Deliverable D03: Chipata (Mwami) Technical Feasibility Report

FP24-001: Chipata and Chanida Water Supply and Sanitation – Feasibility Study

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Disclaimer

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List of Acronyms

Acronym	Long-Form
ADF	African Development Fund
AfDB	African Development Bank
AIDS	Acquired Immune Deficiency Syndrome
ARI	Acute Respiratory Infection
BCR	Benefit-Cost Ratio
CAP	Chapter
CBA	Cost-Benefit Analysis
CBO	Community Based Organisation
CHW	Community Health Worker
CMC	Chipata Municipal Council
CO	Carbon Monoxide
COMESA	Common Market for East and Southern Africa
CRIDF	Climate Resilient Infrastructure Development Facility
CSO	Central Statistics Organisation Zambia
CSE	Contractor Site Engineer
DFID	Department for International Development
DHID	Department of Housing and Infrastructure Development
DWA	Department of Water Affairs
EHS	Environmental, Health and Safety
EHT	Environmental Health Technician
EIA	Environmental Impact Assessment
EMP	Environmental Management Plans
ENPV	Economic Net Present Value
EPB	Environmental Project Brief
ERR	Economic Rate of Return
ESIA	Environmental and Social Impact Assessment
ESR	Environmental Screening Report
EWSC	Eastern Water and Sewerage Company

Acronym	Long-Form
FGD	Focus Group Discussion
FIRR	Financial Internal Rate of Return
GBP	Great British Pound
GPS	Global Positioning System
GRZ	Government of Zambia
HCs	Hydrocarbons
HIV	Human Immune Virus
ICTZ	Inter-Tropical Convergence Zone
MEWD	Ministry of Energy and Water Development
MLGH	Ministry of Local Government and Housing
MoFNP	Ministry of Finance and National Planning
MSA	Mining Safety Agency
NAC	National Aids Council
NCS	National Conservation Strategy
NEAP	National Environment Action Plan
NGO	Non-Governmental Organisation
NGP	National Gender Policy
NHC	Neighbourhood Health Committee
NHCC	National Heritage Conservation Commission
NOX	Oxides of Nitrogen
NPE	National Policy on Environment
NRW	Non-Revenue Water
NWASCO	National Water and Sanitation Council
O&M	Operation and Maintenance
PM	Particulate Matter
PPE	Personal Protection Equipment
PVC	Poly Vinyl Chloride
RDA	Road Development Agency
RTSA	Road Transport and Safety Agency
SADC	Southern Africa Development Community

Acronym	Long-Form
SCF	Standard Conversion Factor
SIWI	Stockholm International Water Institute
SNDP	Sixth National Development Plan
SOx	Oxides of Sulphur
SpC	Specific Capacity of Production
STI	Sexually Transmitted Disease
USD	US Dollar
VIP	Ventilated Improved Pit Latrine
WDC	Ward Development Committee
WHO	World Health Organisation
WPC	Water Point Committee
WTP	Willingness to Pay
ZABS	Zambia Bureau of Standards
ZEMA	Zambia Environmental Management Agency
ZRA	Zambia Revenue Authority
ZWM	Zambian Kwacha

Executive Summary

Background

Several border towns around Zambia lack adequate and safe water supply and sanitation infrastructure, with general coverage limited to a few isolated areas where this is provided by established institutions, mainly for their staff, as well as privately owned facilities. The complete absence of public utilities results in transients crossing at these borders virtually not being catered for, and relying on limited facilities offered by residents, usually at a fee. The risk of spreading of diseases related to inadequate water supply and sanitation infrastructure is therefore very high. The overall scenario translates to a low quality of life at these border towns coupled with stifled commercial activity resulting from poor social services.

The aim of the 12 Towns project is to improve and upgrade water supply and sanitation through targeted investments designed to enhance overall coverage, sustainability and equitable access to water and sanitation by resident and the transient communities. The whole project plans to develop 600 new boreholes to cater for 720,000 inhabitants and to rehabilitate 350 existing boreholes serving an additional population of 420,000. It is also planned to upgrade and expand existing sanitation facilities through the construction of 310,000 latrines to serve a total population of 1.86 million inhabitants. These interventions are expected to support the growth of regional tourism, and reduce the incidence of cross-border waterborne diseases.

Mwami, close to Chipata is one of 12 border posts that have been selected by SADC for inclusion in the project and support by CRIDF. Engineering, environmental and financial and economic studies have been undertaken by CRIDF to establish the need for water supply and sanitation, and to assess the feasibility of the developing required infrastructure. This report summarises the outcome of the feasibility studies.

The proposed project to improve water supply and sanitation services at the Mwami border post in Chipata district located between Zambia and Malawi in the Eastern Province of Zambia is a vital necessity if the general operations at the border post are to be enhanced. The provision of adequate infrastructure at the border post will in specific terms improve the general hygiene and sanitation standards, augment tourism activities and reduce the likely incidence of “cross-border” water borne diseases, which can seriously impair the operations at the border post.

Key Stakeholders

Key stakeholders namely, the Ministry of Local Government and Housing (MLGH), the Eastern Water and Sewerage Company (EWSC), the National Water and Sanitation Council (NWASCO), the Ngoni Tribe Traditional Authority, Chipata City Council and the Residents Committee were consulted to solicit their views, experiences and suggestions. The proposed interventions were strongly supported by all the stakeholders who all indicated their desire to have the project implemented in the shortest possible time to alleviate the current hardships faced by the community.

Climate Resilience Issues

According to the residents interviewed, the Mwami area has experienced changes in weather patterns over the years noticed mainly through reduction in rainfall and reduced rainfall seasons. Most noticeable has been the drying up of wells within the area signifying a lowering of the ground water table.

Providing a reliable source of water to the Mwami community provides resilience to changes in climatic conditions and is therefore provides assurance of sustainability post implementation of the project.

Wastage of water was identified as one factor that exacerbates water shortages in the supply area. The design and operational and maintenance procedures incorporate water saving / reduction features.

Technical Assessment

The current Mwami population is estimated to be 1560 people plus 200 cross border transients. Based on the growth rate up to the 2010 Census (2.2%), the population is expected to reach 2266 (including transients) by 2025.

Based on an estimate of the residual category split and the possible future growth in level of service, the 2025 water demand is expected to be 115 m^3/day.

Ground water is the only option for this project and can be sustainably accessed through boreholes. However the area is regarded as a poor groundwater yielding area (expected yields 1 to 2 l/s) according to the National Aquifer Assessment Study which was commissioned by the Zambian Government through the Department of Water Affairs.

It is expected that four boreholes should meet the summer peak daily demand – 1.5 x average demand (based on the assumption of finding boreholes with a sustainable yield of 1 l/s).

The key interventions shall comprise the following:

- Water supply to low-income group residents who do not have household water connections - four public access points (kiosks)
- Water supply to small commercial and medium to high-cost housing units with stand–alone metered house connections (households to pay for connections).
- Sanitation for border patrons through an ablution facility whose primary purpose is to provide border users and commercial truck drivers with toilet, shower and laundry facilities.
- Training of and influence with the EWSC to enable future upgrades to the system to be in accordance with international norms and best practices.

The project's design outlay was conducted with the full involvement of the EWSC who will operate the services and have proven experience in operating such facilities already within their service area of Eastern Province.

Social Economic Assessment

The socio economic assessment fieldwork was undertaken during the months of May and June 2015. The report contains information obtained through literature review, community meetings and interviews with community members and personnel from various district departments.

The main economic activities in the project area can be groups under three categories as follows.

- Formal employment
- Business and Trading Ventures
- Small scale farming

All the residents including ZRA employees are not satisfied with the current water supply, which they feel is not adequate. Community members drawing from some of the communal water points complained of congestion and prolonged periods spent on drawing water.

The preferred water supply systems was a mixed level of services, which included individual house connections and communal water points using the kiosk model.

The most preferred liquid waste disposal technologies were water closet operated with septic tanks and ventilated pit latrines. If a waterborne sewer were provided, the individual households and premises would take the responsibility of financing connections from the main sewer line to their households. In the absence of a sewerage system, households would have to construct their own systems.

Some of the critical impacts are as follows:

- Positive impacts:
    - Improve resident's health
    - Equality in service provision
    - Increased Population
- Negative Impacts:
    - Water wastage
    - Transformation of the area into and urban area
    - Vandalism
    - Generation of solid waste
- Gender equality
    - Health Impacts - Woman typically care for their families during illness. The supply of a reliable disinfected water supply will reduce the incidence of water borne diseases.
    - Food Security – A reliable supply of water will allow for subsistence farming, food security and alternative ways to feed families, especially of poor families with limited alternatives.

- Water related impacts - women and girls generally assume primary responsibility for collecting water for drinking, cooking, washing and hygiene. Provision of a reliable, nearby, disinfected water supply will reduce the time for collection of the water supply, which allows time for other activities, e.g. employment and schooling.

Environmental Health Assessment

The locally available data for Mwami highlights the vector transmitted disease Malaria as the most prevalent in the community, followed by Acute Respiratory Infections (ARIs). The incidence of ARI transmission is often associated with poor hygienic practices, particularly handwashing. The incidence of diarrhoea, which is the main indicator for many faecal-oral diseases such as cholera, typhoid fever, dysentery and Hepatitis A, is relatively lower than Malaria and ARIs, but still widespread. However it is likely that this is under-reported, as the population may often self-treat or be failing to present themselves at the clinic for diarrhoea treatment.

A number of specific Environmental Health related issues have been identified in Mwami boarder post town (although many of these will be addressed by this project, some of the recommendations lie outside the scope of this feasibility study/ensuing project):

Lack of solid waste management facilities for the market site and other public areas

The liquid waste disposal method in Mwami is on-site via septic tanks and pit toilets. Some residents have mentioned space constraints relating to the digging of new toilets once the existing pit is full. There are currently no pit and septic tank emptying services operating in Mwami.

Open defecation and poor hygienic conditions around the market place (particularly during the Monday market).

Open defecation around the border post, particularly at night.

The majority to the toilets constructed are basic pit toilets, with limited facilities for odour and fly control. Few have handwashing facilities such as tippy taps at the toilet.

Newly arriving residents may not immediately prioritise the construction of a toilet, leading to temporary open defecation.

Environmental Assessment

The project site, being away from the main district and being a small area presented a challenge in terms of data availability especially on environmental baseline conditions.

The report presents the environmental impacts expected from the proposed project. The impacts were assessed from the changes likely to be brought about by the project activities on baseline environmental and social conditions. The impacts are discussed under separate headings namely common impacts; water supply project related impacts; and sanitation project related impacts. The common impacts are those that apply to both projects while those that are specific to each of the two projects are discussed under the respective

headings. The summary explains whether the impact is direct, indirect, reversible, irreversible and/or cumulative. Their significance with respect to the design of the water supply and sanitation project components is also discussed.

In general, as this is an existing town, the environmental impact to the flora, fauna and heritage aspects is expected to be low (already a highly impacted environment). However the project will have an impact on the town population in terms of safety, health and temporary inconvenience.

The report further presents the proposed Environmental Management Plan (EMP) which has been formulated based on the potential environmental impacts, and is intended to provide a link between the predicted impacts, proposed mitigation measures and the proposed framework for their implementation. The EMP is necessary for sustainability of the biophysical, socio-economic environments and the project itself, the impacts identified must be managed responsibly and effectively.

Risk Assessment

A detailed assessment of the risks for the Mwami border water supply and sanitation project was undertaken to assess the potential risks that could inhibit project implementation. The assessment has been effected from two perspectives namely inherent risks and external risks which are out of the project team's control. The risks are categorised under technical, operations and maintenance, socio-economic, environmental, political and financial. Included in the risk assessment are mitigation measures to reduce the possible impact of the risk.

Some of the identified risks include:

- Technical:
    - A lack of understanding of the requirements of the project
    - Varying the scope and or project objectives
    - Groundwater availability (or scarcity)
    - Groundwater contamination
    - Unregulated consumption and wastage of water
    - Denial of construction permits
    - Operations and Maintenance
- Socio-Economic
    - Affordability and willingness to pay
    - Sustainability
    - Environmental
- Political
- Financial

Financial and Economic Assessment

The purpose of the financial and economic assessment is a key part of the Feasibility Study as it provides an analytical method of identifying or confirming project viability. The tool used to determine financial and economic feasibility is the Cost-Benefit Analysis (CBA). The technical infrastructure solution, as outlined in the technical section of this Feasibility Report, proposes the following project design:

- Water supply to local residents without household water connections through the use of kiosks
- Water supply to medium to high-cost housing units with stand–alone metered house connections (where it is expected that households pay for last-mile connections)
- Sanitation for border patrons through an ablution facility whose primary purpose is to provide truck drivers with toilet, shower & laundry and drinking facilities

The CBA assesses the project holistically to identify if it is feasible. It is likely that a project of this nature will not be financially viable on a standalone basis; however, should the economic and social rationale for the project be clearly demonstrated, external financial support for the project can be justified.

