using the new bridge could disturb communities along the approach road.	Trees shall be planted along the road in settled areas to minimize noise and hazardous emissions.
	Noise barriers shall be erected in settled areas where traffic noise may exceed 90 decibel.
Quarries and Borrow Pits	
Un-rehabilitated borrow pits could pose potential hazard to ecological units and residents.	Quarrying shall not be done near water sources and human settlements.
Road Traffic	
Increased accidents due to increased traffic flow.	Provision of adequate warning road signs in black spot areas and speed retarders at pedestrian crossing site.

10.2 Specific Issues Relating to Quarries and Borrow Pits

There are many concerns that may arise from borrow pits and associated operations. Some of them could be the direct effects it has on the environment, the public welfare by destroying or diminishing the utility land for commercial, residential, industrial, agricultural land etc. Below is the list of some of the environmental impacts.

10.2.1 Noise Pollution

Borrow pit and quarrying is associated with noise and many communities are concerned with two areas in this category.

- Noise produced by traffic i.e. trucks moving to and from the site
- Noise emanating from blasting.

One of the major concerns of many communities is the traffic associated with quarries' operations. As a consequence additional drive safety and courtesy training will be required and speed restriction should be actively enforced.

Some of the effects of noise and vibration to communities are:

- Annoyance and sleep loss – surface transport is the major source
- Hearing damage – especially to those exposed to fragments

The Mine Safety and Health Administration (MSHA) regulation provides for the hearing protection of surface mining employees. The limitation for an 8-hour working day is 90 dBA. For every 5 dBA increase in sound level, the allowable time of exposure is reduced by one-half e.g. 95 dBA exposure for 4 hours 100 dBA for 2 hours etc. If every intense noise levels of the order of 135 dB or above at any frequency in the hearing range are experienced, immediate hearing damage is likely to result. However, permanent hearing damage is also produced at much lower sound pressure levels if the noise is experienced over many periods (weeks, months or years).

During the few times when blasting will be done at site, the contractor should ensure that conditions that are adequate are imposed like not blasting at peak hours and notifying the public before any blasting is done. The contractor should follow the mines and minerals act on the use of explosives like ensuring that only people with blasting licences handle explosives at project site.

The contractor shall educate its workforce on the use of hear protectors, ear piece/muffs and ear plugs.

10.2.2 Air Pollution (Dust)

Dust is defined as minute solid particles of matter that may form clouds in air having been stirred up as a result of various kinds of activity or disturbance.
The air quality at and around the project site is directly linked to:

(a) Traffic leaving and entering the site
(b) Blasting
(c) Crushing and excavation process

Of particular interest are particulates from these activities, which may contain silica as discrete silt-or-sand-size grains of minerals. These grains may be disseminated on the rock or concentrated in laminae and bids. Dentrital rock especially may contain a considerable percentage of quartz silt and sand. These particulates may contain reparable crystalline silica, which when combined with oxygen from the atmosphere, crystalline silica form silicon dioxide (SiO_2), which may cause silicosis, bronchitis, fibrosis (Scar tissue in the lungs) granulomalosis infections (such as tuberculosis) and lung cancer. The international agency for Research on Cancer (IARC) placed crystalline silica in Group 2A, as probably carcinogenic to humans.

Silicosis is defined as a fibrotic lung disease characterized by the formation of small nodules on the lungs. Symptoms include shortness of breath, fever and cyanosis (bluish skin) progressive

diminutive of working capacity and complete incapacity. Workers exposed to crystalline silica risk being attacked by silicosis depending on particle size, concentration and duration of exposure.

Acute silicosis – exposure to high concentrations of crystalline silica over a short period of time.

Accelerated Silicosis – is the result of high exposures to crystalline silica and may develop 5 to 10 years after the initial exposure.

Chronic Silicosis – results from prolonged exposures to low concentrations of free crystalline silica and may not develop until after 10 or more years of exposure.

One of the factors which should be considered is prevention of dust at source. The first principle that should be at play is suppression of dust using water at the site. Water should be used to spray surfaces where dust may be liberated as a result of blasting, dumping, traffic or any other rock processes. The others are;

- Workers should be encouraged to wear respiratory protective clothes.
- Provision of adequate ventilation at the site
- Binding dust in dust collectors of filtration devices at site.

Workers should be exposed to pneumoconiosis check ups every often (every six months) and an entitlement to milk every day.

10.2.3 Impact on Vegetation

Clearing of vegetation will be limited to the borrow and quarry site. At and around the project site the top soil stock pilling is likely to disfigure the landscape. Though in the long run there will be need to work around decommissioning after finishing the bridge.

The areas where over burden will be placed shall be allowed to re-vegetate at a later stage with grass and trees.

10.2.4 Overburden

Removal and disposal of over burden are challenges facing crushed stone operators. Over burden is in most cases wasted but ideally strata mining has a plan of placing the material where it will not need to be moved twice.

The material (over burden) would be used for creating barriers (visual or sound), which will help with attractiveness of the operation.
Alternatively, the material will be stock piled for future redemption by grading and seeding so as to prevent erosion and loss.

10.2.5 Impact on Soil

There is a potential impact for soil compaction as heavy machinery work on site. And the fact at soil and rock excavation and removal of over burden will be in progress, soil erosion is also a possibility. Exposed soils may be lost through rain water and further degrade the water courses.

Contractor should formulate a deliberate program to re-vegetate areas where erosion and other vices arising from operations would have occurred. Trucks and other heavy-duty

machinery should have a permanent service route to avoid soil compaction on the bigger acreage.

10.2.6 Impact on Topography

The operation of borrow pit and quarry mining is generally open mining. This means that they will Impact on landscape since there will be a pit, which will be generated by excavation and rock removal. These pits could pose as a great danger to surrounding communities when filled with rainy water and could pose as fertile grounds for mosquito breeding and multiplication.

Another impact is the removal and disposal of overburden, which will ideally cover the soils and disfigure the topographic appearance of the area.

- Over burden will be used for beams to fill road surfaces, create visual or sound barriers which will in the end assist with the attractiveness of the operation.
- This same over burden could be used for brick making cement raw materials or land fills.
- Resultant pit could be used as a water reservoir for agricultural purposes after work has been completed.
- Workers should be informed on the dangers of the pits. There should be clear signs that will indicate that one is in the vicinity of a pit and at closure the pits be fenced off.

10.2.7 Impact on Land Use

With the growth of bridge construction works access roads will be expected to improve which may give rise to increased settlements on the peripheral of project. These could initiate unplanned development and modification of natural environment.

- Control measures should be put in place such as sensitizing the communities on the mode of employment offers to discourage these settlements
- The contractor should ensure close collaboration with the local authorities (Council, ECZ) in curbing/reducing illegal settlements.

10.3 Proposed Measures to Address Concerns of the Communities in the Project Area

10.3.1 Road Site and Its Surroundings

Detours, access roads and equipment park site location shall be done in consultation with local people and shall take into account the existing land use in the settled areas.

10.3.2 Quarries and Borrow Pits

Quarries and borrow pits shall not be done near the communities. However, construction waste may be reused for rehabilitation of the borrow pits.

10.3.3 Selection of Camp Site

Selection of camp siting shall be done in consultation with the local authority and local community. This will help to deal with social upheavals such as temporary marriages, casual sex relationships and more chances of transmission of sexually transmitted diseases due interaction. There shall be sensitization to both construction workers and the local community on STDs and HIV/AIDS using aids such as video shows, pamphlets. Further waste disposal from camp site shall be done at sites designated by the Local Authority and ECZ.

10.3.4 Abstraction of Water from Local Sources

Exploitation of water sources for construction works shall be done with approval by the local authority and with consent from the local community. This will avoid conflicts and also to receive support from the local community.

10.3.5 Drainage Desgin/Culverts

Drainage systems shall discharge into settlement basins where water may collect which could then be available to the local community for livestock use.

10.3.6 Road Accidents & Black-Spots

Provision of adequate warning road signs in black spot areas and speed retarders at pedestrian crossing areas.

10.3.7 Project Benefits to the Local Community

The Contractor shall ensure that the local people with the necessary skills are employed in the road project.

10.3.8 Detour, By-pass, Lay-bys and Access Roads

Detours, access roads and equipment park site location shall be done in consultation with local people and shall take into account the existing land use in the settled areas.

10.3.9 District/Community Role in the Project

The District/local community shall participate in the project through their local authority during the project implementation phase. The EMU shall ensure that the local authority becomes part of the project monitoring team during the implementation of the mitigation measures by the Contractor in those areas under the jurisdiction of the local authority. A report on the contractor's performance prepared by the EMU shall also be made available to the affected in the respective areas. The major communities along the road, which should be considered as part of the project monitoring team, are Chirundu and Chiawa. This will ensure that the community's concerns expressed during the scoping report and stated in this report are not overlooked.

11. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

11.1 Introduction

The EIA Regulations state that the developer must provide an Environmental Management and Monitoring Plan. An EMP is a document where all the measures that are required for environmental protection, which will include the mitigation measures and the monitoring plan, will be found for easy reference. The aim of an environmental management plan is to avoid, minimise, or ameliorate effects or impacts resulting from project implementation and where possible, enhance beneficial effects.

In reality, the environmental management plan seeks to limit the interaction of disturbed with undisturbed lands and through the various process of road rehabilitation, restore the disturbed land to a pre-determined form of land-use or to a productivity level similar to that occurring prior to disturbance.

11.2 Environmental Management Plan

Environmental management is carried out in all stages of the Project namely; Pre-construction, Construction and Operational. The key stakeholders in the environmental management activities are: RDA-Environmental Management Unit, Environmental Council of Zambia, the Consultant, the Contractor, Government agencies, Local Authorities, the affected Local Communities, the Road users and the general Public.

Effective environmental management during pre-construction and construction requires the establishment of effective institutional arrangement for the implementation of the EIA. For optimum effect, any environmental management programme should be carried out as an integrated part of project planning and execution, making a significant and continuous contribution to the overall development of the scheme. It must not be seen merely as an activity limited to monitoring and regulating activities against a predetermined checklist of required actions. Rather it must interact dynamically as project implementation proceeds, dealing flexibly with environmental impacts – both expected and unexpected as they arise. For this reason the plan should provide for periodic audits which will serve to evaluate compliance of on-site environmental management practices with the EMP requirements and also to refocus the plan in the light of experience and issues arising.

The construction of the bridge will present challenges in terms of maintaining environmental quality; minimising nuisance and disturbance to local residents; and ensuring supplies of essential requirements such as clean drinking water, energy, medical care and schooling to the construction workforce, their families and local residents during the construction period.

The broad objective of the EMP will be to ensure that the various environmental protection measures identified during the planning phase are implemented during the construction phase, so that environmental degradation and pollution resulting from construction activities are minimised.

Specific objectives of the plan are to:

- Define organisational and administrative arrangements for environmental monitoring of the contracts, including the definition of responsibilities of staff, and the coordination, liaison and reporting procedure.
- Discuss procedures for proactive environmental management so that potential problems can be identified and mitigating measures adopted, prior to works being carried out.

The tender documents should require the Contractor to state his environmental policy. The designation of clear responsibility for environmental protection within the Contractor's organisation is a critical factor in the achievement of good environmental control.. This should include:

- Details of their organisational framework
- Details of the principal pollution control facilities proposed
- Details of the proposed environmental monitoring procedures
- Details of the environmental awareness training programme proposed for the workforce.

From the Resident Engineer's side an Environmental Monitor should be assigned either directly through the project. Alternatively this role should be carried out by the Environmental Management Unit of the RDA. The Environmental Monitor has to act on two levels, on the one side he has to give overall advice and define the general procedures which will include environmental reports, on the other side he will be involved in the establishment of the day to day monitoring procedures. Monthly reporting procedures will summarise the issues arising and actions taken and required and the EM should attend the site progress meetings, where environmental issues will be a part of the agenda. Liaison with the local community will be important during the construction period, to ensure that their views are being taken into account and that problems and nuisances, such as noise and dust, are reduced to a minimum.

The Environmental Management Plan for the management of the identified environmental impacts associated with this project consists of three main components:

1. Implementing the Impact Mitigation Plan
2. Monitoring the implementation of the EMP
3. Institutional Framework for Monitoring, Reporting and Supervision of EMP

11. 3 Impact Mitigation Plan

The impact mitigation plan allocates the responsibilities for implementation of the proposed mitigation measures to the various stakeholders and indicates at what stage in the project they should be performed. The Plan is presented in this chapter under Section 12.3 and it addresses the negative impacts generated by the rehabilitation works and presents the associated cost estimates of mitigating the adverse impacts. The key components of the proposed impact mitigation plan are:

- Land and Soil
- Vegetation
- Wildlife and Wildlife habitats
- Water Quality
- Air Quality
- Noise
- Landscape and Aesthetics
- Land-use and Surrounding Environment
- Socio-economic issues
- Cultural and Historic Sites
- Human Settlements
- Quarries and Borrow Pits
- Work Accidents
- Construction Camps
- Road Traffic

a) Surface Water Management

Surface water is an important component of both ecological and human use of the land. The aim of the surface water management programme is to ensure that where practical, flows into

and through the project site and the nearby streams are maintained and that water quality to these systems is maintained.

b) Erosion Control and Sediment Retention

The highly flocculated nature of the soils in the project areas indicates that they are prone to erosion in a disturbed state. According, and where appropriate, all surface runoff from areas of disturbance and areas with elevated runoff coefficient will be directed by correctly designed drainage system, to sediment traps with sufficient volume and retention time to maximise settlement of suspended sediment prior to release.