The financial appraisal assesses the project's financial cash-flows (revenues and expenditures) over the life of the project to determine the profitability of an investment in the project. This is done from the perspective of Eastern Water and Sewerage Company (EWSC), who will be the project owner. The costs included in the financial appraisal are the capital investment costs and annual O&M costs. The revenue streams are expected to flow from the three groups of users – households without water connections who access water through kiosks, metered households and border patrons. They are based on estimations of water demand by the three usage groups and their corresponding water tariffs.

The project demonstrates financial viability, with a FNPV of GBP 94,215, and an FIRR of 15.2%. This return is higher than the discount rate of 11.5%, indicating that the project is marginally financially profitable. Excluding the initial capital investment, the project's operational cost-recovery is positive. Annual operating cash-flows (annual revenues less annual O&M costs) have a positive FNPV of GBP 440,369 and a BCR of 4. This indicates that the present value of the project's benefits, are approximately four times higher than the operating costs of the project. The strongly positive BCR is driven by the substantial revenues generated from the border patrons and implies that over the project's life, the revenues generated are sufficient to cover its on-going operating costs. If an external grant for the full capital amount (GBP 300,735) is secured, the financial return on the project infrastructure to EWSC will be 43.6% with a FNPV of GBP 363,933.

A sensitivity analysis conducted on the financial appraisal indicates that the above results are robust to variations in the project's main parameters. A 25% increase in capital costs would be required to generate a negative FNPV. The projects operational sustainability also remains robust to sensitivities in the project parameters. A 50% decline in the border traffic, the main revenue source for the project, would not shift the operational sustainability of the project to negative.

The economic appraisal component of the CBA assesses a wider spectrum of costs and benefits relative to the financial appraisal. Both quantitative and qualitative costs and benefits are included to provide a holistic view of the expected net socio-economic impact of the project. The costs considered are the capital and O&M costs adjusted by the relevant conversion factors to take into account market distortions in their financial prices. The benefits considered quantitatively are the time savings to households and the positive impact on the health and productivity of the residents and border patrons due to the water and sanitation infrastructure. Additionally, the longer term impact of the project as an enabler of economic development is discussed qualitatively.

The results of the quantitative economic appraisal shows that the project is economically viable and beneficial. At a 10% discount rate, the project's ENPV is 48,785 and the BCR is 1.02; at a 3.5% discount rate, the ENPV is GBP 285,455 and the BCR is 1.38. The ERR at both discount rates is 12%. A strong argument can be made that these results are an understatement of the true benefits that stem from the intervention due to the fact that some of the positive social externalities cannot be quantified in monetary terms. However, the combination of quantitative results, bolstered by the significant qualitative benefits, provides a robust justification for the project from a socio-economic perspective. A sensitivity analysis conducted on the economic appraisal confirms that the positive results are robust to variations in the assumed parameters but that time savings are a driver of these positive economic benefits.

Financial and Economic Summary Table

Budget	
Capital investment	£300,735
Beneficiaries	
Direct beneficiary households	300 (2015), expected to increase to 463 by 2035
Indirect beneficiary households	73,000 border patrons per annum, including trucks and passenger vehicles. *The indirect beneficiary population includes the significant transitory population passing through Mwami, including commercial vehicles (trucks) as well as other border patrons. As the project infrastructure includes sanitation facilities for this population, they are included as indirect beneficiary households.*

Assumed number of people per household	5.2[1]	
Analysis timeframe	20 years	
Economic Benefits		
Time savings (NPV)	£579,943 (3.5%); £369,556 (10%)	
Health (NPV)	£156,906 (3.5%); £95,153 (10%)	
Financial appraisal performance indicators (11.5% Discount Rate)		
Financial Net Present Value (FNPV)	£94,215	
Financial Internal Rate of Return (FIRR)	15.2%	
Financial Benefit Cost Ratio (FBCR)	1.23	
Economic appraisal performance indicators		
	(3.5% SDR)	**(10% SDR)**
Economic Net Present Value (ENPV)	£285,455	£48,785
Economic Rate of Return (ERR)	12%	12%
Economic Benefit-Cost Ratio (EBCR)	1.38	1.02
Sustainability		
Operationally the project is sustainable as annual revenues that accrue from households and the sanitation facility exceed the annual operation and maintenance costs of the infrastructure over its project lifespan. Additionally, the monthly household spend on water is 2% of household income for those that will use the water kiosks and 1.3% for metered houses. Benchmarks provided by the World Bank and UNDP suggest that household spend on water for low income households should not be more than 5% or 3% of monthly income.		

[1]National Census. Zambia (2010), Chipata district.

For median income households in Africa, the average household spend on water is roughly 2.8% of monthly income[2]. Affordability for the project thus falls well within these benchmarks and suggests that the population of Mwami should be able to afford the proposed water prices.

The sanitation facility's tariffs are based on the current prices that truckers pay in the informal market for water and sanitation in Mwami, demonstrating that there is sufficient willingness to pay for these services and that in reality it may be possible to charge higher tariffs for the same services offered through a formal, and therefore, more efficient system. However, if tariffs remain at current levels, the project is still operationally sustainable.

Sustainability of the project relies strongly on revenue generating parameters such as the current population figures, the expected population growth rate, the number of border patrons passing through Mwami and the proportion of households which have reticulated systems and those that use communal water points. Sustainability also relies on the on-going cost parameters of the project, including the operation and maintenance costs of the proposed intervention. As these are calculated as a percentage of the total capital expenditure on the project, the percentage assigned to these costs as well as the total cost of the immediate investment are both important variables in determining financial viability as well as operational sustainability.

Source: CRIDF CBA

Conclusion and Recommendations

In summary, there is a strong socio-economic justification for the Mwami project. While the project is financially profitable, its returns are not sufficient to attract private sector finance due to the long payback period and risk associated with rural water supply. External grant financing will therefore be required to cover the capital investment. Should this be secured, the CBA indicates that the project is strongly operationally sustainable. Grant funding of GBP 300,735 for the full capital amount should be secured to operationalize the project.

[2]Hutton, G. (2012) " Monitoring "Affordability" of water and sanitation services after 2015: Review of global indicator options", PhD – A paper submitted to the United Nations Office of the High Commission for Human Rights, http://www.wssinfo.org/fileadmin/user_upload/resources/END-WASH-Affordability-Review.pdf

Introduction

Background

The Climate Resilient Infrastructure Development Facility (CRIDF) is DFID's water infrastructure programme for southern Africa, working to deliver sustainable small-scale infrastructure across 11 SADC countries. The demand-driven programme focuses on water services, water resource management, and water for livelihoods, fostering sustainable development of the region's water resources and addressing the water, food and energy nexus. This project aims to provide sustainable and equitable access to a safe water supply and appropriate sanitation in 12 border towns in Zambia. In relation to water supply, the Project as currently envisaged aims to establish some 600 new boreholes providing water to 720,000 inhabitants, and to rehabilitate 350 existing boreholes serving an additional population of 420,000. Sanitation is also to be upgraded, through the construction of 310,000 latrines serving 1.86 million inhabitants in total. These interventions are not solely aimed for the general upgrading for water and sanitation services, but are also envisaged to improve regional tourism and reduce the incidence of cross-border waterborne diseases. This report summarises the feasibility of a water supply scheme and sanitation facility at Mwami Border Post located on the boundary between the Republics of Zambia and Malawi approximately 21 km from Chipata town, the provincial headquarters of the Eastern Province in Zambia.

Project Location

Mwami Border Post is located in the Eastern Province of Zambia, at geographic co-ordinate 13°45'2.34"S and 32°47'45.22"E, on the boundary between the Republics of Zambia and Malawi, approximately 21 km south east of the provincial capital of Chipata. **Figure 1** below shows the location of Mwami border post.

Figure 1 Locality Map

General Description of the Project Site

The Mwami Border post area is bounded by hilly terrains prevalent on the eastern and western flanks. It lies close to the foot of the hills located on the western side (the eastern range of hills is approximately 4km away). One natural feature located in close proximity to the border post is the source of the Lutembwe River, which is approximately 2 km away in a North Easterly direction. The Lutembwe River is perennial and has been dammed 20 km from the border post to form the Lutembwe dam used to supply water for the City of Chipata. The prime activity at Mwami is the border crossing for pedestrians, domestic and commercial vehicular traffic from either Zambia into or in transit through Malawi and vice versa. These activities have given rise to the establishment of small business enterprises such as trading stores, restaurants, and entertainment venues, all of which serve the locally residing and travelling populace.

Mwami border post is situated along a 2 km long narrow strip straddling the Great Eastern Road from Lusaka to Malawi. The spatial structure of the border post is spontaneous, with no discernible elements of land use and development of land in the area. Apart from the main road, the interconnecting road network and layout of housing developments is haphazard. The general planning structure is therefore not conducive to the efficient and cost-effective provision of public utility services. Low cost and high cost housing are intermingled, thus complicating the supply of water and disposal of generated wastewater, i.e. the selection of an appropriate level of service in the provision of public utilities for the various areas of the township.

The Google Earth image of the central part of Mwami in **Figure 2** below illustrates the spontaneous planning structure of the border post. Typically, there is no network of planned road services to provide a spatial skeleton for the location of water supply and wastewater networks.

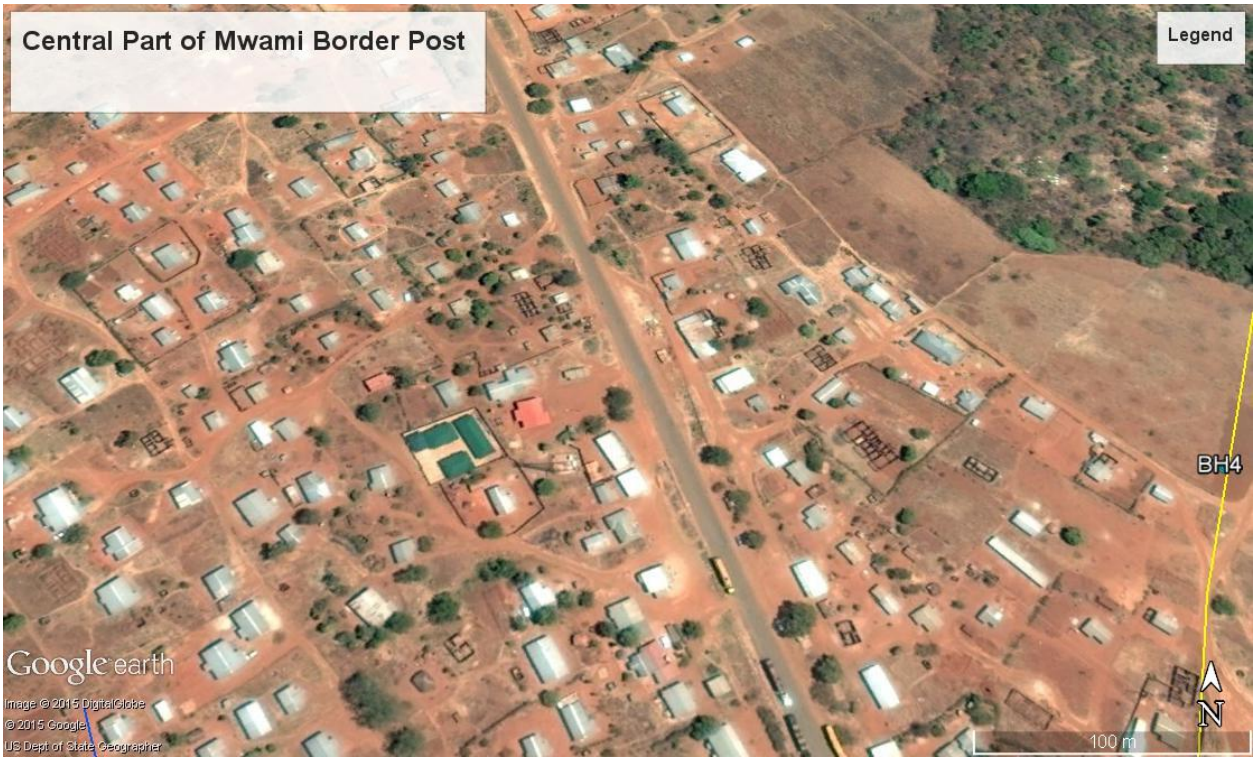


Figure 2 Central Part of Mwami

Climate Resilience Issues

This project has been identified based on being one of the 12 Zambian border towns.