The drains will be designed according to the characteristics of peak flows for the pre-determined design storm, and the requirement to discharge flows without causing erosion.

c) Vegetation and Flora

A number of management initiatives will be implemented to reduce potential impacts and disturbance to flora and vegetation. These include:

- Raising awareness in the workforce about conservation issues and legal obligations of construction workers by structuring the environmental awareness programme to include issues relating specifically to project site.
- Designing the project layout to reduce the area of clearing required.
- Clearly marking and restricting access to areas of high conservation value.
- Providing adequate drainage control systems along the road and access tracks constructed as part of the project.
- Establishing an efficient dust suppression plan in all areas where the generation of dust has been identified as an environmental management issue.
- Retaining topsoil, and vegetation wherever possible during clearing for use during restoration.
- Progressively rehabilitating disturbed areas as they become available and are no longer required for project operations.

d) Fauna

Experience indicates that fauna adapt readily to the general effects of project operations. However; it is most likely that the more mobile species will tend to move away from the areas of greatest activity during rehabilitation but will return during the operation of the road. Potential impacts on fauna will be reduced by:

- Restricting disturbance and clearing of habitats to the minimum required for safe and efficient operations.
- Where appropriate installing fauna access zones along access corridors.
- Progressively rehabilitating disturbed areas to re-establish habitats;
- Declaring a 50m *'no-go'* buffer zone around the nearby Stream to prevent disturbance.
- Avoiding road shoulder effects generally throughout the rehabilitation project by providing appropriately designed roadside drainage systems.

e) Construction Waste

Construction waste will be generated as a result of road rehabilitation. All construction waste that has been generated will be recycled or placed in designated disposal sites and covered with soil.

f) Noise.

Noise management will be limited to standard sound retarding devices on all operational vehicles as recommended by the manufacturer. Noise generated from operations at the project site is not expected to impact on local communities due to the distances between the

operations area and areas of habitation. However, the Environmental Management Unit from Roads Department will investigate any noise complaints received.

g) Management of Air Quality

Throughout road rehabilitation standard water trucks will use water to suppress dust. The water trucks will continually apply water to potential dust generation areas such as the main detours and access roads.

h) Rehabilitation of De-vegetated Areas

Rehabilitation will be ongoing and progressively throughout the life of the project. Evidence to date indicates that the re-vegetation of disturbed areas will be both natural and rapid. As the first principle of rehabilitation is long –term stability, practices that address this issue will be implemented as part of long-term approaches.

i) Community Consultation and Interaction

The EMU will ensure that the road project will be very much a part of the local community. The EMU will establish a Community Consultation Programme as a means of providing a forum for dialogue between the local and the project. The framework for this plan will be set up during the construction phase so that the aims and objectives of EMU are clearly understood by the community.

j) Workforce Awareness

Work force awareness and culture is an important component in minimising environmental and cultural impacts resulting from project operations. Construction personnel will be made aware of the EMU's Environmental Policy.

An environmental awareness induction plan will be implemented to ensure that all construction workers are aware of their environmental responsibilities.

Table 20: Impact Mitigation Plan: Land and Soil

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impact on Land and Soil						
Soil contamination due to improper storage of materials, fuels and poor waste oil disposal methods.	Petroleum products dispensing points shall have drip pans.	To trap any fuel or oil spillage from getting to the soil.	Petroleum products dispensing points shall be inspected and approved by RDA EMU before commissioning.	Tendering process Construction Phase	⇨Contractor ⇨MU RDA	Concrete loading bay Approx US$ 200/m^3
	Storage of potential pollutants such as fuel, oil and chemicals should be done on sealed surfaces to prevent soil contamination.	To avoid direct contact of soil with oil, fuel and chemicals in case of accident.	Sites for storage of fuel, oil and chemicals shall be inspected and approved by EMU Officers from RDA before commissioning.	Tendering Process Construction Phase	⇨EMU RDA ⇨Contractor	Tanks to be placed on concrete hard standing. Concrete @ US$200/$m^3$
	Collection and recycling of used oil & lubricants.	To reduce on the amounts of oil waste generation and its disposal on soil.	Containers for collection of used oil shall be made available on site.	Construction Phase	⇨Contractor ⇨EMU RDA	Metal drums for collection and storage. One drum @ US$20
Soil contamination due to improper storage of materials, fuels and poor waste oil disposal methods.	Petroleum storage tanks shall have bund walls around them and shall be high enough to contain any spillage.	To contain any petroleum spillage from spreading in case of an accident.	Petroleum storage tanks shall be inspected and approved by EMU Officers from RDA before commissioning.	Construction Phase	⇨Contractor ⇨EMU RDA	Reinforced concrete wall and slab at the bottom. US$55/$m^2$

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Table 20: (Continued) Impact Mitigation Plan: Land and Soil

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impact on Land and Soil						
Exposed soil is prone to erosion by water or wind.	Limitation of earth moving to dry periods;	To avoid erosion of soil by fast flowing rainwater.	Period of construction shall be specified in the Tender Document	Tendering Process Construction Phase	⇨Contractor ⇨EMU RDA	US$6.50/$m^3$ of gravel
	Protection of susceptible soil surface with grass;	To control the current of the fast flowing rainwater.	Mitigation measures for this impact shall be in the overall Tender Document.	Tendering Process Construction Phase	⇨Contractor E⇨MU RDA	US$2/$m^2$ for planting turf/grass
	Protection of drainage channels by planting grass or stone pitching;	To avoid direct contact of fast flowing surface water with susceptible soils.	Stone pitching and grass planting in drainage systems shall be part of the overall Tender Document.	Tendering Process Construction Phase	⇨Contractor ⇨EMU RDA	US$2/$m^2$ for planting turf/grass US$50/$m^2$ for stone pitching
Exposed soil is prone to erosion by water or wind.	Installation of sedimentation basins or planting of erodible surfaces as soon as possible.	To trap soil particles from the current of the fast flowing water.	Mitigation measures for impacts on soils shall be part of the overall Tender Document.	Tendering Process Construction Phase	⇨Contractor ⇨EMU RDA	Excavate in common soils @ US$3/$m^3$ Excavate in rock @ US$50/$m^3$
Stripping and stockpiling of topsoil could lead to erosion and degradation of soil quality.	Exposed soil should be avoided by selective soil stripping;	To prevent highly prone soils from getting exposed to erosion.	Mitigation measures this impact is part of the Tender Document.	Tendering Process Construction Phase	⇨Contractor ⇨RDA	US$2/$m^3$
	Areas requiring less clearing shall be preferred for stock piles. Clearing shall be limited to the site approved by the local authorities.	To limit on the size of area prone to erosion.	Mitigation measures for this impact is part of the Tender Document.	Tendering Process Construction Phase	⇨Contractor ⇨RDA	US$1.50/$m^3$

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Table 20: (Continued) Impact Mitigation Plan: Land and Soil

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impact on Land and Soil						
Soil compaction could result following construction activities.	Only heavy equipment with pneumatic tyres shall be used on access roads.	To limit the size of area prone to compaction.	Mitigation measures for impacts on soils compaction shall be part of the overall Tender Document.	Tendering Process Construction Phase	⇨Contractor ⇨Road Engineers at RDA	For rolling activities use the rate of US$30/hr
Soil erosion near culverts and drainage channels where water velocity could increase.	Soil erosion should be prevented especially near culverts by construction of correctly designed culverts;	To control soil erosion and check for culverts and drainage channels requiring attention.	Programme for regular road drainage maintenance shall be developed and made available.	Operational Phase	⇨RDA	Concrete headwalls, aprons, wing-walls @ US$200/$m^3$
	Regular maintenance of culverts & drainage channels;	To prevent clogging of the culverts & the drainage system by debris carried with water flow.	Mitigation measures for impacts on soil erosion shall be part of the overall Tender Document.	Tendering Process Construction Phase	⇨Contractor ⇨RDA	Linear maintenance of the culverts @ US$50/m
Soil contamination by waste and spillages of road users and un-maintained vehicles.	Soil contamination by waste and spillages of road users and un-maintained cars.	To control waste disposal methods worth & ensure cars that are maintained use the road.	Enforcement of ECZ Regulations on waste management & Road Traffic Regulations.	Operational Phase	⇨Road users ⇨ECZ ⇨Road Traffic Commission ⇨Road Safety Council	ECZ monitoring activities

Table 21: Impact Mitigation Plan: Vegetation

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Vegetation						
Retardation of vegetation growth due to contamination from dust particles and gas emissions.	Dust control by application of water;	To suppress dust generation	Mitigation measures for this impact is part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨EMU RDA	Water bowsers to water gravel roads @ U$50/hr
	Haulage trucks shall not exceed the speed limit of 60km per hour.	To reduce the amount of dust generation.	Mitigation measures for impacts on vegetation shall be part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨EMU RDA	N/A
Loss of vegetation due to site clearing which will lead to loss of habitat and displacement of fauna species, especially avifauna.	Less vegetated areas shall be preferred;	To reduce the extent of the area without vegetation.	Mitigation measures for this impact is part of the overall Tender Document	Construction Phase	⇨Contractor ⇨EMU RDA	US$1.50/$m^2$ to clear less vegetated area
Increased access as a result of the road improvement could lead to increased deforestation on the road.	Provision of forest conservation awareness programme to communities along the rehabilitated road;	To sensitize the communities about the importance of forests.	Forest conservation programme is budgeted for and its implementation schedule is prepared.	Construction Phase Operational Phase	⇨Forestry Dept ⇨EMU RDA	US$15,000 for awareness programme

Table 22. Impact Mitigation Plan: Wildlife and Habitat

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Wildlife and Wildlife Habitat						
Disturbance to birds and small animals and loss of habitat.	Rehabilitation should be confined to the road reserve area;	To reduce on the extent of the area to be impacted upon.	Mitigation measures provided for impacts of noise shall be part of the overall Tender Document	Construction Phase	⇨Contractor ⇨EMU RDA	Haulage of suitable gravel from outside game area US$0.35/$m^3$. km
	Noisy activities to be scheduled to occur within prescribed normal working hours.	To reduce sleep disturbance to birds and small animals.	Mitigation measures provided for impacts of noise shall be part of the overall Tender Document	Construction Phase	⇨Contractor ⇨EMU RDA ⇨Local Authority	Haulage of suitable gravel from outside game area US$0.35/$m^3$. km
Wildlife loss due to accidental killings caused by speeding traffic as a result of improved road.	The road shall have adequate road furniture signs for warning road users of wildlife presence;	To warn motorists of the presence of wildlife in certain sections of the road so that motorists drive with caution.	Mitigation measures provided for impacts on Wildlife shall be part of the overall Tender Document	Operational Phase	⇨ZAWA ⇨RDA ⇨Local Authority	Road signs @ US$100/each on average

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Table 22. (Continued) Impact Mitigation Plan: Wildlife and Habitat

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Wildlife and Wildlife Habitat						
Wildlife loss due to accidental killings caused by speeding traffic as a result of improved road.	There shall be adherence to speed limits in wildlife areas. Monkeys were observed around the Muchinga escarpment on the way to Chirundu	To control over-speeding through provision of warning signs & mounting of speed control traps.	Provision of speed retarders in the road designs and their implementation as part of the overall Tender Document	Operational Phase	⇨Police Traffic ⇨Patrol Unit ⇨ZAWA	Speed humps @ US$500/ each
Noise disturbance to wildlife due to increased vehicular traffic passing through the wildlife areas.	Control of noisy activities on site (through local by-laws);	To monitor and control noise generation.	Enforcement of local by-laws.	Operational Phase	⇨Local Authority ⇨ZAWA ⇨ECZ	Working hours limited to day light only.
	ECZ Regulation on Noise Abatement;	To monitor and control noise generation.	Enforcement of ECZ Regulations on noise	Operational Phase	⇨Local Authority ⇨ZAWA	N/A
	The road shall have adequate road furniture signs for warning road users of wildlife presence.	To warn motorists of the presence of wildlife in certain sections of the road so that motorists drive with caution.	Provision of speed retarders in the road designs and their implementation as part of the overall Tender Document	Construction Phase Operational Phase	⇨Zambia Police ⇨ZAWA	Approx US$100/sign

Table 23: Impact Mitigation Plan: Water Quality

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Water Quality						
Siltation of water courses due to soil erosion of nearby drains and culverts.	Sides of the drainage shall be planted with grass or stone pitched;	To filter of the sediment particles in the fast flowing rain water with grass and also to avoid erosion of soil surfaces by stone pitching.	Mitigation measures provided for impacts on Water Quality shall be part of the overall Tender Document	Construction Phase Operational Phase	⇨Contractor ⇨EMU RDA	Grassing @ US$3/$m^2$ Stone pitching @ US$50/$m^2$
	Drainage systems shall have scour checks;	To reduce the current of rainwater flow.	Mitigation measures provided for impacts on Water Quality shall be part of the overall Tender Document	Construction Phase Operational Phase	⇨Contractor ⇨EMU RDA	Using stone masonry at US$12 each
	Drainage systems shall discharge into settlement basins;	To create a water reservoir which can be used by livestock or wildlife.	Mitigation measures provided for impacts on Water Quality shall be part of the overall Tender Document	Construction Phase Operational Phase	⇨Contractor ⇨EMU RDA	US$3.50/$m^3$ lining material or US$50/$m^3$ in rock

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Table 23: (Continued) **Impacts Mitigation Plan: Water Quality**