According to the residents interviewed, the Mwami area has experienced changes in weather patterns over the years noticed mainly through reduction in rainfall and reduced rainfall seasons (Focus Group Discussion at Mwami Border Post; 29th March, 2015). Most noticeable have been the drying up of wells within the area signifying a lowering of the ground water table and the reduced size or expanse of the upper catchment area of the Lutembwe river which originates in Mgambi village adjacent to the border area. Furthermore, the forest cover in the area and surrounding hills has substantially reduced due to increased charcoal production to service the rapidly growing Chipata district. Water scarcity has increased as there are few reliable access points from which water for domestic use can be sourced.

Providing a reliable source of water to the Mwami community provides resilience to changes in climatic conditions and is therefore provides assurance of sustainability post implementation of the project.

Wastage of water was identified as one factor that exacerbates water shortages in the supply area. The design and operational and maintenance procedures incorporate water saving / reduction features:

- All water access points will be metered and the water consumed will be levied and paid for proportional to the volume of water consumed.
- The quality of fixtures used for the network should be durable and robust to minimise malfunction and therefore unnecessary water loss.
- The community through their representatives should also undergo awareness creation on the network with emphasis on aspects that include vandalism, pilferage, water wastage, good hygiene practice and standards, maintenance, latrine and septic tank construction etc.

The EWSC staff that shall oversee the operations should undergo training on operation and maintenance procedures with emphasis on aspects such as water balances, water restrictions, response times, wear and tear, stocking of critical replacement parts and septic tank construction.

Technical Assessment

Water Resources Design

Water Sources

Two possible water source types were investigated namely surface and groundwater.

The only surface water body in the vicinity of the project area is the Lutembwe River (approximately 2 km to the North from the upper boundary of the settlement). The project area is located in the upper catchment of the Lutembwe River, at the northern foot of a mountain range which straddles the border between Zambia and Malawi. Relief is flat and gently sloping towards the east, with no discernible drainage lines. The nearest watercourse is Lutembwe River.

The project area lies on the main divide of north-eastern tributaries of the Zambezi, where drainage is towards the North into the Luangwa River and south into the Vumbwe River, a minor tributary of the Zambezi River. The potential for surface water is therefore very limited. The flow rates in the river are very low in the Mwami locality as the runoff is small due to the small overall size of the catchment at this point (source of the river. Therefore, the demand cannot be met and this option cannot be viably pursued (see **Figure 3**).

Figure 3 Lutembwe River from its source

The second option is that of abstracting from the groundwater sources. An evaluation of the ground water potential in the area was therefore conducted as part of the feasibility study. Technical staff from the Department of Water Affairs (DWA) were consulted on the ground water potential and availability in the area, based on their recent documented experience with two drilled boreholes in the area. Residents living in the area where also interviewed to garner a clear appreciation on their challenges and the strategies they employ to acquire their daily water needs.

A water source options matrix was produced (**Table 1**).

Table 1 Water Source Options Matrix

Option and Ranking	Option Description	Benefits	Key Issues
Option 1 (Boreholes)	• Drill boreholes within the service area • Transfer water (distance less than 1km) from borehole to reservoirs to be installed on hill adjacent to the border post • Chlorinate the water • Distribute water from overhead reservoirs to the Mwami settlement directly below the reservoir location • Access to water through individual metered household connections and communal access points called kiosks manned by vendors contracted by EWSC	• Potential drilling sites available • Power readily available within service area • Treatment process not complex • Regulated usage which minimises wastage	• Traditional leadership to be engaged so as to give an undertaking to avail land where drilling can be effected • Tariffs are set by NWASCO • Community participation through vendors and Ward Development Committee, which enhances ownership • Access by all is assured which will positively impact sanitation and general hygiene levels
Option 2 (From Lutembwe River)	• Extract surface water from the Lutembwe River point 12kms from Mwami • Construction of a water treatment plant that can effect coagulation, flocculation, sedimentation, filtration, chlorination • Construct a 13kms high pressure pumping main to Mwami including high lift centrifugal pumps	• Water source reliable	• More expensive option as much more infrastructure is required • More manpower required for operations and general security for the transmission line • Higher energy costs due to very long pumping distances

Groundwater in the Project area: Quantity aspects

The project area lies in low yielding aquifer zones that are described as argillaceous, Karoo basalts and the older basement complex[3], and can be defined as having a high variability of hydrogeological characteristics. Pump tests undertaken in argillaceous aquifers as part of the NWRMP show a median average specific yield (aquifer yield per unit drawdown) of about 0.057m^2/day. Furthermore the reports from DWA indicate that the project area has low-yielding aquifers averaging 1 litre per second.

Three sites were selected for possible location of boreholes as follows (refer to **Figure 4**):

- Well Field 1 - To the east of Mwami.
- Well Field 3 – To the south-west of Mwami, at the foot of a highly elevated hilly range.
- Well Field 2 – To the north of Mwami, which is within a depression

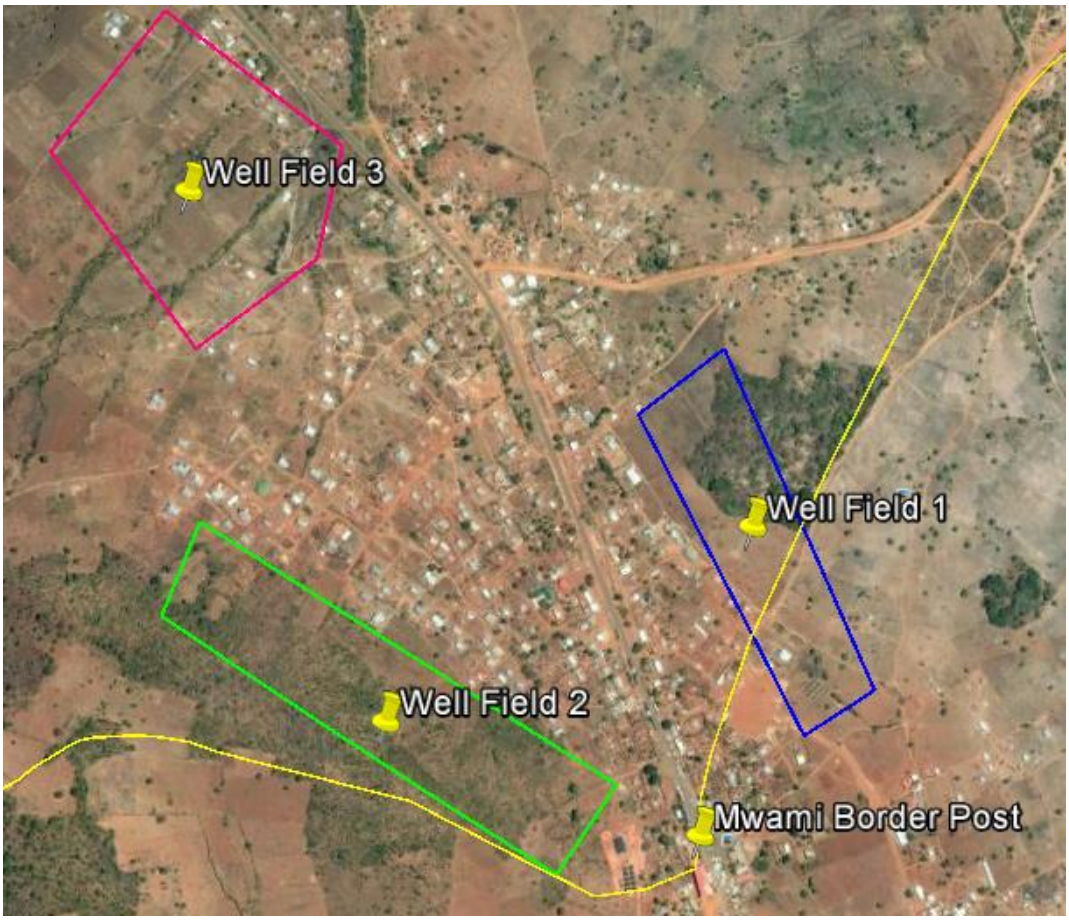


Figure 4 Possible Borehole Positions

[3] Zambia National Water Resources Master Plan (NWRMP)

- Proposed Well Field 3 has a geology that is predominantly clay and granite. It was reported that in some cases, the clay extends beyond 40m depth. The expected yields in this area were envisaged to be below 0.5 litres per second. During the Focus Group Discussions (FGDs), residents attested to the low yields and indicated that most of the boreholes in this area dry up during the peak of the dry season.
- Proposed Well Field 2 which is in a depression on the northern side of site was said to have higher yields (say above 0.7 l/s).
- Proposed Well Field 1 which is on the eastern side of the main road was expected to generally have yields of over 0.7 l/s with safe yields being in the range of 1.5 to 2 l/s in some cases.

It should be noted that Proposed Well Field 3 is the closest to the proposed location of the overhead distribution tanks, but is expected to have the lowest yields. The low yields will result in high-energy consumption as many boreholes would be required to sustain the demand. Compared to the Proposed Well Field 1, which is expected to give the highest yields, but is disadvantaged by location, which will necessitate a booster pumping facility. Despite this shortcoming, the area for the Well Field 1 has been adopted and the costed for planning and budgeting purposes.

In the absence of geophysical surveys to establish groundwater potential at the project site, anecdotal information from the Department of Water Affairs (DWA) and residents has been used to obtain an indication the most likely areas to site borehole water sources. Three areas were considered to the north, west and east of the settlement. The latter area was found to have the greatest potential, with expected yields of between 1.5 and 2 l/s. It is proposed to carry out investigation in the area to confirm the availability of groundwater, and to develop the source for the supply of water to the settlement.

For planning purposes, a safe yield of 1 l/sec per borehole has been assumed. Based on a 16 hour pumping period, 1 borehole is expected to yield **58 m^3/day**.

The National Aquifer Assessment Study

The findings contained in the Groundwater Resources Management Support Programme National Aquifer Assessment Study undertaken by Messrs Gauff Ingenieure on behalf of the Ministry of Minerals, Energy and Water Development in 2013. The Mwami area is located in the lower Luangwa Aquifer which is classified as a “low yielding”. The map below shows the aquifer types and expected yields in the Mwami area (page 21 in the appendix section of the National Aquifer Assessment study, Gauff Ingenieure 2013).

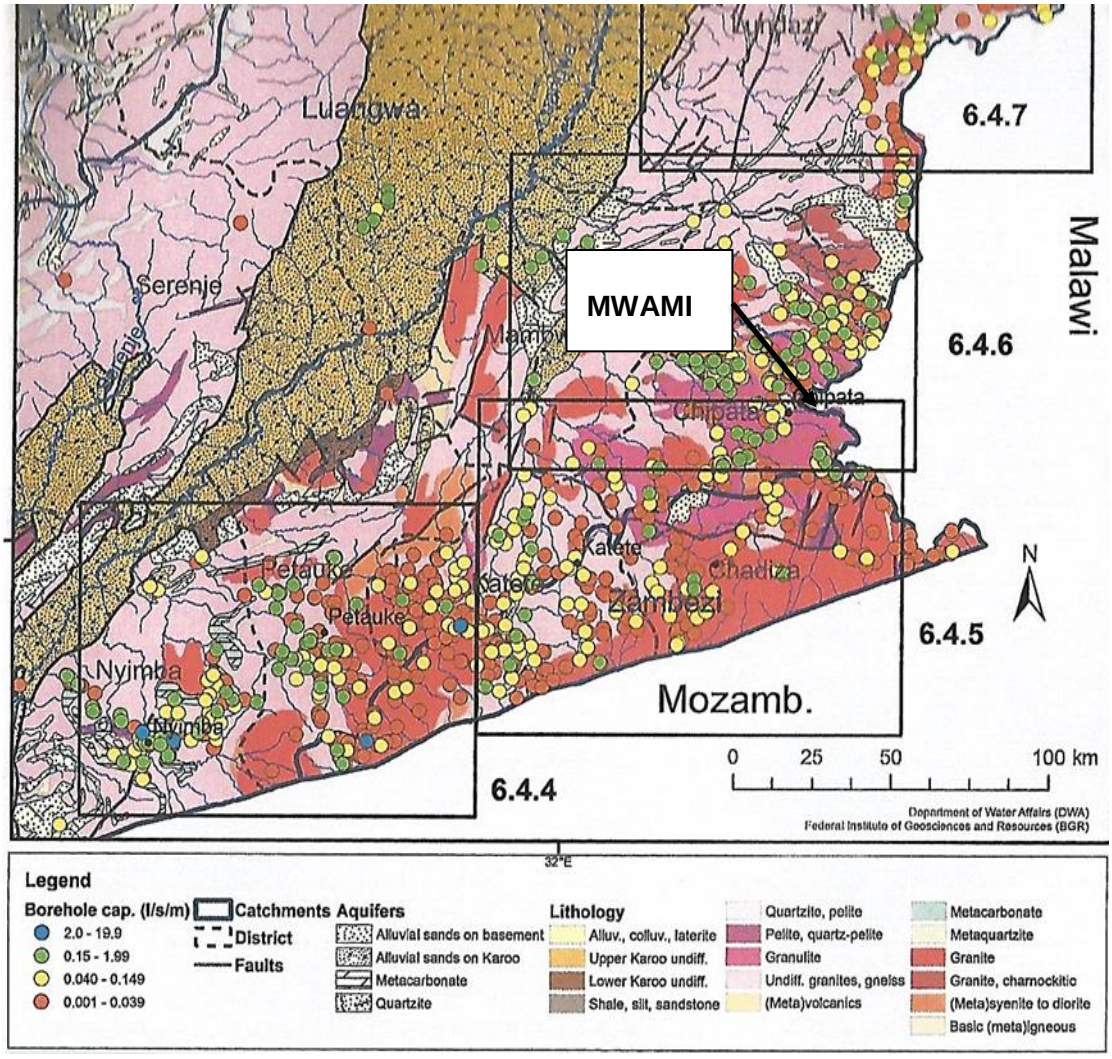


Figure 5 Aquifer types and expected yields in the Mwami area

The border post area has according to the study expected borehole Specific Capacities of Production (SpC) ranging between 0.040 to 0.149 l/s/m (yellow legend) categorised as a “sufficient to poor” yield. The yield is obtained using the conversion table that shows the aquifer ranking system for Zambia (page 3-5 National Aquifer Assessment study, Gauff Ingenieure 2013).

Table 2 Mwami border post Specific Capacity of Production

specific capacity (SpC_ l/s/m)	permitted draw-down (m)	yield (l/s)	Yield (l/min); appr.	yield (m^3/h) appr.	Ranking	
50.000	5	250.000	15000.0	900.000		SpC > 19.9 l/s/m; excellent
30.000	5	150.000	9000.0	540.000		
20.000	10	200.000	12000.0	720.000		
10.000	10	100.000	6000.0	360.000	2	SpC 2-19.9 l/s/m; good
5.000	10	50.000	3000.0	180.000		
3.000	15	45.000	2700.0	162.000		
2.000	15	30.000	1800.0	108.000		
1.000	20	20.000	1200.0	72.000	3	SpC 0.15 - 1.99 l/s/m; fair
0.500	20	10.000	600.0	36.000		
0.300	20	6.000	360.0	21.600		
0.200	20	4.000	240.0	14.400		
0.150	20	3.000	180.0	10.800		
0.100	20	2.000	120.0	7.200	4	SpC 0.04 - 0.149 l/s/m; sufficient to poor
0.080	25	2.000	120.0	7.200		
0.060	25	1.500	90.0	5.400		
0.040	25	1.000	60.0	3.600		
0.020	25	0.500	30.0	1.800	5	SpC 0.001 - 0.0 39 l/s/m; very poor
0.015	25	0.375	22.5	1.350		
0.010	25	0.250	15.0	0.900		
0.005	25	0.125	7.5	0.450		
0.001	30	0.030	1.8	0.108		

The Mwami border post Specific Capacity of Production ranges between 0.040 to 0.149 l/s/m (ranked in group 4) as per the aquifer ranking table. The corresponding borehole yields for this range are between 1 to 2 litres per second (l/s).

Groundwater in the project area: Quality aspects

Water samples were collected from three boreholes in the project area and analysed for several parameters that are used to ascertain the quality of potable water. The locations of the boreholes are indicated in **Figure 6** below. The GPS coordinates are shown in **Table 3** and water quality results in **Table 4**.

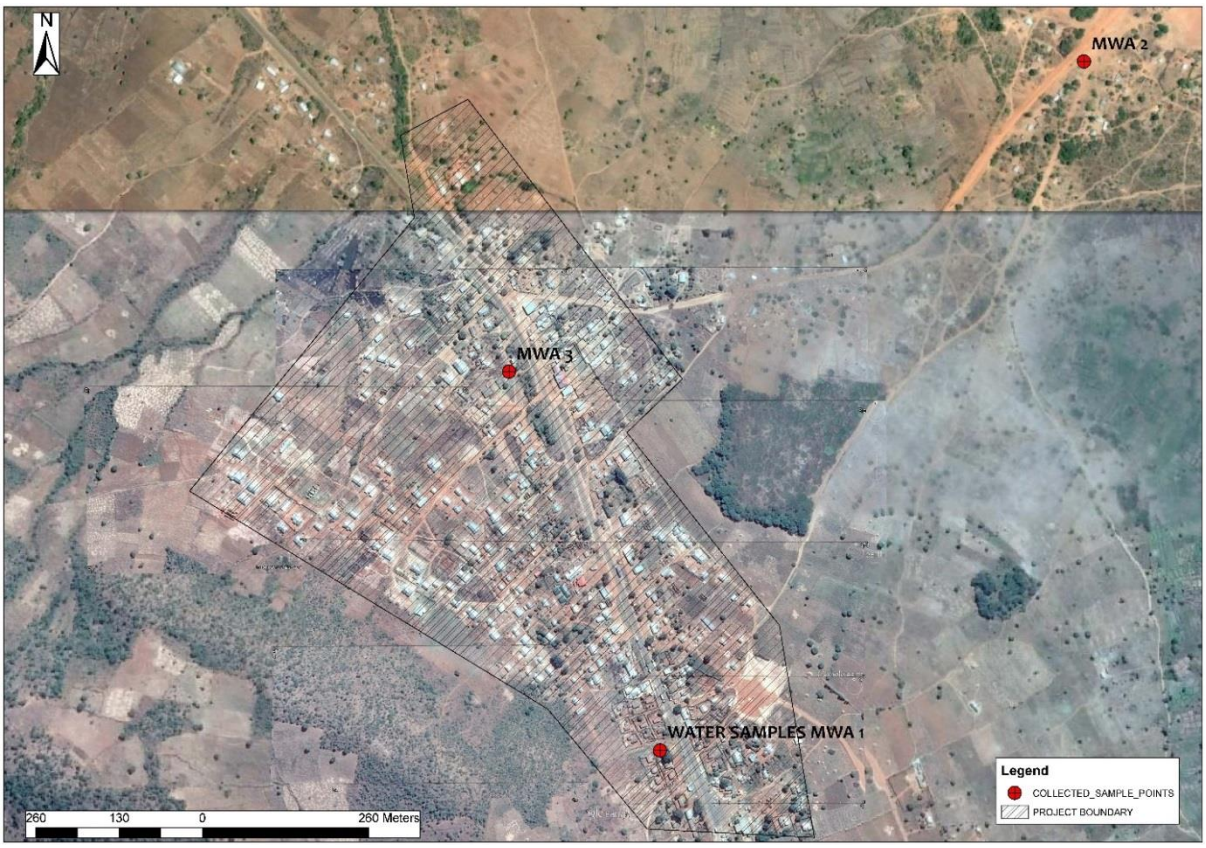


Figure 6 Borehole locations

Table 3 GPS Locations of the sampling points

Name of Point	Location	
	Latitude	**Longitude**
MWA 01	0477871	8479931
MWA 02	0478533	8481006
MWA 03	0477635	8480522

Table 4 Water quality results for samples collected from boreholes

Parameter	MWA01	MWA02	MWA03	WHO guideline value
pH	6.65	6.96	6.84	6.5- 8.5
Turbidity (NTU)	0.14	0.30	0.15	5.0
Total Dissolved Solids(mg/l)	185	105	153	1000
Sulphide (mg/l)	<0.01	<0.01	<0.01	-
Total hardness (as mg $CaCO_3$/l)	145	90	180	500
Calcium hardness (as mg $CaCO_3$/l)	80	65	98	500
Iron (mg/l)	0.02	<0.01	<0.01	0.30
Ammonia (as NH_4-Nmg/l)	0.04	<0.01	0.03	1.50
Sulphates (mg/l)	<0.01	<0.01	<0.01	250
Chlorides (mg/l)	50.0	15.0	20.0	250
Nitrates (as NO_3–Nmg/l)	11.68	<0.01	<0.01	10.0
Orthophosphates (mg/l)	<0.01	<0.01	<0.01	5.0
Magnesium (mg/l)	15.60	6.00	19.68	-
Calcium (mg/l)	32.0	26.0	39.2	200
Copper (mg/l)	<0.003	<0.003	<0.003	2.0
Potassium (mg/l)	10.56	3.17	4.22	-
Sodium (mg/l)	22.99	12.90	15.20	200
Manganese (mg/l)	<0.01	<0.01	<0.01	0.50
Nitrites (as NO_2–Nmg/l)	<0.001	<0.001	<0.001	0.100
Zinc (mg/l)	<0.005	<0.005	<0.005	3.0
Arsenic(mg/l)	<0.002	<0.002	<0.002	0.01
Bacteriological Results				
Total coliforms (#/100ml)	0	7	0	0
Feacal coliforms (#/100ml)	0	2	0	0

These results indicate that the physical and chemical parameters for all the boreholes fall within the WHO and Zambian Standards for drinking water. Key features in the test results include acceptable and “within limit” levels of iron, manganese, copper, zinc and arsenic.

However, one of the samples (MWA02) tested positive for microbiological contamination. The level of contamination was low, especially considering the requirement that water for public consumption needs to undergo chlorination prior to distribution to guard against possible contamination during distribution. Due to the nature of the source at this point, it was not possible to ascertain whether the contamination was primary or secondary. The likelihood that it could have been secondary seems very plausible as the system has a rising piped network that delivers into the tank prior to gravitational flow from the tank to the taps as illustrated on **Figure 3**. Note the ponding of water around the tap at MWA02, which could contribute to secondary contamination.

Figure 7 Sanitary conditions around the taps at MWA002

Sanitary measures to safeguard quality

The proposed system is in a rapidly expanding residential area. It is therefore important that the area where the boreholes to supply the area will be located is secured on title to avert issues of potential encroachment, assure access for operations, maintenance and ownership. Currently, the land falls within the jurisdiction of

paramount Chief of the Ngoni people, His Royal Highness Mpezeni – The Inkhosi Ya ma Nkhosi of the Ngoni tribe. It is thus recommended that the project, through EWSC acquires the needed land and also ensures that the land is on legal title. In addition, it should be ensured that there are no developments allowed within the protected area to prevent possible contamination, which can emanate from latrine or septic tank effluents, poor solid waste practices, gardening or crop production using agro-chemicals all of which can compromise water quality and impact negatively on overall project sustainability.

Water Supply System Design

Population

Various population data sources were consulted to estimate the population of the Chanida Border Post, including the 2010 Zambian Census, the Ward Development Committee (WDC), the Neighbourhood Health Committee (NHC), Water Point Committee (WPC) and the Environmental Health Technician (EHT). In addition to this, the number of households was counted using aerial photography (Google Earth imagery).

The last published population census in Zambia was undertaken in 2010. From the Census report, key population statistics for Chipata district under which the project area falls are summarised below:

- Population growth rate over the period 2000 - 2010 2.2% per annum
- Household size 5.2 persons per household

Data from the Ward Development Committee (WDC), the Water Point Committee and the Neighbourhood Health Committee (NHC) indicated that there are currently 300 households. This figure was confirmed through aerial photography house count. Using the 2010 Census household size the population was estimated as 1560 people.

As a border post, Mwami also has a transient population, which due to delays at the border post place a demand on the water and sanitation infrastructure of the town.

On average, about 200 people (transients) pass through the border post daily.

For the purposes of this report, it is assumed that the number of border crossings will grow by 5% per annum, which is equivalent to the target cited in the African Development Fund (ADF) report 'Nacala Road Corridor Development Project- Phase IV – Project Appraisal Report'.

Population projections have been categorised based on the observed trend in the development of housing in the project area, which indicates housing floor areas ranging from averages of 50 m^2 (low cost) to 180 m^2 (high cost) with a respective approximate distribution of approximately 70:30. Due to the spontaneous / haphazard structure of the settlement, this ratio has been used to estimate the water demand.

Table 5 Residential categories for Mwami Border Post

Category	Connection Category	Percentage in Category	Percentage of Total
High Cost (180 m²)	House	100 %	30%
Low Cost (50 m²)	House	50 %	35%
Low Cost / Peri-urban or rural housing	Communal	50 %	35%

Based on the residential categories in **Table 5**, the breakdown of population per category is given in **Table 6**.

Table 6 Total number of exiting housing plots and current population

	Total No of Stands	Total Population
High Cost (180 m²)	90	468
Low Cost (50 m²)	105	546
Low Cost / Peri-urban or rural housing	105	546
Sub Total	**300**	**1560**
Transient		200
Total Population		**1760**

Current and projected water supply level of service

Currently access to water is via standpipes. Field inspections and interviews revealed that demand projections for the area will be derived using a “mixed development” approach due to the variation in customer types. On category will access water from public communal standpoints housed in small kiosk buildings whilst another category will require an “in-house” connection that will facilitate provision for fixtures that include a water borne closet, wash basins, and shower or bath tub. The field survey also revealed that several households were constructed with in-house facilities but these were non-functional due to the non-availability of a direct household water connection. This area can hence be categorised as a “mixed development” as it comprises housing types ranging from high cost to rural dwellings. (refer to **Figures 8 and 9**).