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Water Quality (Cont'd)						
Siltation of water courses due to soil erosion of nearby drains and culverts.	Silt traps shall be put along drainage systems;	To protect surface water pollution through filtering finest particles in water current.	Mitigation measures provided for impacts on Water Quality shall be part of the overall Tender Document	Construction Phase Operational Phase	⇨Contractor ⇨EMU RDA	Approx US$10/m
	Spoon drains shall have scour checks.	To control excessive flow and risks of erosion.	Mitigation measures provided for impacts on Water Quality shall be part of the overall Tender Document	Construction Phase Operational Phase	⇨Contractor ⇨EMU RDA	US$15 each
Water shortage to the local community due to over exploitation for rehabilitation works.	Exploitation of water sources for rehabilitation works shall be done with approval by the local authority and consent from the local community.	To avoid conflicts and to receive support from the local community.	Mitigation measures provided for impacts on Water Quality shall be part of the overall Tender Document	Construction Phase	⇨Contractor ⇨EMU RDA	Nominal exploitation when works are not reconstruction
Ground water contamination due to construction of sub-standard campsite pit latrines for workers.	Proper siting of pit latrines away from water logged areas;	To filter pollutants which may from getting to the ground water.	Mitigation measures provided for impacts on Water Quality shall be part of the overall Tender Document	Construction Phase	⇨Contractor ⇨EMU RDA	VIP latrine @ US$600 each
	Good hygienic standards and proper maintenance of pit latrines.	To promote cleanliness and avoid epidemics in construction camps.	Mitigation measures provided for impacts on Water Quality shall be part of the overall Tender Document	Construction Phase	⇨Contractor ⇨EMU RDA	Cleaning activities @ US$150/ month

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Table 23: (Continued) **Impacts Mitigation Plan: Water Quality**

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Water Quality (Cont'd)						
Sedimentation and increased turbidity in surface water caused by erosion of bare areas and runoffs resulting from excavation and grading works and drainage channels left after construction.	Excavated soils shall be used for other road works such as shoulder building;	To make use of available soils and reduce on creating more bare areas which are prone to soil erosion.	Mitigation measures provided for impacts on Water Quality shall be part of the overall Tender Document	Construction Phase	⇨Contractor ⇨EMU RDA	For gravel soil @ U$6.50/$m^3$ For top soil spreading and compacting @ US$2/$m^2$
Sedimentation and increased turbidity in surface water caused by erosion of bare areas and runoffs resulting from excavation and grading works and drainage channels left after construction.	Sides of drainage channels shall be planted with grass or stone pitched;	To filter of the sediment particles in the fast flowing rain water with grass and also to avoid erosion of soil surfaces by stone pitching.	Mitigation measures provided for impacts on Water Quality shall be part of the overall Tender Document	Construction Phase Operational Phase	⇨Contractor ⇨EMU RDA	For loose soil/ susceptible soil, grassing @ US$3/m2 For firm soil US$3/m3
	Drainage systems shall have scour checks.	To reduce the current of rainwater flow.	Mitigation measures provided for impacts on Water Quality shall be part of the overall Tender Document	Construction Phase Operational Phase	⇨Contractor ⇨EMU RDA	US$12 each stone masonry

Table 24: Impact Mitigation Plan: Air Quality

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Air Quality						
Air pollution caused by exhaust fumes and dust from excavators, bull dozers, graders as well as site clearing will affect human, vegetation and also disturb habitats for birds and insects.	Regular maintenance of construction vehicles and equipment in order to reduce emission of exhaust fumes;	To check for defects and servicing of the vehicles and equipment so that they are in good operation condition.	Log book on vehicle & equipment maintenance shall be kept on site for inspection and shall be part of the overall Tender Document	Construction Phase	⇨Contractor ⇨EMU RDA	US$30,000/ month for medium to old equipment
Air pollution caused by exhaust fumes and dust from excavators, bull dozers, graders as well as site clearing will affect human, vegetation and also disturb habitats for birds and insects.	Periodically water down on temporary roads;	To suppress dust.	Log book on dust control showing watering times shall be kept on site for inspection and shall be part of the overall Tender Document	Construction Phase	⇨Contractor ⇨EMU RDA	US$50/ hr
Unpleasant odours due to poorly maintained toilets and poor waste management.	Cleaning and regular maintenance of toilets to avoid unpleasant odours.	To maintain and promote a healthy environment at campsites and prevent the spread of diseases.	Public Health standards as provided under the Public Health Act Cap 295 shall noted and enforced under the Tender Document	Construction Phase	⇨Contractor ⇨EMU RDA ⇨Local Authority	US$150/ month

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Table 24: (Continued) **Impacts Mitigation Plan: Air Quality**

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Air Quality						
Unpleasant odours due to poorly maintained toilets and poor waste management.	Waste should be carefully managed to prevent unpleasant odours.	To maintain and promote a healthy environment at campsites and prevent the spread of diseases.	Public Health standards as provided under the Public Health Act Cap 295 and ECZ Regulations on Waste Management shall be enforced shall be part of the overall Tender Document	Construction Phase	⇨Contractor ⇨EMU RDA ⇨Local Authority	US$100/ month
Excessive diesel fumes due to un-maintained equipment.	Enforcement of the Roads and Road Traffic Act, Cap 464 and ECZ EPPCA Cap 204 on Air Pollution so that only road worth cars that are maintained are on the road.	To monitor and control unfit cars from using the road.	Enforcement of Roads and Road Traffic Act, Cap 464 and EPPCA, Cap 204 on Noise Abatement.	Construction Phase	⇨ECZ ⇨EMU RDA ⇨Road Traffic Commission	Police Traffic Patrol Unit
				Operational Phase	⇨ECZ ⇨Road Traffic Commission	

Table 25: Impact Mitigation Plan: Noise

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts of Noise						
Noise and vibration caused by construction machinery, equipment and drilling.	Working hours limited to day light only;	To avoid sleep disturbance at night.	Enforcement of EPPCA, Cap 204 on Noise Abatement.	Construction Phase	⇨Contractor ⇨EMU RDA ⇨ECZ ⇨Local Authority	Cost not applicable as programme is based on 9-day working hours.
Noise and vibration caused by construction machinery, equipment and drilling.	Enforcement of the Factories Act, Cap 441.	To promote occupational health and safe working conditions among the construction workers.	Enforcement of the Factories Act, Cap 441.	Construction Phase	⇨Contractor ⇨EMU RDA ⇨Ministry of Labour	US$3,000/yr
Noise from increased traffic.	ECZ Regulation on Noise Abatement;	To monitor and control noise generation.	Enforcement of EPPC Act, Cap 204 on Noise Abatement.	Operational Phase	⇨ECZ ⇨Local Authority	Police Traffic Patrol Unit
	Control of noise generating activities (by local by-laws).	To monitor and control noise generation.	Enforcement of EPPC Act, Cap 204 on Noise Abatement.	Operational Phase	⇨ECZ ⇨Local Authority	Police Traffic Patrol Unit

Table 26: Impacts Mitigation Plan: Landscape and Aesthetics

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Landscape and Aesthetics						
Visual impact of the road rehabilitation works could be substantial if designs are not compatible with the slope angles of the surrounding environment.	Development of road designs must be environmentally safe enough and compatible with the surrounding environment.	To maintain areas of scenic beauty.	Road design shall be environmentally safe enough and compatible with the surrounding environment.	Design Phase Construction Phase	⇨Design Engineers ⇨RDA ⇨EMU RDA	Cut to fill/ spoil @ US$3.50/$m^3$
Disfigurement of the natural landscape and aesthetic view due to construction works.	Development of road designs must be environmentally and compatible with the natural landscape and the surrounding environment.	To maintain areas of scenic beauty.	Road designs shall be environmentally and compatible with the natural landscape of the surrounding environment.	Design Phase Construction Phase	⇨Design Engineers ⇨RDA ⇨EMU RDA	Cut to fill/ spoil @ US$3.50/$m^3$
Abandoned construction structures, excess construction materials of laterite, stone aggregate and concrete slabs left in areas of scenic beauty reduces the quality of scenery.	Abandoned structures in areas of scenic beauty shall be converted into visitor facility.	To avoid vandalism and ruining the structures, which may become an eye sore and distort the scenic beauty of the surrounding environment.	Disposal of structures to be determined at the Tendering Process	Design Phase Construction Phase	⇨EMU RDA	Construction waste can be reused to refill borrow pits as part of the rehabilitation programme on borrow pits.

Table 27: Impact Mitigation Plan: Land Use and Surrounding Environment

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Land-use and surrounding environment						
The proposed road might influence migration and settlement patterns if labour requirements are not planned in advance.	Local people with the necessary skills shall be employed for the road works;	To avoid unplanned settlements which may lead to land-use change and social upheavals.	Recruitment of local people for unskilled labour shall be the priority and as part of the overall Tender Document.	Design Phase Construction Phase	⇨Contractor ⇨Community Representative ⇨Local Authority	About US$3000 per unity of structure relocated
	Resettlement of communities in new areas shall be done in consultation with host or existing community.	To avoid conflicts of land ownership.	The project does not foresee any resettlement of communities as rehabilitation works will be confined to the road reserve, however should there be any resettlement then it shall be done in accordance with the Department of Roads Resettlement Framework	Design Phase Construction Phase	⇨Contractor ⇨Community Representative ⇨Local Authority ⇨RDA	US$3,000/ unit of structure relocated.
Construction of temporary detours will disturb the environment within the immediate and surrounding environment.	Detours, access roads and equipment park site location shall be done in consultation with local people and shall take into account the existing land use in settled areas.	To avoid conflicts between the Contractor and the local community and also to monitor land-use change.	Mitigation measures for impacts on land-use shall be part of the overall Tender Document	Design Phase Construction Phase	⇨Contractor ⇨Community Representative ⇨Local Authority ⇨RDA	To construct detours @ US$76/m

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Table 27: (Continued) **Impacts Mitigation Plan: Land Use and Surrounding Environment**

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Land-use and surrounding environment						
If labour is not recruited from local areas people who reside far may start to settle near the road project.	Local people with the necessary skills shall be employed in the road project;	To avoid unplanned settlements which may lead to land-use change and social upheavals.	Recruitment of local people for unskilled labour shall be the priority and as part of the overall Tender Document.	Design Phase Construction Phase	⇨Contractor ⇨Community Representative ⇨Local Authority	Lump Sum US$2,500/ month
	Resettlement of communities in new areas shall be done in consultation with host or existing community.	To avoid conflicts of land ownership	The project does not foresee any resettlement of communities as rehabilitation works will be confined to the road reserve, however should there be any resettlement then it shall be done in accordance with the Department of Roads Resettlement Framework	Design Phase Construction Phase	⇨Contractor ⇨Community Representative ⇨Local Authority ⇨RDA	US$3,000/ unit of structure relocated.
Emission of exhaust fumes to the surrounding environment due to increased traffic.	ECZ Regulation on Air Pollution;	To monitor and control emission of exhaust fumes to the surrounding environment.	Enforcement of EPPC Act, Cap 204 on Air Pollution.	Operational Phase	⇨ECZ ⇨Local Authority	ECZ Monitoring Costs
	Adherence to engine maintenance schedules and standards to reduce air pollution.	To check for defects and repair any malfunctioning engine.	Development of engine maintenance schedules and making them available for inspection on site.	Construction Phase	⇨Contractor ⇨EMU RDA ⇨ECZ	US$15,000/ month

Table 28: Impact Mitigation Plan: Socio-Economic Environment

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Socio-economic Environment						
Temporary marriages, casual sex relationships and more chances of transmission of sexually diseases due to interaction of project workers with local communities.	There shall be provision of education both to the local community and camp workers on STDs and HIV/AIDS using aids such as video shows, pamphlets, talks, etc.	To sensitize the construction workers and local communities about the dangers of STDs and HIV/AIDS and to protect themselves.	Mitigation measures for impacts of STDs and HIV/AIDS shall be part of the overall Tender Document.	Construction Phase Operational Phase	⇨Contractor ⇨EMU RDA ⇨Community Based Organisations ⇨Local Authority	Lump Sum US$20,000 for whole project
Increased road accidents due to increased vehicular traffic and over speeding in black spots areas.	Provision of adequate warning road signs in black spot areas and speed retarders and/ or mechanisms at pedestrian crossing sites.	To prevent fatal accidents.	Mitigation measures for impacts on socio-economic shall be part of the overall Tender Document.	Construction Phase Operational Phase	⇨Contractor ⇨RDA ⇨Local Authority	US$100 per road sign

Table 29: Impact Mitigation Plan: Cultural and Historic Sites

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Cultural and Historic sites						
No significant impacts are foreseen.	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

Table 30: Impact Mitigation Plan: Human Settlements

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Human Settlements						
Although no negative impacts on human settlements are foreseen since construction works will be confined to the road reserve however, construction of detours, access roads and park sites in settled areas leads to land use conflicts with communities.	Detour, access roads and equipment park site location outside road reserve areas shall be done in consultation with local people and will take into account existing land use in settled areas.	To avoid land-use conflicts with the local communities.	Mitigation measures for impacts on Human Settlements sites shall be part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨ RDA ⇨ Local Authority ⇨Community Representatives	Liaison allowances US$100/ month
Improved road enhances accessibility, mobility and economic activities for the communities along the road.	There shall be no conversion of communal land into state land along the improved road.	To avoid land ownership disputes with the local communities.	Mitigation measures for impacts on Human Settlement sites shall be part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨RDA ⇨Local Authority ⇨Community Representatives	Liaison allowances US$100/ month

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Table 30: (Continued) **Impacts Mitigation Plan: Human Settlements**

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Human Settlements						
Improved roads lead to increased human settlements, changed settlement patterns, increased cultivation and commercial activities along the road;	There shall be no conversion of communal land into state land along the improved road.	To avoid land ownership disputes with the local communities.	Mitigation measures for impacts on Human Settlements sites shall be part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨RDA ⇨Local Authority ⇨Community Representatives	Liaison allowances US$100/ month
Improved roads lead to increased land values and land resource tenure along the road,	There shall be no conversion of communal land into state land along the improved road.	To avoid land ownership disputes with the local communities.	Mitigation measures for impacts on Human Settlements sites shall be part of the overall Tender Document.	Operational Phase	⇨Contractor ⇨RDA ⇨Local Authority ⇨Zambia Police ⇨Road Safety Council	Liaison allowances US$100/ month
Improved road increase risks of road traffic accidents to communities along the road	Speed limits of 40km per hour shall be observed in settled areas.	To save lives of pedestrians and domesticated animals.	Mitigation measures for this impact is part of the overall Tender Document.	Operational Phase	⇨Contractor ⇨RDA ⇨Local Authority ⇨Zambia Police ⇨Road Safety Council	Speed humps @ US$500 each

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Table 30: (Continued) **Impacts Mitigation Plan: Human Settlements**

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts on Human Settlements (Cont'd)						
	Improved road in settled areas shall have appropriate and adequate pedestrian crossing facilities.	To save lives of pedestrians and domesticated animals.	Mitigation measures for impacts on Human Settlements sites shall be part of the overall Tender Document.	Operational Phase	⇨Contractor ⇨RDA ⇨Local Authority ⇨Zambia Police ⇨Road Safety Council	Painted pedestrian crossing plus corresponding road signs @ US$150 each
Improved road with high traffic volume lead to increased health risks to communities along the road from vehicle emissions.	Trees shall be planted along the road in settled areas to minimize hazardous emissions.	To filter off hazardous emissions and also to act a barriers to traffic that may career of the road and cause accident to nearby settled areas.	Mitigation measures for impacts on Human Settlements sites shall be part of the overall Tender Document.	Operational Phase	⇨Contractor ⇨RDA ⇨Local Authority	US$20/per tree planted
Noise from high traffic volumes using the improved road disturbs communities along the road.	Noise barriers shall be erected in settled areas where traffic noise may exceed 90 decibel.	To avoid impairment of hearing organs.	Mitigation measures for this impact is part of the overall Tender Document.	Operational Phase	⇨Contractor ⇨RDA ⇨Local Authority	US$20/$m^2$ of wall built to bar the noise from the settlements

Table 31: Impact Mitigation Plan: Quarries and Borrow Pits

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts of Quarries and Borrow Pits						
Quarries and borrow pits location may negatively impact on important ecological units.	Quarrying shall not be done near surface water sources.	To avoid water pollution which might lead to deprivation of water to the local community.	Mitigation measures for impacts of Quarries and Borrow Pits shall be part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨RDA ⇨Local Authority ⇨Local Community	Haul of suitable gravel @ US$0.35/$m^3$. km
Quarries and borrow pits location may negatively impact on important ecological units.	There shall be no quarrying near Chirundu Fossil Forest Monument.	To preserve the Fossil Monument.	Mitigation measures for this impact is part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨RDA ⇨Local Authority ⇨National Heritage and Conservation Commission	Haul of suitable gravel @ US$0.35/$m^3$. km
Excessive noise from blasting and machinery may disturb nearby communities.	Quarrying shall not be done near communities.	To avoid the risk associated with flying pebbles from blasting operations and minimise disturbance from noise.	Mitigation measures for this impact is part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨RDA ⇨Local Authority ⇨Mine Safety Department of Ministry of Mines.	Haul of suitable gravel @ US$0.35/$m^3$. km
Excessive noise from blasting and machinery may disturb nearby communities.	Quarrying shall be done in conformity to the Mines and Minerals Act, No. 31 of 1995.	To ensure compliance with the Law on quarrying.	Mitigation measures for impacts of Quarries and Borrow Pits shall be part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨RDA ⇨Local Authority ⇨Mine Safety Department of Ministry of Mines.	License fees about US$1,000 per quarry
Abandoned borrow pits could pose potential hazard to ecological units and residents.	Borrow Pits shall not be done near water sources and human settlements.	To avoid harbouring disease causing organisms and other dangerous animals that may find these as suitable habitats.	Mitigation measures for impacts of Borrow Pits shall be part of the overall Tender Document.	Operational Phase	⇨Contractor ⇨RDA ⇨Local Authority ⇨Mine Safety Department of Ministry of Mines.	Haul of suitable gravel @ US$0.35/$m^3$. km

Table 32: Impact Mitigation Plan: Road Traffic

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts of Road Traffic						
Failure to use established routes might result in surveyors' vehicles negatively impacting on the environment.	Surveyors should not venture too far away from the proposed route in order to avoid impacts on the surrounding environment.	To avoid off-site impacts associated with surveying.	Mitigation Measures for impacts of Surveying shall be part of the overall Tender Document.	Design Phase Construction Phase	⇨Contractor ⇨EMU of the ⇨RDA ⇨Local Authority	US$20,000 to survey and stake
Construction traffic could impact on undisturbed areas adjacent to the proposed route.	Established routes should be used where possible in order to reduce impacting on undisturbed areas.	To maintain the existing environment in the adjacent areas.	Mitigation Measures for impacts of construction traffic shall be part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨EMU of the RDA ⇨Local Authority	To use existing detours, maintenance @ US$5/m
	Construction vehicles must only use pre-determined access roads that should be determined in the design phase.	To avoid un-necessary disturbance of traffic flow and cause danger to other road users.	Mitigation Measures for impacts of construction traffic shall be part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨EMU of the RDA ⇨Local Authority	Maintenance of existing/ predetermined roads @ US$55/m
	Allowance should be made for alternative routes for the existing road users during construction where possible.	To avoid un-necessary disturbance of traffic flow and cause danger to other road users.	Mitigation Measures for impacts of construction traffic shall be part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨EMU of the RDA ⇨Local Authority	New detours @ US$76/m

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Table 32: (Continued) **Impacts Mitigation Plan: Road Traffic**

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts of Road Traffic						
Excessive dust from construction could disturb nearby communities.	Control of dust through watering of dust roads.	To avoid respiratory and visibility problems and the gathering of dust on other protected areas and property.	Mitigation Measures for impacts of construction traffic shall be part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨EMU of the RDA ⇨Local Authority	Water bowser US$50/hr
Increased accidents due to increased traffic flow.	Provision of adequate warning road signs in black spot areas and speed retarders at pedestrian crossing sites.	To save lives and injury that could arise as a result of accidents.	Mitigation Measures for impacts of traffic shall be part of the overall Tender Document.	Operational Phase	⇨Contractor ⇨EMU of the RDA ⇨Local Authority	US$100/ road sign

Table 33: Impact Mitigation Plan: Work Accidents

Impacts of Work Accidents						
Advanced planning of safety equipment requirements	Development of safety procedures and operational manual.	To ensure that people undertaking these tasks know exactly what is to be done.	Mitigation Measures for impacts of work accidents shall be part of the overall Tender Document.	Operational Phase	⇨Contractor ⇨EMU of the RDA ⇨Local Authority	US$800/ month
Lack of enforcement of safety and health regulations could impact negatively on construction workers.	Enforcement of Public health and safety regulations.	To safe guard the health and safety of workers.	Mitigation Measures for impacts of work accidents shall be part of the overall Tender Document.	Operational Phase	⇨Contractor ⇨EMU of the RDA ⇨Local Authority	US$3,000/ month

Table 34: Impact Mitigation Plan: Construction Camps

Impact	Mitigation Measure	Objective	Actions to be taken for its implementation	Period of Implementation	Authority Responsible	Cost of Mitigation
Impacts of Construction Camps						
Advanced planning of construction camp siting.	Selection of camp siting must be done in consultation with the local authority and local community.	To ensure camp siting is considered at the design phase and communities are consulted well in advance.	Mitigation Measures for impacts of construction camps shall be part of the overall Tender Document.	Design Phase Construction Phase	⇨Contractor ⇨EMU of the RDA ⇨Local Authority ⇨Local Community	US$1,000 for siting and planning
Loss of vegetation at construction site.	Clearing for camp siting must be limited to the actual site to avoid vegetation loss on a larger scale.	To conserve vegetation around the camp site and protect the site from extensive loss of vegetation	Mitigation Measures for impacts of construction camps shall be part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨EMU of the RDA ⇨Local Authority ⇨Local Community	Site clearance @ US$0.99/$m^2$
Waste generation at campsite.	Waste disposal to be done at designated sites approved by the local authority.	To control waste disposal practices and avoid illegal dumping.	Mitigation Measures for impacts of construction camps shall be part of the Tender Document.	Construction Phase	⇨Contractor ⇨EMU of the RDA ⇨Local Authority ⇨ECZ	Disposal of waste @ US$0.10/ton.km
Interaction of construction workers with nearby communities may lead to transmission of sexually transmitted diseases.	Provision of education both to the local community and camp workers on STDs and HIV/AIDS using aids such as video shows, pamphlets, talks, etc.	To prevent the transmission of sexually transmitted diseases between the local community and construction workers.	Mitigation Measures for impacts of construction camps shall be part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨EMU of the RDA ⇨Local Authority ⇨CBO on Health	US$15,000 Lump Sum
Interaction of construction workers with the nearby communities may lead to transmission of sexually transmitted diseases.	Local people with the necessary skills shall be employed in the road project.	To ensure the local community benefit from the project and also to avoid immigration which may result in land disputes and social upheavals.	Mitigation Measures for impacts of construction camps shall be part of the overall Tender Document.	Construction Phase	⇨Contractor ⇨EMU of the RDA ⇨Local Authority ⇨Labour Department of Ministry of Labour ⇨Community representative	US$2,500 per month

11.4 Environmental Monitoring Plan

Environmental monitoring is the continuous assessment of project implementation in relation to agreed schedules. It is an integral part of good management by the Engineer during construction. The main objectives of monitoring are to provide continuous feedback on implementation, and to identify actual or potential successes or problems as early as possible, to facilitate timely adjustments to project operation. The creation or strengthening of monitoring activities under the project should not be seen as a temporary requirement, but an institution-building component of the project which should permanently improve overall management practice.

Environmental monitoring ensures that the impacts have been accurately predicted and that appropriate mitigation measures are being implemented as planned and that they have the expected effects. Identification of potential environmental impacts associated with the construction of the bridge indicates a need to design and implement a specific environmental monitoring plan. The monitoring process begins with supervision of implementation. The bulk of the activities may take place during the implementation stage.

The environmental objectives of these activities are to ensure mitigation measures outlined in the contracts are being properly implemented, that environmental contractual measures are being respected, construction is going in accordance with the agreed design standards and that no unforeseen negative impacts are occurring as a result of project execution.

The objective of a monitoring system is to assist project management through:

- Defining requirements and procedures for environmental monitoring, including equipment needs, frequencies of monitoring, parameters, analytical services required, data management and presentation etc.
- Identifying targets and objectives for project implementation.
- Maintaining easily retrievable records of project implementation which can be used for evaluation.
- Identifying problems encountered by the project and defining procedures for environmental control, in the event of pollution or similar incidents requiring action and,
- Providing readily available analyses for decision-making.

The aim of a monitoring plan is to provide a cost-effective approach to monitoring the contractor’s environmental performance. Baseline data must be collected during the EIA to provide a basis for future monitoring. The monitoring requirements will be identified in the Mitigation plan. The following table illustrates the likely issues to be the subject of a monitoring plan:

The key components of the proposed environmental monitoring plan are presented in Table 4 on Monitoring Activities and Indicators.

Table 35: Monitoring Activities and Indicators

Element to be Monitored	Method of Monitoring	Frequency of Monitoring	Indicator	Means of Verification	Authority Responsible
Land and Soil					
Land and Soil	Site Engineer to make inspections of sites for storage of materials, oil and fuels and ensure they have sealed surfaces.	Periodical inspections through out the Construction Phase	Clean storage sites free from any oil or fuel spillage maintained through out Construction Phase.	Inspection Report is available at EMU-RDA	⇨Contractor's Site Engineer ⇨EMU RDA
	Site Engineer to inspect the waste disposal sites.	Periodical inspections through out the Construction Phase	Waste oil is being disposed of in designated sites and in the approved method.	Inspection Report is available at EMU RDA	⇨Contractor's Site Engineer ⇨EMU RDA
	Site Engineer to ensure used oil is being collected for recycling.	Periodical inspections through out the Construction Phase	Containers for collection of used oil are available on site.	Used oil from serviced plant machinery has been collected in containers.	⇨Contractor ⇨EMU-RDA
	Site Engineer to inspect storage tanks and ensure they have bund walls around them high enough to contain any spillage.	Once before the fuel storage tanks are put to use.	Bund wall design and construction plan has been developed approved and is available.	Bund walls around fuel storage tanks have been constructed.	⇨Contractor ⇨EMU-RDA

Table 35: (Continued) Monitoring Activities and Indicators

Element to be Monitored	Method of Monitoring	Frequency of Monitoring	Indicator	Means of Verification	Authority Responsible
Land and Soil (Cont'd)					
Land and Soil	The Site Engineer to make inspections and ensure that heavy construction equipment is confined to operational areas only and avoids croplands.	Daily inspections through out the Construction Phase.	Absence of caterpillar trampling in croplands.	Complaints from the local community on invasion of croplands by construction equipment are non-existent.	⇨Contractor ⇨EMU RDA
	The Site Engineer to undertake inspection of earthworks and ensure that slopes are graded to specifications.	Daily inspections through out the Construction Phase.	Absence of rills, gullies	Absence of erosion features.	⇨Contractor ⇨EMU RDA
	Once earthworks are completed, the Site Engineer should monitor the restoration measures to be implemented such as re-vegetation	Each time earthworks are completed through out Construction Phase	Presence of re-vegetation in erosion prone areas.	Restoration programme for re-vegetation of exposed soils is available and is being implemented.	⇨Contractor ⇨EMU RDA