Figure 8 High cost housing units at Mwami Border Post

Figure 9 Low cost or rural housing units at Mwami Border Post

The proposed system is in a fast expanding residential area. It is therefore important that the area where the boreholes are located to supply the area is secured on title. Adequate land should be secured to cater for future expansions beyond the project's life span. Currently, the land falls within the jurisdiction of paramount Chief of the Ngoni people, His Royal Highness Mpezeni – The Inkhosi Ya ma Nkhosi. This project requires land dedicated to it which should preferably be on title and under the jurisdiction of the local authority / EWSC, which currently has very little presence in the area. As a way of safeguarding water quality, it will be imperative that no developments are allowed within this area as this may compromise the water quality. No

farming activities should also be permitted in the vicinity of the well field sites to avoid contamination with agro-chemicals.

Future Population Size and Split

The following assumptions were used to calculate the projected future population:

- 2010 Census growth rate of 2.2% and average household size of 5.2 people
- 5% Growth rate for border crossing traffic
- 10 year design horizon

Based on these assumptions, the projected population is shown in **Table 7**:

Table 7 Project Population

Category	2015	2025
High Cost (180 m²)	468	582
Low Cost (50 m²)	564	679
Low Cost / Peri-urban or rural housing	564	679
Transient	200	326
Total	**1760**	**2266**

The current and projected population, split by category, is summarised in **Table 8**.

Table 8 Current and projected population by residential area and housing cost category

Residential Zone	Current Category Population			2025 Category Population		
	High Cost	Low Cost	Low Cost - Communal	High Cost	Low Cost	Low Cost - Communal
High Cost (180 m²)	468			582		
Low Cost (50 m²)		546			679	
Low Cost / Peri-urban or rural housing			546			679
Sub Total	**468**	**546**	**546**	**582**	**679**	**679**
Transient Community		200			326	
Total	**468**	**746**	**546**	**582**	**1005**	**670**
	1760			**2266**		

The above table shows an estimated total projected population of 2,266 in 2025.

Current and projected water demand

The Zambian Standard (ZS 361 of 2009) has been used as a guideline in selecting suitable consumption rates for the various consumer categories at the border post. The water demand consumption rates in **Table 9** have been adopted for use in the estimation of water demand.

Table 9 Typical average per capita consumption

Category	Average per capita consumption litre/capita /day
High Cost	100
Medium Cost	75
Low Cost and Transient Consumers	40
Low cost – communal (Peri-Urban / Rural)	25

The definitions of the various categories according to the national standards are as follows:

- High Cost Houses (HC): Low density housing with plot area greater than 900 m^2 with multiple taps, more than one Water Closet (W.C) and water borne sanitation;
- Medium Cost Houses (MC): Medium density housing with plot area ranging between 400 and 900 m^2 with multiple taps, one or more W.C and water borne sanitation;
- Low Cost Houses (LC): High density housing with Plot area of less than 400 m^2 with reduced number of taps, one W.C and water borne sanitation; and
- Peri-urban or Rural Housing: Housing with communal or shared standpipe or one tap in a plot with no water borne sanitation (i.e. uses latrines as a means of excreta disposal).

The above rates have been used in conjunction with population projections to obtain estimates of projected average water demand for each consumer category in each residential area. The results are summarised in **Table 10**.

Table 10 Estimated current and projected water demand by category for the main development areas

Residential Zone	Current Water Demand			2025 Water Demand		
	m3/day			m3/day		
	High Cost	Medium Cost	Low Cost	High Cost	Medium Cost	Low Cost
High Cost (180 m^2)	46.8	0.0	0.0	58.2	0.0	0.0
Low Cost (50 m^2)	0.0	21.8	0.0	0.0	27.1	0.0
Low Cost / Peri-urban or rural housing	0.0	0.0	13.7	0.0	27.1	17.0
Sub Total	**46.8**	**21.8**	**13.7**	**58.2**	**27.1**	**17.0**
Transient Community	0.0	8.0	0.0	0.0	13.0	0.0

Total	46.8	29.8	13.7	58.2	40.2	17.0
	90.3			115.3		

The above shows a projected average water demand of 115.3 m^3/day for the year 2025.

Description of the proposed water supply system

The water supply system will have three distinct components namely:

- the water sources;
- storage facilities; and
- a distribution system.

There is currently no piped supply to the community at Mwami or any other acceptable form of service except two handpump operated boreholes.

Details of the proposed borehole water source has been elaborated on in the preceding sections.

Design criteria

The following design criteria was used for the feasibility design:

Elevated storage volume – 2 x average daily demand

Pipe sizes – Peak hourly demand (3 x average daily demand)

Supply (boreholes) – Peak daily demand (1.5 x average daily demand)

A simple distribution network comprising a gravity mains from the reservoir and a main stem which runs along the main road to feed the eastern and western parts of the border post has been developed. A secondary main bisects Zone 3 to supply the residential properties to the west. The layout of the proposed network is shown in **Figure 10**.

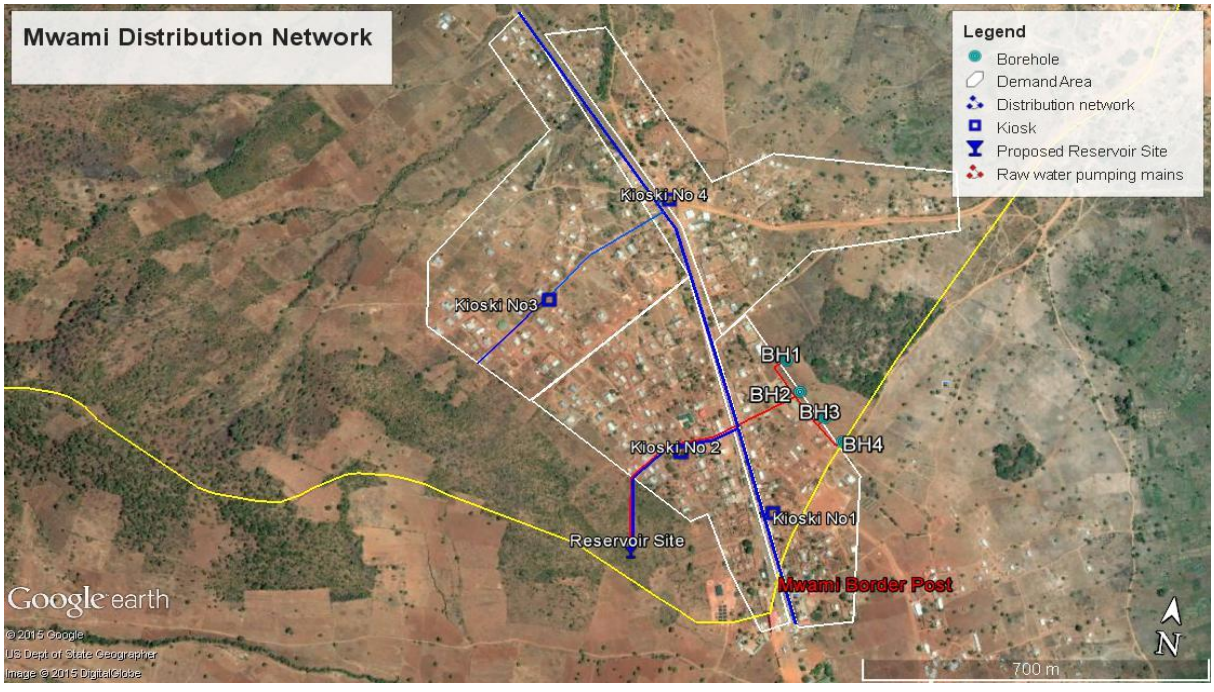


Figure 10 Proposed Mwami Border Post Distribution Network

A total of four water kiosks located as shown in **Figure 10** will be provided to cater Low Cost access to water, while individual connections will be made on application.

Four demand Zones have been identified centred around each kiosk, as shown in **Figure 10**. Average water demand in each of the four demand zones has been estimated on the basis of the total number of buildings in each zone, pro rata the total water demand for the year 2025.

Peak day and peak hourly demand for each centre was then computed by multiplying average daily demand for year 2025 by 1.5 and 3 respectively. The results for the 2025 peak water demand are summarised in **Table 11**.

Table 11 Mwami peak water demand by demand centre for year 2025

	Peak Hour		Peak day (16 h)	
Zones	m3/day	m3/h	m3/day	m3/h
1	85	5.3	42.5	2.66
2	124	7.7	62.0	3.87
3	68	4.3	34.1	2.13
4	74	4.6	36.8	2.30
Total		**21.9**		**10.96**

The network has been designed to cater for future housing developments through infills and densification of residential houses. It will serve as a nucleus within which new developments will occur, thus discouraging expansion of housing developments to unserviced areas.

Borehole Development

The hydrogeology has indicated the possibility to develop borehole sites on the eastern side of the border post, each with a potential safe yield of 3.6 m^3/hr. It is proposed to develop borehole water supply to cater for water demand up to 2025. An assessment of required raw water supply is as follows:

Peak day water demand at 2025 (16 h) = **10.96** m^3/hr

No of boreholes required to cater for the demand = 10.96/3.6 = 3.05

A total of 4 boreholes drilled at locations in the east of the border post, across the highway will be adequate to cater for peak day water demand.

Based on an aquifer Specific Capacity of 0.056 l/s/m the total drawdown required to produce 1l/s is estimated at 20 m. Assuming water table depths in the region of approximately 30 m, the boreholes will require to be

drilled up to at least 50 m, and sited at least 80 m apart. All the boreholes operating together will deliver in excess of the peak day demand.

Pumping system

It is proposed to pump water from the four boreholes by means of 1 kw electrically submersible pumps, through short 50 mm diameter class 12 uPVC pipelines to a bifurcation, from where it will be delivered to a high level distribution reservoir, through a 530 m long, 110 m diameter, Class 9 uPVC pipeline.

The results of the network analysis of the raw water pumping system showing node pressures and pipe diameters are illustrated in **Figure 11**.

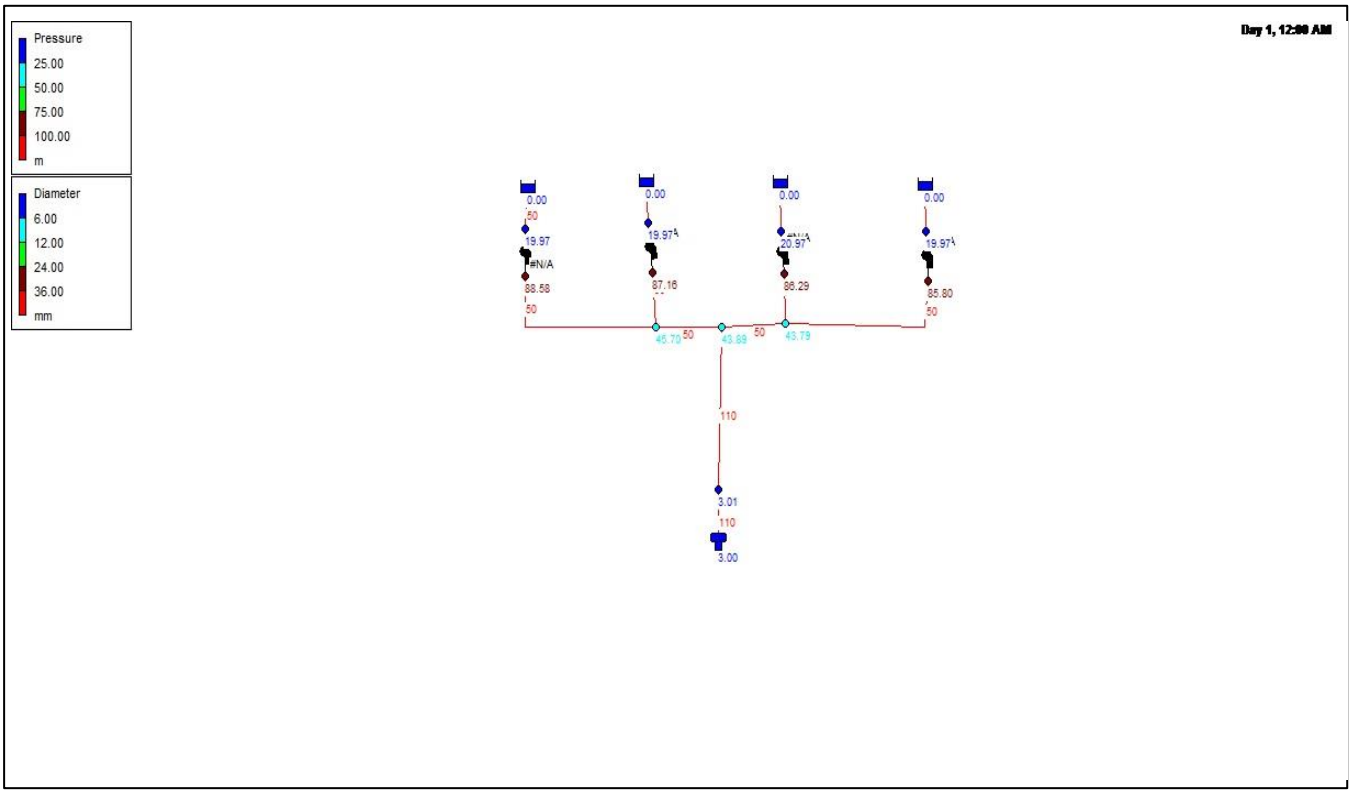


Figure 11 Results of Mwami border post raw water pumping network analysis

Storage Reservoir

It is proposed to construct a 250 m^3 brick reservoir at a high level location shown in **Figure 10** to cater for 2 day storage requirements, based on the 2025 average water demand.