Table 35: (Continued) Monitoring Activities and Indicators

Element to be Monitored	Method of Monitoring	Frequency of Monitoring	Indicator	Means of Verification	Authority Responsible
Vegetation					
Vegetation	Site Engineer to ensure that excessive clearance of vegetation is avoided and should be confined to the project site.	Each time clearance of vegetation is being done through out Construction Phase	The area of vegetation cleared is minimal	Area for vegetation clearance is clearly marked and is confined to the designs.	⇨Contractor ⇨EMU RDA
Wildlife and Wildlife Habitat					
Wildlife and Wildlife Habitat	The Site Engineer to carry out inspections and report evidence of wildlife intrusion onto the project site.	Periodical inspections through out Construction Phase	Absence of animal damage to project site.	Inspection report	⇨Contractor ⇨EMU RDA ⇨ZAWA
Water Quality					
Water Quality	Site Engineer to inspect and satisfy that interceptors are put in place and working well.	Periodical inspections through out the Construction Phase.	Clean water supply maintained through out the Construction Phase.	Absence of water pollution incidents	⇨Contractor ⇨EMU RDA

Table 35: (Continued) Monitoring Activities and Indicators

Element to be Monitored	Method of Monitoring	Frequency of Monitoring	Indicator	Means of Verification	Authority Responsible
Water Quality (Cont'd)					
Water Quality	Site Engineer to inspect and satisfy that areas where hazardous liquids are stored are bunded.	Periodical inspections through out the Construction Phase.	Clean water supply maintained through out the Construction Phase.	Absence of water pollution incidents	⇨Contractor ⇨EMU RDA
	Site Engineer to inspect and satisfy that water from concrete batching plants is treated.	Periodical inspections through out the Construction Phase.	Clean water supply maintained through out the Construction Phase.	Absence of water pollution incidents	⇨Contractor ⇨EMU RDA
	Site Engineer to inspect and satisfy that silt traps are put along drainage systems;	Periodical inspections through out the Construction Phase.	Clean water supply maintained through out the Construction Phase.	Absence of water pollution incidents	⇨Contractor ⇨EMU RDA
	Site Engineer to inspect and satisfy that spoon drains have scour checks.	Periodical inspections through out the Construction Phase.	Clean water supply maintained through out the Construction Phase.	Absence of water pollution incidents	⇨Contractor ⇨EMU RDA
	Site Engineer to inspect and satisfy that siting of pit latrines is done away from water logged areas;	Before construction of pit latrines.	Construction is done according to design specifications.	Pit latrine siting and construction report	⇨Contractor ⇨EMU RDA

Table 35: (Continued) Monitoring Activities and Indicators

Element to be Monitored	Method of Monitoring	Frequency of Monitoring	Indicator	Means of Verification	Authority Responsible
Water Quality (Cont'd)					
Water Quality (Cont'd)	Site Engineer to inspect and satisfy that written detail of the procedures to be followed in the event of pollution incident is given to the Site Engineer By the Contractor.	Immediately there is a pollution incident during Construction Phase.	Operational procedures are being followed.	Presence of Operational Manual on site.	⇨Contractor ⇨EMU RDA
Air Quality					
Air Quality	Site Engineer to observe the level of dust generated during Construction. Watering down should be done if dust levels are unacceptable.	Regular inspections through out the Construction Phase.	Deposition of dust on surfaces such as grasses, shrubs, trees and rooftops should decrease with watering.	Dust deposition on the immediate surroundings is controlled.	⇨Contractor ⇨EMU RDA
	Site Engineer to check and ensure that construction vehicles and equipment are maintained in order to reduce emission of exhaust fumes;	Regular inspections through out the Construction Phase.	Exhaust fume emissions are controlled.	Maintenance logbook is available on site.	⇨Contractor ⇨EMU RDA

Table 35: (Continued) Monitoring Activities and Indicators

Element to be Monitored	Method of Monitoring	Frequency of Monitoring	Indicator	Means of Verification	Authority Responsible
Air Quality (Cont'd)					
Air Quality	Site Engineer to inspect and ensure that toilets are cleaned and maintained to avoid unpleasant odours.	Regular inspections through out the Construction Phase.	Unpleasant odours are controlled.	Clean toilet environment free from unpleasant odours.	⇨Contractor ⇨EMU RDA
	Site Engineer to inspect and ensure waste is carefully managed and disposed of in designated places to prevent unpleasant odours.	Regular inspections through out the Construction Phase.	Controlled waste disposal method.	Waste is dumped in designated places.	⇨Contractor ⇨EMU RDA
Noise					
Noise	Sit Engineer to monitor noise and vibrations on an ad-hoc basis in order to establish noise levels at the project site and the nearest sensitive receptors and should not exceed 90-decibels.	Regular inspections through out the Construction Phase.	Noise levels at the nearest sensitive receiver are minimised.	Number of complaints of noise disturbance is controlled.	⇨Contractor ⇨EMU RDA

Table 35: (Continued) Monitoring Activities and Indicators

Element to be Monitored	Method of Monitoring	Frequency of Monitoring	Indicator	Means of Verification	Authority Responsible
Noise (Cont'd)					
Noise Cont'd)	Site Engineer to check and ensure that working hours are limited to day light only;	Daily inspections through out the Construction Phase.	Sleep disturbance is minimised.	Number of complaints of sleep disturbance is minimised.	⇨Contractor ⇨EMU RDA
Landscape and Aesthetics					
Landscape and Aesthetics	Site Engineer to make visual inspection of earth works to ensure that excessive excavation other than those agreed upon is not carried out, particularly at borrow pit sites, temporary and approach roads and around the contractor's camp.	Daily inspections through out the Construction Phase.	Landscape alterations are reduced to a minimum.	Final landscape and aesthetic view is compatible with the surrounding environment.	⇨Contractor ⇨EMU RDA

Table 35: (Continued) Monitoring Activities and Indicators

Element to be Monitored	Method of Monitoring	Frequency of Monitoring	Indicator	Means of Verification	Authority Responsible
Land-use and surrounding environment					
Land-use and Surrounding Environment	Contractor shall ensure that local people with the necessary skills are employed to work on the project to avoid migration and settlement near the project by construction workers who are taken from far areas.	Before recruitment planning for labour requirements shall be done during the Pre-Construction Phase.	Potential construction workers from the local community are identified.	Construction workers are recruited from the local community	⇨Contractor ⇨EMU RDA
	The Site Engineer to monitor and ensure that detours, access roads and equipment park site location takes into account the existing land use in settled areas.	Planning for detours, access roads and equipment park site location shall be done during the Pre-Construction Phase.	Designs for detours, access roads and equipment park site location have taken into account the existing land use in settled areas.	Designs for detours, access roads and equipment park site location are being implemented according to specifications.	⇨Contractor ⇨EMU RDA

Table 35: (Continued) Monitoring Activities and Indicators

Element to be Monitored	Method of Monitoring	Frequency of Monitoring	Indicator	Means of Verification	Authority Responsible
Socio-economic Environment					
Socio-economic Situation	Contractor shall conduct and ensure that education is given both to the construction workers and local community on STDs and HIV/AIDS using aids such as video shows, pamphlets, talks is disseminated.	Planning for education both to the construction workers and local community on STDs and HIV/AIDS shall be done during the Pre-Construction Phase.	Programme for education both to the construction workers and local community on STDs and HIV/AIDS is developed during the Pre-Construction Phase.	Target group for receiving education on STDs and HIV/AIDS is identified and the programme is being implemented during the Construction Phase.	⇨Contractor ⇨EMU RDA ⇨Local Community ⇨CBO
	Site Engineer to check and ensure that adequate warning road signs in black spot areas and speed retarders at pedestrian crossing site are erected.	Planning for erection of warning road signs in black spot areas and speed retarders at pedestrian crossing site shall be done in the Pre-Construction Phase.	Black spot areas are identified for erection of warning road signs and speed retarders and are included in the overall project designs	Warning road signs and speed retarders in black spot areas and pedestrian are constructed.	⇨Contractor ⇨EMU RDA ⇨Local Authority ⇨Road Safety Council

Table 35: (Continued) Monitoring Activities and Indicators

Element to be Monitored	Method of Monitoring	Frequency of Monitoring	Indicator	Means of Verification	Authority Responsible
Cultural and Historic Sites					
Cultural and Historic Sites	Site Engineer to monitor and ensure that detours, access roads and equipment park sites are not constructed through Chirundu Fossil Forest Monument and other heritage sites.	Planning for construction of detours, access roads and equipment park sites shall be done in the Pre-Construction Phase.	A project design, which takes into account protection of the Chirundu Fossil Forest Monument, is developed.	Detours, access roads and equipment park sites are constructed outside the Chirundu Fossil Forest Monument during the Construction Phase.	⇨Contractor ⇨EMU RDA ⇨NHCC
Human Settlements					
Human Settlements	Site Engineer to inspect and satisfy that exploitation of water sources for rehabilitation works is done with approval from the local authority and with consent from the local community.	Planning for exploitation of water resources from the local community shall be done during the Pre-Construction Phase in consultation with the Local authority and local community.	Exploitation of water resources from the local community for the project works is controlled.	Water to local community is available.	⇨Contractor ⇨EMU RDA ⇨Local Authority ⇨Local community
Human Settlements	Site Engineer to check and ensure that adequate warning road signs in black spot areas and speed retarders at pedestrian crossing site are erected in human settlement areas.	Planning for erection of warning road signs in black spot areas and speed retarders at pedestrian crossing site shall be done in the Pre-Construction Phase.	Black spot areas are identified for erection of warning road signs and speed retarders and are included in the overall project designs	Warning road signs and speed retarders in black spot areas and pedestrian are constructed.	⇨Contractor ⇨EMU RDA ⇨Local Authority ⇨Road Safety Council

Table 35: (Continued) Monitoring Activities and Indicators

Element to be Monitored	Method of Monitoring	Frequency of Monitoring	Indicator	Means of Verification	Authority Responsible
Quarries and Borrow Pits					
Quarries and Borrow Pits	Site Engineer to monitor and ensure that quarries and borrow areas are not located near surface water sources.	Planning for exploitation of construction materials from quarries and borrow areas shall be done in the Pre-Construction Phase.	A project design, which takes into account protection of the water resources is developed.	Quarries and borrow areas are located outside the water resources catchment areas during the Construction Phase.	⇨Contractor ⇨EMU RDA ⇨Ministry of Mines
	Site Engineer to monitor and ensure that quarries and borrow areas are not located near Chirundu Fossil Forest Monument.	Planning for exploitation of construction materials from quarries and borrow areas shall be done in the Pre-Construction Phase.	A design for the bridge, which takes into account conservation measures of the Chirundu Fossil Forest Monument is developed.	Quarries and borrow areas are located far away from the Chirundu Fossil Forest Monument during the Construction Phase.	⇨Contractor ⇨EMU RDA ⇨Ministry of Mines ⇨NHCC
Quarries and Borrow Pits	Site Engineer to monitor and ensure that quarries and borrow areas are not located nearby communities.	Planning for exploitation of construction materials from quarries and borrow areas shall be done in the Pre-Construction Phase.	A design for the bridge, which takes into account protection of the local community is developed.	Quarries and borrow areas are located far away from the local community during the Construction Phase.	⇨Contractor ⇨EMU RDA ⇨Ministry of Mines ⇨Local Authority
Work Accidents					
Work Accidents	Site Engineer to monitor and ensure that the procedures on Safety, Health and Environment for construction workers are being followed during the Construction Phase.	Periodical inspection through out the Construction Phase.	Operational Manual on Safety, Health and Environment for construction workers is developed and available on site.	Operational Manual on Safety, Health and Environment for construction workers is being implemented during the Construction Phase.	⇨Contractor ⇨EMU Road Dept ⇨Local Authority

Table 35: (Continued) Monitoring Activities and Indicators

Element to be Monitored	Method of Monitoring	Frequency of Monitoring	Indicator	Means of Verification	Authority Responsible
Construction Camps					
Construction Camps	Site Engineer to monitor and ensure that waste disposal is done in designated sites approved by the local authority and ECZ.	Periodically through out the Construction Phase.	Designated waste disposal site is identified and available.	Waste is being dumped in designated sites.	⇨Contractor ⇨EMU Road Dept ⇨Local Authority ⇨ECZ

11.5 Monitoring of Water Quality

Wherever feasible, settlement ponds should be used to allow settlement of suspended load before the water is drained back into the river.

The impact monitoring of water quality should be carried out by determining the changes in water quality of waterways at start of construction works. This can be achieved by taking water samples prior to commencement of works that are representative of the site's condition, which will be determined and agreed by ECZ. Report on the variations to be submitted to ECZ every month of the year.

Indicators: Water quality changes should be ascertained by determining variations between the existing water quality and the baseline data. Parameters that should be determined are Total Suspended Solids, turbidity, dissolved oxygen, pH, Biochemical Oxygen Demand, Chemical Oxygen Demand, Oil and Grease and washing chemicals.

Three sampling locations should be identified: first at the upstream point, second at the bridge construction site, and third at downstream point.

All collected samples shall be analyzed by an accredited laboratory for Total Suspended Solids (TSS), turbidity, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand for 5-days (BOD5), Faecal Coliform Count. The suggested laboratory centres are University of Zambia and Scientific research laboratory centres in Lusaka.