Distribution Mains

Water will gravitate from the storage reservoir into a distribution network, designed to cater for peak hourly demand. The layout of the network will promote densification of housing developments by utilising infills as people seek to locate their homes within serviced areas. Based on the estimated projected water demand, the distribution network will cater for growth within the existing infill areas up to 2025.

Components of the proposed network, shown in **Figure 12** below, are as follows:

1. 300 m long, 110 mm diameter class 6 gravity mains reducing to a 150 m long 63 mm diameter class 6 pipeline which terminates at a bifurcation in the vicinity of the main road.
2. A 1,370 m long main stem running parallel to the main road comprising of 63 mm diameter Class 6 uPVC and 40 mm diameter Class 6 sections.
3. A 500 m long 40 mm 63 mm diameter branch line feeding the lager demand Zone 3 and Kiosk No 3.

The lay out of the distribution mains is shown on the Google Earth image **Figure 10**.

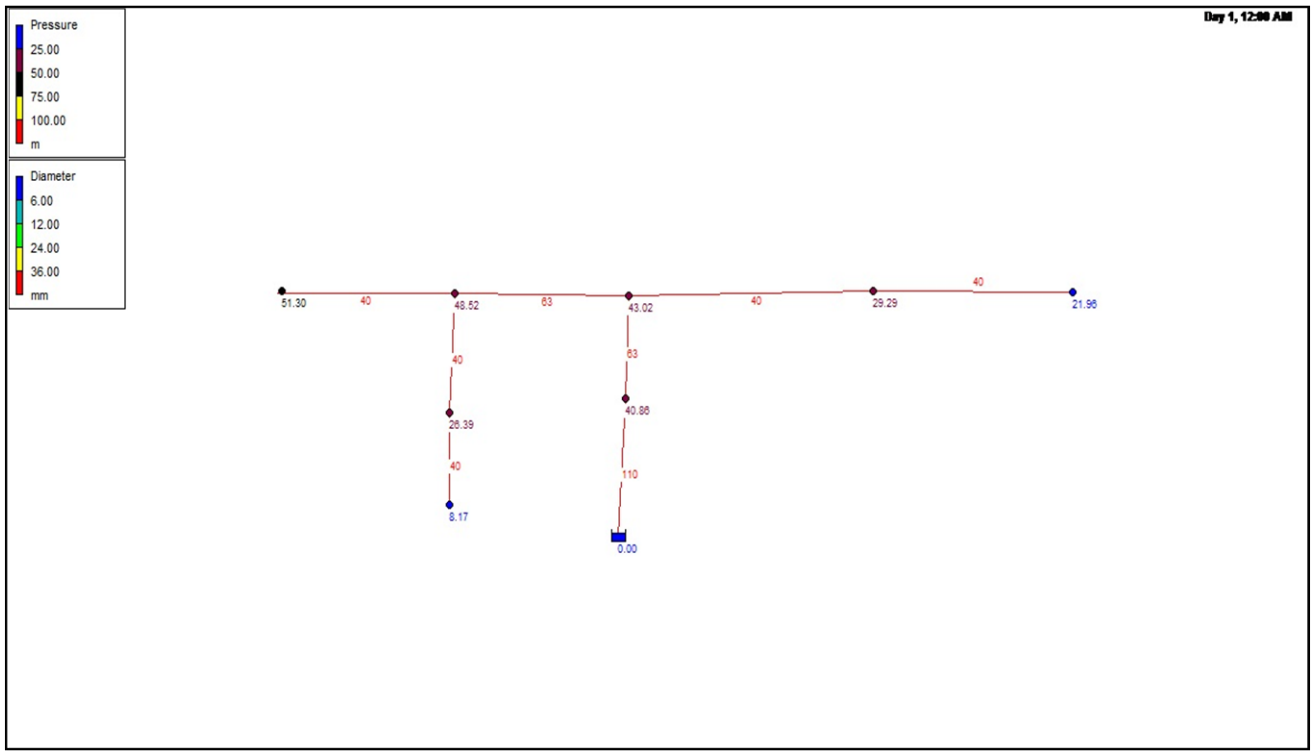


Figure 12 Results of Mwami border post distribution network analysis

Water Kiosks

It is proposed to construct four water kiosks for the sale of water to unconnected households. The distribution of the kiosks is show in **Figure 10**. Each kiosk will be directly connected to the network, with provisions for the

metering of water used. In order to enhance the commercial operation of the service, each Kiosk will be equipped with shelving to

Permits and authorisations for ground-water extraction

The Zambian Government did in April 2011 give assent to the Water Resources Management Act No 21 of 2011 which establishes the Water Resources Management Authority (WRMA) and defines its functions and powers; provides for the management, development, conservation, protection and preservation of the water resources and their ecosystems; provides for the equitable, reasonable and sustainable utilisation of the water resource and ensure the right to draw or take water for domestic and non-commercial purposes. With regard to permits for water extraction it states that the appropriate authority shall not issue or grant any licence, permit or other authorisation for the doing of any activity by any person, in any catchment or on, or along, a water resource, before the appropriate authority first consults as to whether the issuing or the grant of any licence, permit or other authorisation will affect the resource quality or quantity of water in any water resource.

To date the WRMA is still in the process of developing the appropriate tools and other relevant procedures, which are to be used to regulate groundwater extraction, which will be instituted through issuance of a statutory instrument to support the prevailing legislative instrument. The regulatory provisions once effected will be fully complied with in this project.

Permits and authorisations for provision of water supply and sanitation services

The Water Supply and Sanitation Act No 28 of 1997 provides for the establishment of the National Water Supply and Sanitation Council (NWASCO), which is the supreme regulatory body for water supply and sanitation service provision. NWASCO's functions include;

- Licensing of all service providers
- Issuance of service level guidelines, setting performance standards and to monitor the performance of the service providers

These requirements will be fully complied with, as the service delivery process will be through the EWSC, which is already licenced by NWASCO.

Sanitation

Existing systems in place

The principal mode of sanitation in the project area consist mainly of pit latrines which account for 80% of existing facilities, with the balance of 11% and 4% comprising VIPs and water borne systems respectively. Of particular concern, is the plight of travellers crossing the border post who do not have designated safe sanitation.

Proposed interventions

It is proposed to construct a public ablution facility for use by travellers crossing the border. The ablution block will consist of toilets, shower and laundry facilities, which will be separate for males and females, designed to cater for a maximum of 200 travellers. Sewage treatment will be by means of a septic tank, designed to be emptied every 3 years. The sludge will be discharged into sewage ponds located at the nearest town with sewage treatment facilities, such as the provincial capital of Chipata

Figure 13 shows the layout of the ablution block.

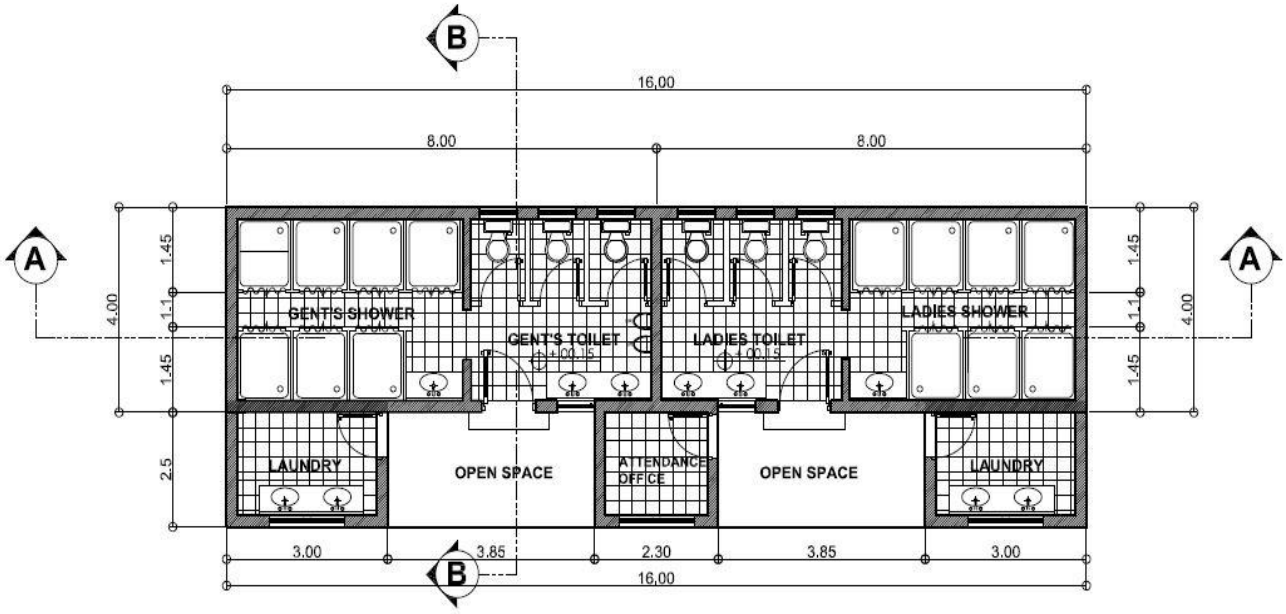


Figure 13 Proposed layout of ablution block at Mwami Border Post

The facility will be under delegated management. Charges will be levied for the use of ablution facilities by travellers, as a cost recovery measure to fund cleaning and water supply services.

Construction Options

The existing layout at Mwami border area demands that the infrastructure to service the area be constructed in one single phase since the project area comprising mainly of dwelling houses is located parallel alongside the main trunk road. Construction in phases will not be cost effective due to the relatively small size of the project area. The main water supply lines will be constructed alongside the main road to service the existing and proposed developments and provision will be made for any developer to connect to the main distribution lines for an individual connection and also for the public access points (kiosks).

Cost Estimates

Cost estimates for the above proposed works were undertaken based on the preliminary technical assessment outlined above. It is assumed that the expected borehole yields from the development of the aquifer east of the border post will be realised. There will be a need to confirm these yields through geophysical investigations.

A summary of preliminary cost estimate is given in **Table 12**.

Table 12 Summary of costs

	Cost Estimate	
	US$	£
Allow for 20% Contractor's P&Gs	66,038	43,585
Investigation and Development of groundwater source	28,000	18,480
Raw water delivery system	93,044	61,409
Storage Reservoirs	47,476	31,334
Distribution Network	77,385	51,074
Water Kiosks	13,000	8,580
Sanitation facilities	71,283	47,047
Subtotal Cost	**396,226**	**261,509**
Add 15% contingencies	59,434	39,226
TOTAL PROJECT COST	**455,660**	**300,735**

Proposed Operations and Maintenance Management structures for the systems

The facility will need to have an operations and maintenance plan in place to attend to the daily maintenance and cleaning requirements as well as desludging when the septic tank fills up. It is therefore important that provision of these services is sustainable for the facility to operate to the satisfaction of the would-be users.

As the facility will fall under EWSC Limited, the sewerage section of the company should take up the operations and maintenance aspects of the facility. The utility should provide attendant/attendants to be collecting the user fees as well as to clean the facilities on a daily basis. The funds raised should be managed in such a way that in three and half years, there should be enough funds in the coffers to enable desludging of the facility.

The proposed structure for the management of the facility is presented in **Figure 14** below.