11.6 Institutional Framework for Monitoring, Reporting and Supervision

Establishment of Collaborating Network

In order to ensure that the identified environmental issues are addressed both during and after construction of the bridge there will be need by the EMU/RDA to collaborate with key stakeholders. The collaborating network should also involve representatives from the affected local authorities (Chiawa & Chirundu), representatives of District Development Co-ordinating Committees, representatives of CBOs in affected projected areas and representatives of the Environmental Council of Zambia. The main objective of this collaborating network is to ensure that mitigation measures outlined in contracts are being properly implemented by the Contractor and also that EMU supervision is complemented by encouraging greater use of local community as part of project monitoring team. The main responsibilities of the collaborating network will be to:

- Complement the efforts for continuous monitoring and assessment of the implementation of the environmental management plan by EMU and other relevant institutions;
- Assist in the sensitization of the local communities with regard to environmental problems and their obligation;
- Liaise with respective local communities on environmental issues which may arise during the construction and operation of the road.

Monitoring Arrangements

To avoid deliberate creation of gaps between what is reflected in the mitigation plan and what actually gets implemented on the ground, the contracts must spell out the sanctions for non-compliance with mitigation measures. Monitoring will involve field visits by EMU staff accompanied by representatives from the local authority in the affected area being visited. The rationale to involve the local authority members in monitoring in their area of jurisdiction is to ensure greater use and participation of local community in project monitoring. This approach is also to ensure that the particular project concerns expressed by the communities

during the public consultation meeting (EIA Scoping exercise) receive attention in the project implementation.

Reporting Procedure and Flow of Information

The EMU will compile a quarterly Environmental Report from the field visits that will form the basis for assessment of environmental performance. The report will contain the results of the environmental monitoring and the need for plan adjustment. The report will be circulated to the local authority in the affected project area and to other key stakeholders for review and comment. If there are any comments from the stakeholders these will be communicated to EMU for possible follow up and for possible corrective action to be undertaken by the Contractor. The key stakeholders are outlined in Table 11 on Monitoring and Reporting Responsibilities.

Construction Phase

All major stakeholders in the Project have a monitoring role and responsibility during the construction phase. However, only the Consultant, the RDA - Environmental Management Unit (EMU) and Environmental Council of Zambia (ECZ) are allocated specific and formal monitoring obligations.

During the construction phase, the Environmental Management Unit from RDA will ensure that the contractor implement the mitigation measures recommended in the EIS. Further, the EMU will ensure that construction workers are sensitized with regard to environmental problems and their obligation. In addition the EMU will liaise with respective government agencies such as local authorities in the affected areas and Environmental Council of Zambia on environmental issues, which may arise during the road rehabilitation phase.

Traffic police, ZAWA, Forestry Department, health authorities and other public authorities will automatically monitor some of the effects of the Project during their daily work. This information should on a regular basis be collected and analysed by those with a formal monitoring responsibility such as the EMU staff. Table 36 illustrates the different stakeholders and their monitoring responsibilities and reporting.

Operational Phase

The local authorities, ZAWA, the Forest Department, Department of Agriculture as well as the RDA should be responsible for monitoring and management of all indirect impacts occurring after the construction of the bridge.

Full reporting on the causes of accidents is required for implementation of properly targeted safety measures.

Table 36: Monitoring and Reporting Responsibilities

RESPONSIBLE ORGANISATION	PARAMETERS TO BE MONITORED	OUTPUT
ECZ	Overall environmental performance of the Project	✓ Discussions with EMU/ RDA ✓ Site Engineer
EMU/ Road Development gency	Monitoring the implementation of EMP	✓ Regular environmental progress reports to stakeholders
	Overall environmental performance of the Project	
Consultant/Site Engineer	Construction methods and materials	✓ Regular environmental progress reports to EMU ✓ Incident reports as and when required (Pollution, accidents, etc.) by EMU
	Implementation of mitigating measures for air, water, soil, traffic, vegetation, etc.	
	Environmental management of worksites	
	Environmental management of construction camps	
	Environmental management of quarries and borrow pits	
	Contractor's waste management	
	Rehabilitation of abandoned worksites	
Consultant/Site Engineer	Performance of Contractor's equipment	✓ Regular environmental progress reports to EMU ✓ Incident reports as and when required (Pollution, accidents, etc.) by EMU
	Accidents (traffic, pollution spills, etc.)	
	Community relations	
	Negative social and environmental impacts	
	Gender balance in employment	
Contractor	Environmental performance of equipment	✓ Maintenance records ✓ Accidents reports ✓ Mitigating actions
	Implementation of mitigating measures	
	Occupational health and safety	
	Traffic and worksite accidents	
	Air quality	
ZAWA	Conducting spot checks on the impacts on vegetation and wildlife	✓ Instructions to the Contractor and the Consultant/Site Engineer
NHCC	Impacts on Cultural and Historic Sites	✓ Instructions to the Contractor and the Consultant/Site Engineer
Forestry Department	Impacts on vegetation and trees	✓ Instructions to the Contractor and the Consultant/Site Engineer
Traffic Police	Traffic accidents	✓ Police reports and instructions to Contractor
	Traffic nuisances	
	Traffic safety measures	
Local authorities	Negative social and environmental impacts	✓ Complaints to Contractor and Consultant/Site Engineer

Table 37: Implementation Schedule of Mitigation Measures

IMPLEMENTATION SCHEDULLE OF MITIGATION MEASURES	YEAR 1				YEAR 2				YEAR 3			
ACTIVITY	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Implementation of Mitigation Measures for Impacts on Land and Soil												
Construct concrete loading bay at petroleum products dispensing points	■	■				■				■		
Construct concrete sealed surfaces for storage sites of oil, chemicals & other potential pollutants	■	■				■				■		
Procure metal drums for collection and storage of used oil & lubricants	■					■				■		
Construct reinforced concrete bund walls & slab around petroleum storage tanks.	■					■				■		
Control soil erosion through tree/ grass planting and or stone pitching			■				■				■	
Construct concrete headwalls, aprons and wing-walls to prevent soil erosion near culverts			■				■				■	
Carry out linear maintenance of the culverts & drainage channels			■	■			■	■			■	■
Implementation of Mitigation Measures for Impacts on Vegetation												
Control dust generation through watering of gravel roads when levels exceed limits	■	■	■	■	■	■	■	■	■	■	■	■
Sensitize the communities along the project areas about the importance of forest conservation	■			■			■			■		
Implementation of Mitigation Measures for Impacts on Wildlife and Wildlife Habitats												
Identify borrow sites for gravel material outside game area to avoid loss of habitat	■				■			■			■	
Erect road signs in identified wildlife areas to warn road users on the presence of wildlife	■		■		■			■			■	
Erect speed humps in wildlife areas to limit speed	■		■		■			■			■	
Implementation of Mitigation Measures for Impacts on Water Quality												
Plant sides of road drainage with grass or stone pitch to prevent siltation of nearby water courses			■	■			■	■			■	■
Construct scour checks on drainage system using stone masonry			■				■				■	

Table for Implementation schedule of Mitigation Measures (Cont'd)

IMPLEMENTATION SCHEDULLE OF MITIGATION MEASURES	YEAR 1				YEAR 2				YEAR 3			
ACTIVITY	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Implementation of Mitigation Measures for Impacts on Water Quality (Cont'd)												
Construct silt traps along drainage channels												
Identify pit latrine sites away from water sources & water logged areas												
Implementation of Mitigation Measures for Impacts on Air Quality												
Carry out regular maintenance of construction vehicles to control emission of exhaust fumes												
Control dust emission through watering of gravel roads when levels exceed limits												
Control unpleasant odours by regular maintenance of pit latrines & solid waste disposal sites												
Implementation of Mitigation Measures for Impacts of Noise												
Ensure construction equipment working hours are limited to day light to avoid sleep disturbance												
Implementation of Mitigation Measures for Impacts on Landscape and Aesthetics												
Maintain areas of scenic view & avoid disfigurement of natural landscape & aesthetic view												
Implementation of Mitigation Measures for Impacts on Land-use and surrounding environment												
Employ local people with the necessary skills to avoid unplanned settlements from migrants												
Construct detours, access roads in consultation with local community												
Implementation of Mitigation Measures for Impacts on Socio-economic Environment												
Sensitize the construction workers & local community on dangers of STDs and HIV/AIDS.												
Employ local people with the necessary skills to avoid social upheavals												
Erect road signs in settled areas to prevent fatal accidents												
Implementation of Mitigation Measures for Impacts on Cultural and Historic Sites												
Identify borrow sites for gravel material outside cultural and historic sites												
Engage one NHCC Officer to work with the project in identified areas of cultural & historic sites												

Table for Implementation schedule of Mitigation Measures (Cont'd)

IMPLEMENTATION SCHEDULLE OF MITIGATION MEASURES	YEAR 1				YEAR 2				YEAR 3			
ACTIVITY	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Implementation of Mitigation Measures for Impacts on Human Settlements												
Construct detour & access roads outside human settlements	■	■				■			■			
Provide speed retardars in settled areas	■	■					■	■				■
Install pedestrian crossing signs and corresponding road signs in settled areas	■	■					■	■				■
Plant trees in settled project areas to control hazardous emissions from reaching the community	■	■					■	■				■
Install noise barriers in settled project areas	■	■					■	■				■
Implementation of Mitigation Measures for Impacts of Quarries and Borrow Pits												
Select quarry and borrow pit areas outside wildlife areas	■		■		■			■			■	
Select quarry and borrow pit areas outside cultural and historic sites	■		■		■			■			■	
Select quarry and borrow pit areas away from human settlements	■		■		■			■			■	
Select quarry and borrow pit areas away from water sources	■			■			■			■		
Implementation of Mitigation Measures for Impacts of Road Traffic												
Provide sufficient roadsigns to inform motorists of roadworks to avoid disruption to traffic flow	■	■					■			■	■	
Control dust levels by watering of detour and access roads to avoid disruption to traffic flow	■	■	■	■	■	■	■	■	■	■	■	■
Implementation of Mitigation Measures for Impacts of Construction Camps												
Locate construction camps in liaison with the local community	■			■			■			■		
Identify site for disposal of solid waste in liaison with local community	■			■			■			■		
Liaise with Local Authority & sensitize camp workers on dangers of STDs and HIV/AIDS.	■			■			■			■		

Table 38: Implementation Schedule of Monitoring

MONITORING SCHEDULLE OF PERFORMANCE	YEAR 1				YEAR 2				YEAR 3			
ACTIVITY	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Observe the Performance of Mitigation Measures for Impacts on Land and Soil												
Assess the condition of land and soil at storage sites with respect to soil contamination	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Check for availability of designated dumpsites for disposal of construction wastes	σ				σ				σ			
Check for availability of metal drums for collection and storage of used oil & lubricants on site	σ				σ				σ			
Check for presence of concrete bund walls & slab around petroleum storage tanks on site	σ				σ				σ			
Check if there exist caterpillar trampling in croplands at project site	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Check if there exist rillls and gullies around the project site	σ			σ	σ			σ	σ			σ
Check for existence of re-vegetation programme in erosion prone areas			σ	σ			σ	σ			σ	σ
Observe the Performance of Mitigation Measures for Impacts on Vegetation												
Assess the extent of vegetation clearance in project areas	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Check for existence of awareness program for communities on importance of forest conservation		σ		σ		σ		σ		σ		
Observe the Performance of Mitigation Measures for Impacts on Wildlife and Wildlife Habitats												
Check if there exist animal damage to project site	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Check if there exist animal accidents in identified wildlife areas	σ		σ		σ			σ			σ	
Observe the Performance of Mitigation Measures for Impacts on Water Quality												
Assess the quality of drinking water sources likely to be contaminated by project activities	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Observe the Performance of Mitigation Measures for Impacts on Air Quality												
Check for condition of dust level emissions and deposition on surrounding areas	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Check for exhaust fume emission levels from construction vehicles and equipment	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Check for condition of pit latrines & solid waste disposal sites	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ

Table 38:Table for Implementation Schedule of Monitoring (Cont'd)

MONITORING SCHEDULLE	YEAR 1				YEAR 2				YEAR 3			
ACTIVITY	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Observe the Performance of Mitigation Measures for Impacts of Noise												
Check for existence of complaints of noise & sleep disturbance from communities at project site	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Check if the hours of operation of construction equipment are limited to day light only	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Observe the Performance of Mitigation Measures for Impacts on Landscape and Aesthetics												
Check for the extent of landscape alterations and disfigurement of aesthetic view	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Observe the Performance of Mitigation Measures for Impacts on Land-use and surrounding environment												
Assess if constructed detours, access roads are in conflict with local community landuse interests		σ			σ			σ			σ	
Observe the Performance of Mitigation Measures for Impacts on Socio-economic Environment												
Check for existence of programs on STDs & HIV/AIDS for workers & local community	σ			σ			σ			σ		
Assess No. of local people employed with necessary skills in relation to people from outside		σ			σ			σ			σ	
Check for existence of road signs in settled areas that prevent fatal accidents		σ			σ			σ			σ	
Observe the Performance of Mitigation Measures for Impacts on Cultural and Historic Sites												
Assess the location of borrow pits for gravel material in relation to cultural and historic sites	σ		σ		σ			σ			σ	
Check for presence of NHCC Officer working on the project in areas of cultural & historic sites	σ		σ		σ			σ			σ	
Observe the Performance of Mitigation Measures for Impacts on Human Settlements												
Check if there exist shortage of water resources for community due to exploitation for roadworks		σ			σ			σ			σ	
Assess location of constructed detour & access roads in relation to human settlements	σ		σ		σ		σ		σ		σ	
Check for existence of speed retardars in human settlement areas		σ			σ			σ			σ	
Check for existence of pedestrian crossing signs and corresponding road signs in settled areas		σ			σ			σ			σ	
Check for existence of tree planting programs in human settled areas to control emissions		σ			σ			σ			σ	
Check for existence of noise barriers in human settlement areas		σ			σ			σ			σ	

Table 38: Table for Implementation Schedule of Monitoring (Cont'd)

MONITORING SCHEDULLE	YEAR 1				YEAR 2				YEAR 3			
ACTIVITY	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Observe the Performance of Mitigation Measures for Impacts of Quarries and Borrow Pits												
Assess the location of quarry and borrow pit areas in relation to wildlife areas	σ		σ		σ		σ		σ		σ	
Assess the location of quarry and borrow pit areas in relation to cultural and historic sites	σ		σ		σ		σ		σ		σ	
Assess the location of quarry and borrow pit areas in relation to human settlements	σ		σ		σ		σ		σ		σ	
Assess the location of quarry and borrow pit areas in relation to drinking water sources	σ			σ			σ			σ		
Observe the Performance of Mitigation Measures for Impacts of Road Traffic												
Check if exist traffic congestion at project site due to insufficient roadsigns & alternative routes	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Check for existence of traffic accidents due to high dust levels & lack of detour and access roads	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Observe the Performance of Mitigation Measures for Impacts of Work Accidents												
Check for existence of programs & adherence to procedures on Safety, Health and Environment	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Check if there exist work accidents at project sites	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
Observe the Performance of Mitigation Measures for Impacts of Construction Camps												
Check if the local community was consulted over workers camp siting		σ			σ			σ			σ	
Check if the local community was consulted over waste disposal siting		σ			σ			σ			σ	
Check for existence of programs to sensitize camp workers on dangers of STDs and HIV/AIDS.	σ			σ			σ			σ		

12. CONCLUSIONS AND RECOMMENDATIONS

12.1 Conclusions

The findings from the Environmental Impact Assessment show that although the proposed construction of a Bridge at Chiawa on the Kafue River is expected to have a number of negative impacts on the environment, most of these are anticipated to occur during the construction phase and are mitigated in the overall road design. Generally, the proposed project is planned to follow existing alignments thus the potential impacts are therefore reduced.

However there are sensitive areas of the approach road, which if not properly engineered could have negative impacts. The section of the approach road crossing the Kafue River from Chirundu will be re-aligned over a stretch of approximately 800m before the bridge and may entail physical relocation of metallic huts belonging to MoWS. In addition areas of settlements may experience long-term socio-economic effects that may also impact on the success of the new bridge and its benefits to the project community.

12.2 Recommendations

The study has proposed an Environmental Management and Monitoring Plan (EMP) to addres the management of the identified environmental issues associated with the project .The plan consists of implementing the listed components stated below as follows:

1. Implementing the Impact Mitigation Plan
2. Monitoring the implementation of the EMP
3. Institutional Framework for Monitoring, Reporting and Supervision of EMP

The mitigation of the negative impacts on biophysical environment will be part of the road design. The negative social impacts will require some level of intervention as outlined below:

- Improvement and expansion of social facilities and services
- Collaboration with local stakeholders to counter social upheavals
- Sex education campaigns to fight HIV/AIDS threats
- Provision of alternative social services, facilities and jobs for local people affected by the project.

The mitigation measures will require constant information flow and consultation with the stakeholders to ensure the least adverse social-economic impact from the project. The project area of influence outweigh the “no-development” scenario. The project is therefore being recommended for implementation assuming the incorporation of the recommended mitigating measures and implementation of the Impact Mitigation Plan.

Annex 1: Annotated List of Endangered Species

Trees that are deemed to be endangered in this country are usually used as sources of timber, building material, edible fruits, seed oils, firewood, charcoal, traditional medicine, production of honey, making of baskets and mats and harvesting of edible caterpillars. The threat to the survival of utilised tree species is manifested in the mood in which resources are collected-often affected by the destructive felling of trees without regard to potential future harvests. A few taxa are of unknown use, but have been included because of their vulnerability to extinction by unknown anthropogenic factors, such as fires of highly specialised habitats and some endemic. The following taxa backed up by notes on use, distribution, ecology and nature of threat to the species survival.

Afzelia quanzesis Welw. (Leguminosae)

A tree used as a resource of timber and charcoal. It is widespread in the country with occasional occurrences in Miombo and Kalahari woodlands. The felling of trees reduces its chance of survival in the long run.

Baikiaea Plurijuga Harms (Leguminosae)

This is the principal source of timber in Mulobezi area. A tree restricted to the low rainfall areas of Kalahari sands in Sesheke and Livingstone districts. Both over exploitation for timber and later seasonal fires pause a threat to the species survival in this area.

Berchemia bakerana Burt & Hutch (Leguminosae)

This tree is a source of edible fruits. It occurs in relative hotter low rainfall riparian woodlands along the Luangwa and Zambezi river channels. The current trend of cultivation on river banks tends to destroy riparian forests which are the natural habitats if this taxon.

Brachystegia bakerana Burt & Hutch (Leguminosae)

A small tree of limited use as source of firewood and building material. A species confined to the Kalahari Sands in Western Province. Late fires, which disrupt the phonological, cycle of most Brachystegia species renders this species vulnerable to irreversible destruct and eventual extinction.

Brachystegia boehmii Taub. (Leguminosae)

A medium sized tree used as a source of building material (poles and fibres) and charcoal. It is widespread in Miombo woodlands, but prefers shallow soils of lithosols type. Both charcoal burning and late fires tend to destroy tree populations. The principal threat being charcoal burning in pre-urban areas.
Brachystegia longifolia Benth. (Leguminosae)

A tree up to 30 m high which is used as building material, charcoal making and the production of honey. Bark cylinders are ringed out for making bee-hives in the North-Western Province where honey production is increasingly getting commercialised. Besides bees collect nectar from several species of Brachystegia to produce a dark-brown honey called Brachystegia honey. Effects of over-exploitation and the late fires spell danger to the species.

Brachystegia puberula Burtt Davy and Hutch (Leguminosae)

A small tree of known use. It occurs along striations of Kalahari Sands in Mwinilunga and Solwezi district stretching into Angola. The destruction of this species by effects of late fires renders it liable to the narrowing its geographical range in the region.

Brachystegia spiciformis Benth (Leguminosae)

A medium sized tree which is the target for charcoal making in the pre-urban areas. Young tree are used as poles for building. It constitutes a dominant taxon in all Miombo woodlands but occurs as an element in Kalahari woodlands. Charcoal making, late fires and clearing for agriculture lands is gradually reducing its ecological range.

Cassia abbreviata Olive. (Leguminosae)

This is a small tree extensively used in traditional medicines in Zambia with proven antibiotic principle. It is widely distributed in open Miombo and mopane woodlands. The use of its back as a source of medicine may lead to unintentional ringing of the trunk with eventual destruction of the trees close to village settlements.

Cyathea dregei Kunze (Cyantheaceae)

A tree fern of ornamental value in their habitats and cultivated sites in botanical gardens. Widespread in the high rainfall region occurring along stream banks and moist edges of forest relicts on the plateau and montane forest of the Nyika. The principal threat is late fires, which touch on relatively drier reaches of the forest edge and stream banks towards the end of the dry season.

Diospyros hoyleana F. White (Ebenaceae)

An evergreen small tree of yet unknown utility. A species of restricted range recorded on a sandy Island along the Zambezi in Mwinilunga's high rainfall area. Only careful management of the habitat will ensure its survival.
Entandorophragma candatum Sprague (Meliaceae)

A large tree used as source of fine timber. Mostly occurs on Kalahari Sands in association with Baikiaea Plurijuga where it is referred to as a Royal tree among the Lozi people. It has also been recorded along the middle Luangwa and lower Zambezi valleys. Effects of fine and land clearing are prone to reduce the population size.

Entandrophragam delevoyi De Wild. (Meliaceae)

This is a large semi-evergreen tree used as source of timber. A species restricted to the high rainfall areas of Copperbelt, Northern and North-Western provinces, with its southern limit recorded in Mumbwa district. It is associated with forest dominants such as Parinari excelsa and Syzgium guineense ssp. afromontanum. Strong fires that have reduced the once extensive evergreen forests to mere relicts at present easily destroy it.

Annex 2: List of People Consulted

No.	Name	Position	Organisation/ Place
1.	Brown Chibale	Technical Officer	Chirundu, Env Council of Zambia
2.	G.C Gwantula	Area Councillor	Kapululira-Chirundu
3.	S.C Tembo	Commercial-Officer	Chirundu-ZAWA
4.	C.A Mandika	Kambale Ward Councillor	Chiawa-Area
5.	Marko Katope	Headman-Kapululira	Chirundu
6.	Kephas Siakalinda	Headman-Mufulutoa	Chiawa
7.	Dorika Pembere	Headwoman	Chiawa
8.	R Mbuyanata	Headman	Chiawa
9.	Kamboro	Kamboro-Village	Chirundu
10.	Wellingo Pharao	Headman-Farrao Village	Chirundu
11.	Kenani	Resident	Chirundu
12.	S Garafa	Seccretary-Charedzera Village	Chirundu
13.	Moses Kachani	Secretary-Mufurutsa	Chiawa
14.	Noah Chipasi	Chairman-K.M.C-Razao	Chirundu
15.	Vincent Gumbe	Secretary-Mulambinda	Chirundu
16.	Allan Wardle	Manager-Gwabi River Lodge	Plot No. 515078 Chirundu
17.	Makenzi Monimoni	Resident	Chirundu
18.	Sydney Chibbabbuka	Assistant Commissioner	Zambia Revenue Authority
19.	Henry Siankunguya	Headteacher-Kapululira	Chirundu
20.	Lemond Claudio Kudongo	Care Taker-Zambia Training Centre	Chirundu
21.	Robert Singuwa	Police Officer	Police-Chirundu
22.	Elijah Mulenge	DDVO	Office of the President (SD) Chirundu
23.	Kelvin Cheembo	Police Officer	Police-Chirundu
24.	Kunonsho Claudio	Caretaker	Zambezi Training Centre
25.	Mushimbei Muliya	EMU RDA	

Annex 3: Checklists

MONITORING AND SUPERVISION CHECKLIST

PROJECT SITE/LOCATION :…….. DISTRICT:……

FORM A. MITIGATION MEASURES REQUIRED & AGREED

AGREED MITIGATION MEASURES/ ACTIVITY TO BE PERFORMED		RESPONSIBILITY FOR IMPLEMENTATION	PHYSICAL PROGRESS ON IMPLEMENTATION			
1. LAND & SOIL			**>75%**	**75% - 55%**	**55% - 45%**	**<45%**
			Good	**Average**	**Fair**	**Poor**
1.1						
1.2						
1.3						
etc						
2. VEGETATION						
2.1						
2.2						
2.3						
etc						
3. WILDLIFE & WILDLIFE HABITAT						
3.1						
3.2						
3.3						
etc						
4. WATER QUALITY						
4.1						
4.2						
etc						
5. AIR QUALITY						
5.1						
5.2						
etc						

MONITORING AND SUPERVISION CHECKLIST

PROJECT SITE/LOCATION :…….. DISTRICT:……

…MITIGATION MEASURES REQUIRED & AGREED (Cont'd)

AGREED MITIGATION MEASURES/ ACTIVITY TO BE PERFORMED		RESPONSIBILITY FOR IMPLEMENTATION	PHYSICAL PROGRESS ON IMPLEMENTATION			
6. NOISE			**>75%**	**75% - 50%**	**55% - 45%**	**< 45%**
			Good	**Average**	**Fair**	**Poor**
6.1						
6.2						
6.3						
etc						
7. LANDSCAPE & AESTHETICS						
7.1						
7.2						
7.3						
etc						
8. LAND--USE & SURROUNDING ENVIRONMENT						
8.1						
8.2						
8.3						
etc						
9. SOCIO-ECONOMIC ENVIRONMENT						
9.1						
9.2						
9.3						
etc						
10. CULTURAL & HISTORIC SITES						
10.1						
10.2						
10.3						
etc						

MONITORING AND SUPERVISION CHECKLIST

PROJECT SITE/LOCATION :…….. DISTRICT:……

…MITIGATION MEASURES REQUIRED & AGREED (Cont'd)

AGREED MITIGATION MEASURES/ ACTIVITY TO BE PERFORMED		RESPONSIBILITY FOR IMPLEMENTATION	PHYSICAL PROGRESS ON IMPLEMENTATION			
11. HUMAN SETTLEMENTS			**>75%**	**75% - 50%**	**55% - 45%**	**< 45%**
			Good	**Average**	**Fair**	**Poor**
11.1						
11.2						
11.3						
etc						
12. QUARRIES & BORROW PITS						
12.1						
12.2						
12.3						
etc						
13. ROAD TRAFFIC						
13.1						
13.2						
13.3						
etc						
14. WORK ACCIDENTS						
14.1						
14.2						
14.3						
etc						
15. CONSTRUCTION CAMPS						
15.1						
15.2						
15.3						
etc						

MONITORING AND SUPERVISION CHECKLIST

PROJECT SITE/LOCATION :…….. DISTRICT:……

FORM B: PERFORMANCE OF MITIGATION MEASURES OBSERVED

AGREED MITIGATION MEASURES/ OBSERVED LEVEL OF PERFORMANCE				CONSTRAINTS/DIFFICULTIES OF IMPLEMENTATION	AGREED FOLLOW UP ACTIONS
	GOOD	FAIR	POOR		
1. LAND & SOIL					
1.1					
1.2					
1.3					
etc					
2. VEGETATION					
2.1					
2.2					
2.3					
etc					
3. WILDLIFE & WILDLIFE HABITAT					
3.1					
3.2					
3.3					
etc					
4. WATER QUALITY					
4.1					
4.2					
4.3					
etc					
5. AIR QUALITY					
5.1					
5.2					
5.3					
etc					

MONITORING AND SUPERVISION CHECKLIST

PROJECT SITE/LOCATION :…….. DISTRICT:……

…PERFORMANCE OF MITIGATION MEASURES OBSERVED (Cont'd)