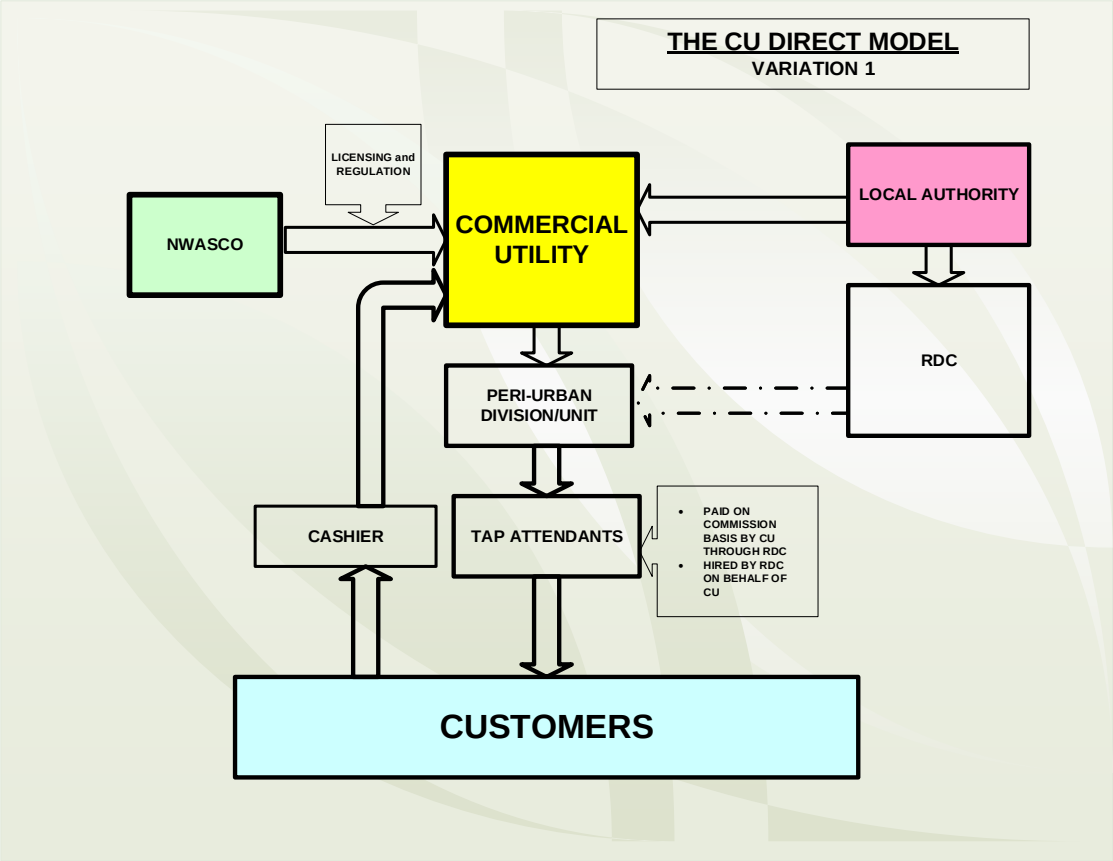


Figure 14 Proposed management structure for the border sanitation facility at EWSC

The operations for the new facilities will fall in the peri-urban services Section

Key Attributes and Operational Features;

i) The CU collects the GROSS revenue accrued from the pre-paid stand post customers and those with individual connections

ii) The TAs do not handle any cash, all the payments are made directly to the CU cashier by customers

iii) The CU is responsible for the cost of electricity

iv) The CU provides the security requirements to guard the very strategic installations on the area network such as pumps and electrical starter panels

v) The CU is responsible for all maintenance interventions required on the network infrastructure. The maintenance artisans are employed from the community.

vi) The RDC (Residents or Ward Development Committee) is paid a commission of **20% from the Gross revenue accrued from the pre-paid stand post customers** only

vii) The TAs are paid from the 20% paid to the RDC

viii) The RDC MUST HAVE membership of females living within the community

Assessment of the Operations and Maintenance for EWSC

The operations and maintenance for EWSC is assessed hereunder;

Table 13 Assessment of the Operations and Maintenance

Issue	Operations and Maintenance
Population coverage	• Has demonstrable capacity having operational oversite in 10 districts in Eastern Province with approximately 11000 connections
Operations and Maintenance	• Has Technical Services Dept. headed by qualified technical staff who oversee day to day operations in the 10 districts, project implementation “in-house”, capital projects (KfW Bank funded Euro 3million dam project in Katete and water reticulation in Nyimba). • EWSC has successfully run similar schemes in small communities such as the Chiparamba sub-centre water supply scheme on the outskirts of Chipata • Has over 80% customers metred which augments revenue collection and general operational efficiency • Capacitation of key staff will be required on the unique dynamics associated with supplying water and sanitation services to border areas

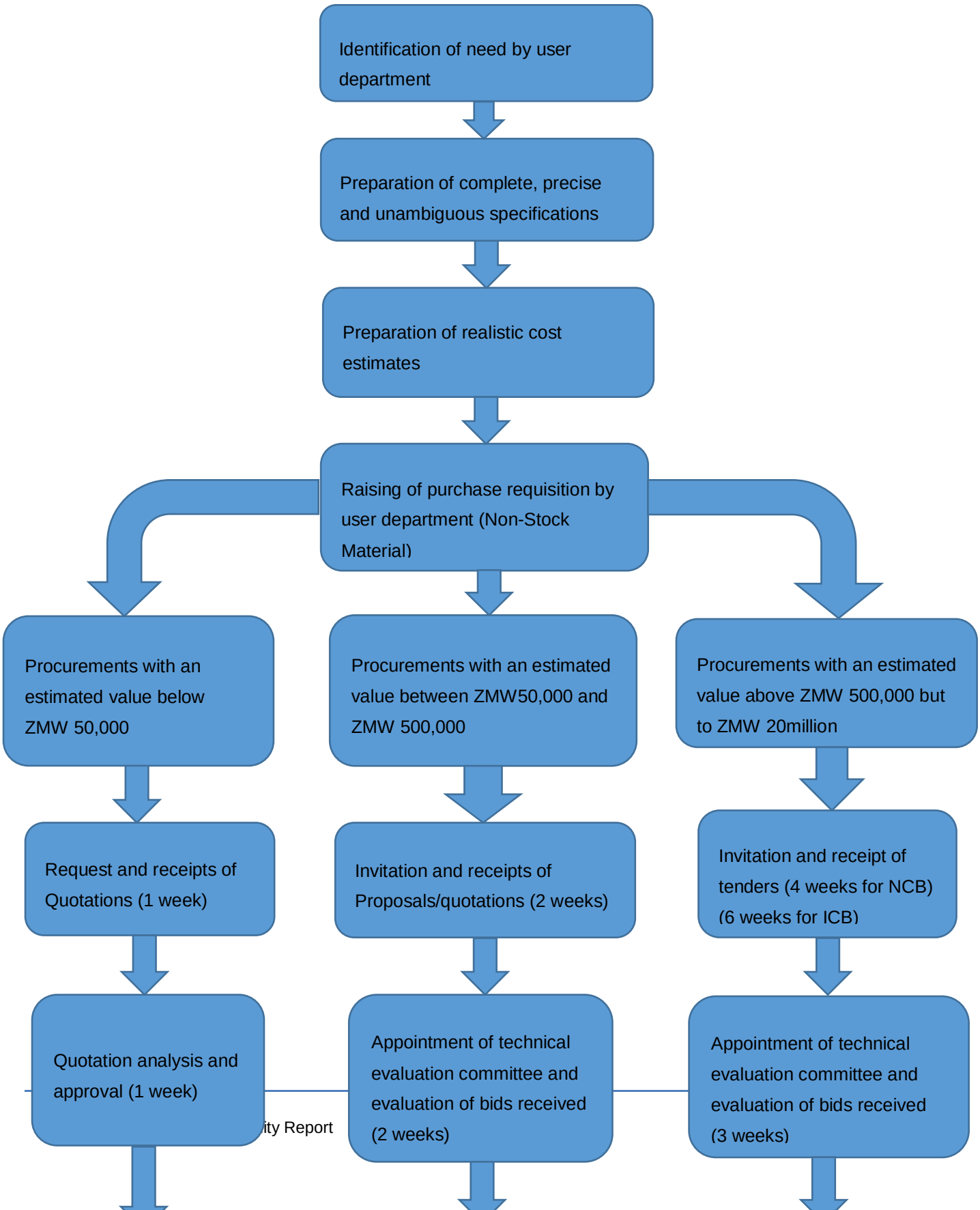
Procurement of Goods and Services

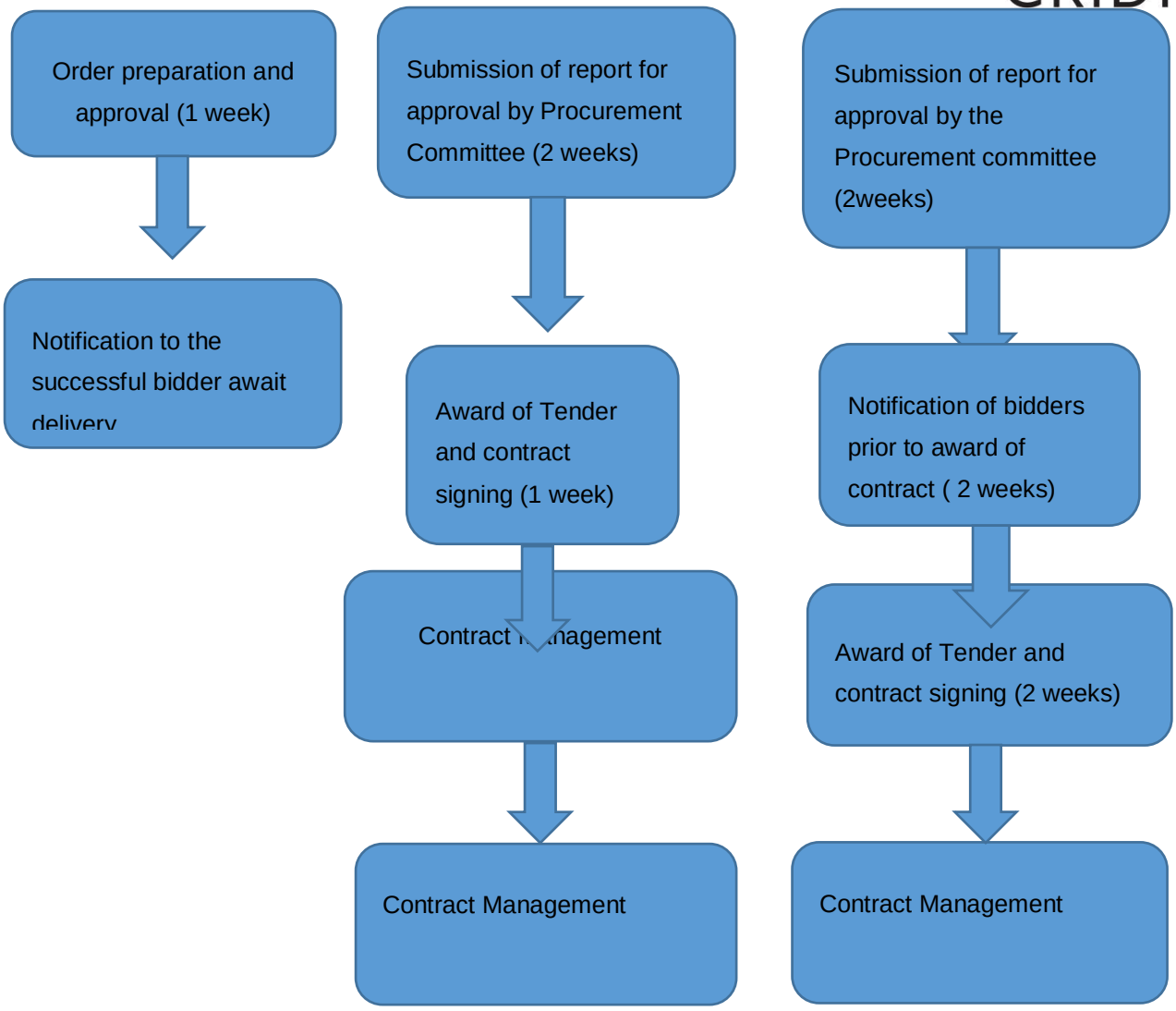
The Zambia Public Procurement Authority (ZPPA) is the single entity empowered by law to REGULATE Institutional Tender Committees which EWSC has by law established as it is owned by government through its shareholders the local authorities. The roles are outlined hereunder.

With the reforms implemented by ZPPA, approved entities do not need to submit requests for approval. ZPPA instead assesses the procuring entities i.e. capacity (staff and systems) to undertake public procurement. Once this is done, the entity is authorized to procure the required goods and services and that, there is no need to go back for approval (except for special cases such as a single source procurement). ZPPA also

provides guidance on procedures and standard solicitation documents that procuring entities can use. They do however undertake random inspections to verify if an entity follows or is in adherence to the established procedures.