AGREED MITIGATION MEASURES/ OBSERVED LEVEL OF PERFORMANCE				CONSTRAINTS/DIFFICULTIES OF IMPLEMENTATION	AGREED FOLLOW UP ACTIONS
	GOOD	FAIR	POOR		
6. NOISE					
6.1					
6.2					
6.3					
etc					
7. LANDSCAPE & AESTHETICS					
7.1					
7.2					
7.3					
etc					
8. LAND-USE & SURROUNDING ENVIRONMENT					
8.1					
8.2					
8.3					
etc					
9. SOCIO-ECONOMIC ENVIRONMENT					
9.1					
9.2					
9.3					
etc					
10. CULTURAL & HISTORIC SITES					
10.1					
10.2					
10.3					
etc					

MONITORING AND SUPERVISION CHECKLIST

PROJECT SITE/LOCATION :…….. DISTRICT:……

…MITIGATION MEASURES REQUIRED & AGREED (Cont'd)

AGREED MITIGATION MEASURES/ ACTIVITY TO BE PERFORMED				RESPONSIBILITY FOR IMPLEMENTATION	PHYSICAL PROGRESS ON IMPLEMENTATION
	GOOD	FAIR	POOR		
11. HUMAN SETTLEMENTS					
11.1					
11.2					
11.3					
etc					
12. QUARRIES & BORROW PITS					
12.1					
12.2					
12.3					
etc					
13. ROAD TRAFFIC					
13.1					
13.2					
13.3					
etc					
14. WORK ACCIDENTS					
14.1					
14.2					
14.3					
etc					
15. CONSTRUCTION CAMPS					
15.1					
15.2					
15.3					
etc					

MONITORING AND SUPERVISION CHECKLIST

PROJECT SITE/LOCATION :…….. DISTRICT:……

FORM C: COMMENTS ON ANY UNFORESEEN ENVIRONMENTAL PROBLEMS

ENVIRONMENTAL ISSUES		PROPOSED ACTION	RESPONSIBILITY
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
etc			

Annex 4: Minutes of the Chiawa-Chirundu Community Consultative Meeting Held at Zambezi Farm Training Centre, Chirundu on 14th January, 2006

1.1 Introduction

As part of the Environmental Impact Assessment (EIA) process, the Community Consultation Meeting for Chiawa construction project was held in Chirundu on 14th January, 2006 at Zambezi Farm Training Centre. A total number of 27 participants took in the meeting drawn from the Chiawa and Chirundu communities.

1.2 Purpose

The Community consultation meeting was held with the affected communities and was intended to present information on the project and to obtain the views of those consulted in the first public meeting.

1.3 Composition and Expertise of the Consultants Team

The consultation team consisted of three persons (Jacob Chishiba, Jones Mulomba and Wizzy Chishiba) who conducted the community consultation meeting and delivered the presentations. The team has specialization in Environmental Management, Socio-Economics and Natural Resources.

The contents of meeting were as follows:

i) Prayer.
ii) Introductions.
iii) Opening Remarks.
iv) Purpose of Meeting
v) Presentation of Proposed Project Activities
vi) Presentation of Impacts on Bio-Physical Environment
vii) Presentation of Impacts on Socio-Economic Environment
viii) Open Discussion/Concerns and questions by the community
ix) Summary
x) Prayer
xi) End of Meeting

The meeting was tailored to focus on key issues and concerns of the community.

The meeting was called to order at 10:30hours by the area Councillor, G. C. Gwantula, after a prayer was offered by one of the participants followed by self introduction.

1.4 Presentation of Proposed Project activities

This was presented by Jacob Chishiba

1.5 Presentation of Impacts on Bio-physical Environment

This was presented by Jones Mulomba

1.6 Presentation of Impacts on Socio-economic Environment

This was presented by Wizzy Chishiba and Jacob Chishiba

1.7 Summary of Community Questions/ Concerns

After all presentations were made there was a session for questions and answers, which was designed to collect views from the participants. A summary of the participants' questions/answers over the Chiawa bridge construction project is presented in the following section.

PROCEEDINGS

Session 1: Introduction to the Consultation Meeting

Facilitator: Area Councilor

The Meeting was called to order at 10:30 hours after a prayer was given by one of the participants. Self-introduction of both Consultants and participants was done and the meeting commenced with the assistance of an interpreter into the local languages (Tonga and Nyanja).

Session 4: Presentation of the Project Activities

Facilitator: Jacob Chishiba

This session was facilitated by Jacob who presented the scope of the project activities and the Chiawa-Chirundu Bridge construction project.

Session 5: Presentation of Impacts on Bio-physical Environment

Facilitator: Jones Mulomba

The session was facilitated by Jones Mulomba who presented the bio-physical environmental impacts of the project. Jones explained the impacts associated with the project activities during its life cycle.

Session 5: Presentation of Impacts on Socio-economic Environment

Facilitator: Jacob Chishiba/Wizzy Chishiba

The session was facilitated by Jacob Chishiba and Wizzy Chishiba who presented the socio-economic impacts of the project. Jacob explained the impacts associated with the project activities during its life cycle.

Session 7: Discussions; Questions and Answers; Suggestions for Issues to be Integrated in the project.

Facilitator: Jacob Chishiba

The following **Questions/Concerns** were raised:

Concern: There was concern raised by the one of the participants Mr Pharao that this time they want government to hire a well established contractor, to construct a bridge that will stand the test of time. Also the contractors should come and employ the local people skilled in a number of skills.

Concern: Another, concern was raised by Mr Makenzi Monimoni that they want the contractor to give first priority to the local people before they can even consider outsiders for employment.

Answer: Its clear that unskilled labour is got locally but for skilled labour its difficult to get the locals because it involves operation of complex machines which are expensive to replace once damaged, hence the need for skilled labour. As for unskilled labour may be the locals can register with their area councillors so that they employ the people you know.

Question: Headman Kamboro: What method are we going to use in recruiting and how many are we recruiting?

Concern: Headman Kamboro said that the people are happy that the bridge will be constructed and hopes that the contractors will come knowing that this is a rural area .When the contractor comes they should first ask for permission to operate in the area and also permission for acquisition of natural in the area.

Concern: Kudongo L.C raised a concern that the community should be consulted on sites for material and upon the completion of the construction of the bridge, the contractor should make sure they bury the pits from which they get sand and also replace the trees that they will use.

Question: Tembo S.C asked what materials will be used and raised a concern that Chirundu is a semi-arid area hence they are a few trees available in the area. Once they harvest them they will be no trees left in the area.

Answer: The materials to be used will include stones, sand, gravel and timber.

Concern: Chipasi Noah raised a concern that when the contractors come they might give money to the Headmen so that they get free materials but in our area we have women who crash stones for sell.

Concern: Mr Mandika Charles raised a concern that in his area they have Area Development Committee Wards. This project is in both in Chirundu and Kambale. Any need for materials could be done through this committee. And about the construction of the bridge government should hire a contractor with a good truck record with a good past experience.

Answer: In order to solve such problems you should involve your two area MPs Kafue and Siavonga in such projects. These MPs are the only people who can represent your views in parliament. Our role here as ASCO Consulting Engineers is to come up with the EIA and include your concerns in the report. So its only your MPs who can see to it that this project is done properly and also ECZ has a say in terms of utilization of natural resources.

Question: How often do you meet with your MPs in the area?

Answer: Councillor Gwantula said that he meets with the locals and whatever is discussed is passed on to the MP.

Concern: They will be reports produced and will be distributed within this area. May be you should present the report to your MPs so that they know what the people at the grass root level want.

Question: During the construction of the bridge they may be camps. Are they such places for camping?

Answer: Councillor Mandika: It's a matter of asking from the Headmen who will sit and decide on what areas to allocate for camps.

Question: Jones Mulomba: Do you want the contractor to camp in tents or build permanent structures, that upon completion of the project they hand over the buildings to the community to be used as a clinic or school?

Answer: Councillor Mandika: We want permanent structures so that even after the project is complete we can still use the structures

Question: Headman Katope Marko: I agree with Councillor Mandika on the issue of building permanent structures. Can we propose some contractors who can come and build the bridge? I say this because there's a lot of corruption involved in choosing a contractor and also sometimes these contractors do not finish the work on time.

Answer: Jacob Chishiba: On the issue of awarding these contracts government has a procedure that it follows. After the EIA is completed government will put an advert in the newspapers where contractors will be asked to bid. The Tender Board will then select the successful bidder based the guidelines.

Concern: Allan Wardle: The traffic going to Chiawa is not that much. I personally feel there's no need for a bridge. Is it true that there is a plan to redirect non-commercial traffic to the would-be Chiawa-Chirundu Bridge leading to Lusaka leopards hill road? Do you have a timetable as to when this project will start and if the road through the bridge leading to Lusaka will be tarred?

Answer: There are Engineers who were tasked to come up with traffic counts and this information will be made available in the next meeting. On the issue of whether the road will be made into a tarmac is essentially Government's decision and not the consultants. Mr Jacob Chishiba then showed the participants the Post Newspaper dated 31st where it reads "Japan to construct bridge in Chiawa". He told them that the construction is likely to commence immediately funds are available.

Concern: Siankunguya Henry: Am provoked with what I have read. To me I think they will be nothing like Tender Board procedures since Japan will construct the bridge. Am I right or wrong?

Answer: On that issue sometimes it might mean Japan may fund the project or may dictate that a Japanese contractor such as Shimizu is contracted. But as at now we also don't know who will be awarded the contract.

Question: Jones Mulomba: From what I have observed we have only talked about traffic, employment and deforestation. Do you have any other areas that may be impacted upon by the construction of the bridge?

Answer: Siankunguya Henry: Spread of HIV/AIDS is likely to be an area where construction of the bridge will impact on the community. He further observed that there should be some deliberate programme to sensitise both the workers and the local community. Due to cash flow school girls may stop school opting for money and in the long run contracting HIV/AIDS.

Question: Jacob Chishiba: Do you have such programmes in the area to address issues of HIV/AIDS? I know that within the Road Development Agency there is a programme to addresses such issues and during the project implementation the contractor will be required to adhere to follow RDA HIV/AIDS guidelines. Also within the construction team there must be someone who has attended an HIV/AIDS sensitisation programme with a certificate, so that he/she can sensitise both the locals and fellow workers. Therefore it can be said that HIV/AIDS issues are covered under RDA guidelines for contractors.

Concern: Allan Wardle: Is it possible to consider tree planting as part of mitigation measures.

Answer: Mr Jones Mulomba: In fact the Forestry Department is trying to come up with some ways which can reduce the abuse of trees which will apply to projects of this nature.

Answer: Jones Mulomba: Basically, there will be an Environmental Management Plan for the project and in the plan the contractor should work in line with government departments, local authority and local community and ensure that if any tree is cut then it should be replanted and we recommend that the trees replanted are the same indigenous trees. So the local forestry office should work in line with the contractor. Also locals should plant nurseries so that they can sell the trees to the contractor.

Question: Tembo S.C: Is the bridge going to be where the pontoon is or somewhere else?

Answer: The bridge will be where the pontoon is. We will also want to know whether there any graves near the bridge?

Concern: Vincent Gumbe: There are no graves near the project site.

Question: Tembo/ Chibbabbuka: What has necessitated the construction of the bridge?

Answer: Its within government's development plan. Bridges requiring attention have been identified country wide and this is just one them.

Concern: Brown Chibale: Come up with the report based on the submissions then the second stage call for submissions.

Conclusion: Jacob Chishiba: He gave concluding remarks and thanked participants for having been active during the deliberations and further informed the participants that further consultation will follow in a detailed EIA after approval of this Scoping Report and TORs by ECZ.

Closing Remarks There being no further questions and concerns, Councillor Gwantula thanked the members of the meeting and closed at 12:31 hrs.

Attendance List

No.	Name	Position	Organisation/ Place
1.	Brown Chibale	Technical Officer	Chirundu, Env Council of Zambia
2.	G.C Gwantula	Area Councillor	Kapululira-Chirundu
3.	S.C Tembo	Commercial-Officer	Chirundu-ZAWA
4.	C.A Mandika	Kambale Ward Councillor	Chiawa-Area
5.	Marko Katope	Headman-Kapululira	Chirundu
6.	Kephas Siakalinda	Headman-Mufulutoa	Chiawa
7.	Dorika Pembere	Headwoman	Chiawa
8.	R Mbuyanata	Headman	Chiawa
9.	Kamboro	Kamboro-Village	Chirundu
10.	Wellingo Pharao	Headman-Farrao Village	Chirundu
11.	Kenani	Resident	Chirundu
12.	S Garafa	Seccretary-Charedzera Village	Chirundu
13.	Moses Kachani	Secretary-Mufurutsa	Chiawa
14.	Noah Chipasi	Chairman-K.M.C-Razao	Chirundu
15.	Vincent Gumbe	Secretary-Mulambinda	Chirundu
16.	Allan Wardle	Manager-Gwabi River Lodge	Plot No. 515078 Chirundu
17.	Makenzi Monimoni	Resident	Chirundu
18.	Sydney Chibbabbuka	Assistant Commissioner	Zambia Revenue Authority
19.	Henry Siankunguya	Headteacher-Kapululira	Chirundu
20.	Lemond Claudio Kudongo	Care Taker-Zambia Training Centre	Chirundu
21.	Robert Singuwa	Police Officer	Police-Chirundu
22.	Elijah Mulenge	DDVO	Office of the President (SD) Chirundu
23.	Kelvin Cheembo	Police Officer	Police-Chirundu
24.	Kunonsho Claudio	Caretaker	Zambezi Training Centre