The flow diagram for public procurement is illustrated below:




Order preparation and approval (1 week)
Notification to the successful bidder await delivery
Submission of report for approval by Procurement Committee (2 weeks)
Award of Tender and contract signing (1 week)
Contract Management
Contract Management
Submission of report for approval by the Procurement committee (2weeks)
Notification of bidders prior to award of contract (2 weeks)
Award of Tender and contract signing (2 weeks)
Contract Management

Social Economic Assessment

Introduction

One of the key components in developing a water supply and sanitation project in the Mwami border post in Zambia, is the social assessment which establishes full stakeholder engagement buy in and involvement of involve all relevant government agencies, local authorities, Non-Governmental Organisations (NGO), local traditional leadership, and community members in the area of project influence. CRIDF acknowledge that early engagement provide valuable opportunity to influence public perceptions and set a positive tone with stakeholders, despite the many uncertainties and unknowns. It is also an opportunity to help generate ideas and alternative solutions on early design questions.

This section presents the socio economic assessment comprising a brief profile of the Mwami border post as regards settlement patterns, sources of livelihood, access to services, water security and employment opportunities. It also reveals public perceptions of the existing and proposed water supply and sanitation services and presents some of the predicted project social impacts and their requisite mitigation measures. Lastly, possible community engagement in the management of proposed project interventions has been recommended. . It is envisaged that this feasibility study would not only address issues concerning technical, economic, financial and environmental viability but also address institutional matters that may be required to support the projects and delivery of the desired service levels sustainably.

The socio economic assessment fieldwork was undertaken during the months of May and June 2015. The report contains information obtained through literature review, community meetings and interviews with community members and personnel from various district departments. Background of the Project

Beneficiary Community Description

The area has distinct clusters of built up areas of government offices located at the border boundary, business premises mainly consisting of small stores and restaurants lined along the Great East Road, medium cost houses scattered around the border boundary and villages situated behind the business area outward away from the centre of the border area. Therefore the project beneficiaries lying within 10km radius can be characterised into 3 settlements namely, the Mwami border trading area, Mgambi and Mashanga villages.

The project area has an approximate population of 1560 people with about 300 households. This population consists of government employees from government institutions such as Ministries of Health, Home Affairs, Community Development Mother and Child health, Transport, Works and supply, statutory entities namely, the Road development Agency (RDA), Roads, Traffic Safety Agency (RTSA) Zambia Bureau of Standards (ZABS) and the Chipata Municipal Council. The post also hosts a regional organisation, the Common Market for East and Southern Africa (COMESA).

Other residents include personnel from Non-Governmental Organisations such as, CARE Zambia, SPLASH, Corridors of Hope, and Jesus Cares.

Community social structures responsible for water and sanitation issues include the Water Committee, and the Neighbourhood Health Committee (NHC).

In relation to the project, the latter social structures shall serve as entry points and have a key role in the entire project cycle. Therefore, Eastern Water and Sewerage Company (EWSC) should involve these and other stakeholders to ensure sustainability of the investments.

Land Tenure System and Ownership

Although the Post is characterised by urban services and community it is outside Chipata district council planning area. It still falls under traditional authority, which is vested in His Royal Highness Chief Mpezeni. The two villages are led by headmen who report to the Chief. The area Chief has authority of managing the Post and is responsible for, amongst other things, settling local disputes, land allocation and liaising with relevant government department in respect of any developments taking place within their area. The chief is part of the Chipata district council through a representative that participate in the district council meetings thereby linking the formal administrative structures to the traditional.

At present the Chief is responsible for allocating land to residents who latter formalise the allocation through the district council. The implication of this structure is that land for project infrastructure shall be acquired through the area traditional leadership.

Economic Activities

The main economic activities in the project area can be groups under three categories as follows.

Formal employment - There is a significant number of residents formally employed in formal organisations mentioned above.

Business and Trading Ventures - The local residents from different parts of the district and Zambia at large settled in the area have taken advantage of the business opportunities created by the border post transactions and travelling population. Most entrepreneurs include clearing agents, restaurant, shop, salon and barber shop owners, taxi drivers and cyclists, hawkers, money changers, casual labour assisting travellers.

Small scale farming - Farming is the main occupation of local residents living in the two villages. However, the formally employed and other entrepreneurs are also involved in agricultural activities. Those who do not have land either purchase plots or use rented land. Major crops grown include maize, cotton, groundnuts, and vegetable crops such as sweet potatoes, pumpkins, and cowpeas.

Employment and Income Generating Opportunities

The current economic activities outlined above offer a relatively stable income for the border community. Therefore, individuals including vulnerable women, youths and other groups already engaged in different activities would have to operate at optimal levels in response with the demand. A snap shot income survey showed the following results.

Results in **Table 14** show that vulnerable groups without qualifications to engage in formal employment elsewhere have an opportunity to generate income through above listed economic activities which they are already participating in. It is observed that occupations such as farming, selling at the market, and bicycle deliveries that attract more vulnerable women and youth are low earning. However, availability of employment largely depends on the level of activities at the border. For the farming community, agricultural productivity also depends on other factors such as climatic conditions and market for their produce.

Table 14 Level of income in accordance with occupation

No.	Type of Occupation	Approximate Income per Month (ZMW)	Approximate Income per Month (GB £) (exchange rate 1£= ZMW 11.3)
1.	Formal employment	5,512	487.8
2.	Restaurant owners	2,400	212.4
3.	Taxi driver	2,400	212.4
4.	Car Washer	1,200 - 1,680	106.2 – 148.7
5.	Truck driver	1,400	123.9
6.	Other business ventures	616 – 3,360	54.5 – 297.3
7.	Farmer	600 - 708	53.1 – 62.6
8.	Marketeer	420 - 560	37.2 – 49.6
9.	Bicycle delivery	150 - 240	13.3 – 21.2

Source: Questionnaire administered to 15 respondents amongst border post community

Public Perceptions of Existing and Proposed Water Supply and Sanitation Facilities

Perceptions of Existing Water Supply and Sanitation Facilities and Services

The project area is served by three different water systems provided by Zambia Revenue Authority, Chipata District Council through its partners and private individuals. The two systems include household water connections and communal water points.

a) Zambia Revenue Authority Water Supply and Sanitation

The authority provides pipe household connections to its employees and other public workers. This water supply was adequately planned for a limited number of staff. Overtime the system has been extended to supply other public workers' and other households and this has created a shortfall. In order to ensure equity and supply to all connected households, the company has decided to ration the supply and this has affected quantity.

Residents are not content with the supply as they have to either store or draw water from communal stand points provided by the Council. The water from ZRA is free of charge and the authority is responsible for maintenance.

All housing structures have provision for water borne sanitation, although their functionality is dependent on adequate water Residents complained that these facilities have become 'pour and flush' toilets. Some of the associated problems of pour and flush is that water has to be available at all times and this has created a burden on women and females members who have to ensure that there is water for domestic use in the household at all times.

b) Private water supply and sanitation systems

There are a number of privately operated boreholes with piped water reticulation owned by entrepreneurs such as lodge owners, business houses and a few local residents. Due to availability of water most structures have water borne sanitation systems. In view of the water problems privately owned systems seemed to be the most preferred option for those that could afford the capital investment.

c) Communal water points

The project area has 3 communal boreholes equipped with hand pumps. This is the major source of water supply serving any other resident without piped reticulation, community members in the nearby village, truckers and other travellers. These water points have been provided and are managed in accordance with the Ministry of Local Government and Housing rural water supply institutional arrangements. At present each water point is managed by a Water Committee, which is responsible for collection of user fees and ensuring that water points are taken care of. At present each water user pays ZWM 2 per month.

Although there was an equal distribution of communal water points on either side of the T4 (Great East Road), residents has to cross over in case of breakdowns. Such instances were quite common as the rate of breakdowns was high. This resulted in congestion and at times, women and children have to cross the busy T4 Great East Road to draw water on the other side. The exposes water drawers to accidents. Furthermore, residents were not satisfied with the rate of maintenance as in most cases they depend on local skilled residents who render a free service.

In relation of sanitation, most house structures without inbuilt water borne systems have ordinary pit latrines. These latrines are also quite prevalent amongst restaurants and other business premises. The community in particular business owners complained of the nuisances such as odours and inconvenience of digging new pits from time to time. Others felt this technology was most inappropriate, as the plots are too small to dig out new pits.

Further, due to lack of ablution facilities for travellers and truckers, some households were providing bathing and sanitation services at a fee. Although this served as a source of income, women expressed concerns of the danger of defilement and rape amongst female children in the households.

Perceptions of Proposed Water Supply and Sanitation Facilities

Water supply

The recommended water supply systems were individual house connections and communal water points using the kiosk model.

Nearly all residents consulted preferred individual household connections. In accordance with housing areas, most public workers housing units are standard urban units equipped with in built water connections. In addition the project area is the inner core of the Chief's declared 'trading area', therefore residential and business plots have been allocated to residents who have built low and medium cost houses with in built water systems. Therefore individual water connections were the most preferred.

In order to cater for households that would not be able to afford to pay for expensive options such as individual house connections, it was recommended that communal water points through kiosks would be most appropriate. They however indicated that the communal points should be built with a provision for future individual house connections for those that would eventually have financial capability to afford such connections.

Mwami border had developed into a huge settlement and could evolve into a city, as regional trade increases. Therefore the CWSC and its partners should plan for a system with a realistic population projection of for example 50 years. The projection should be made on the basis of household connection than communal water points.

Sanitation for Truckers and other Travellers

All residents consulted were satisfied with the proposed ablution facilities for truckers and travellers. They proposed that the facilities should include bathing facilities. These should be provided at a fee to ensure sustainability.

Households Sanitation

The most preferred liquid waste disposal technologies were water closet operated with septic tanks and ventilated pit latrines. EWSC's responsibility is to provide a main sewerage system where households would connect to. Individual households and premises have the responsibility of financing connections from the main sewer line to their households. In the absence of a sewerage system, households would have to construct their own systems.

Field consultations and snap survey revealed that most residents preferred water closets and were willing to spend about ZMW 100 for construction. Although this is a minimal amount, it shows the willingness to spend and possess an improved sanitary facility.

Those who felt they were unable to construct water borne facilities opted for ventilated pit latrines.

Positive and Negative Socio-Economic Impacts of the Proposed Project

Some of the critical impacts in addition to those elaborated in the 'Outline Business case for water and sanitation project in both Mwami and Chanida Zambia' project economist report are as follows:

Positive impacts

a) Improve resident's health

Improvements in water supply by the company for the border post community will translate into increased quantity and quality. In relation to quality, communities will be assured of quality water as the company would conduct periodic quality analysis. Improved health will have a positive impact on productivity in which ever occupation is involved engage in as the will be less absenteeism from tasks. Evidence of improved health shall be monitored through health indicators at the nearest health facilities.

b) Equality in service provision

It was noted that residents using communal water points were subjected to user fees, whilst public workers who have a steady income were not paying for the service. A systematic and consistent water supply system will subject all residents in the project area to paying for the service. This will instil a sense of responsibility and cohesion amongst the residents.

c) Increased Population

Increase in population will result in both positive and negative impact. A combination of improved water supply and trade will attract more business people, tourists and settlers to the area. This will create demand and more revenue for EWSC and provide an opportunity to expand the system as the population increases.

Negative Impacts

a) Water wastage

There is a likelihood of water wastage in households through leakage and inefficient practices such as watering lawns, car washing leaking taps and so on. There is also a possibility of water loses through the main reticulation system. These loses can be mitigated by installing meters in each individual premise with individual connections including kiosk. This measure should be coupled with customer sensitisation on demand management. Promoting water use efficiency is useful to the company to ensure that they generate adequate revenue to cover both capital and operational costs and delivery an efficient service.

b) Transformation of the area into and urban area

As stated earlier a combination of extension of Chipata municipal council planning authority, removal of trade barriers, improved infrastructure such as roads, and improved water supply and sanitation will led a complete transformation of the border post into a township.

This will led to diminished agricultural activities and villages will turn into high density areas. Subsistence farmers will either move out of the area or change their occupation. More people from different parts of the Zambia will flock to the area, taking with them other urban vices, such as theft,

In relation to water supply this negative impact would arise if the company does not expand the system due to limited water sources. As has been recommended above the company and CRIDF should plan for an increased population during this initial phase of assistance.

Given that the Chief Mpezeni resides within the border post area, a combination of traditional and municipal authority should prevail to minimise social vices such as theft, deviant behaviour, and vandalism that would impact negatively on trade, and local residents.

c) Vandalism

There should be thorough consideration of the type of technology and materials used in both the reticulation water systems and truckers and travellers facilities. This is view of expected vandalism which might be necessitated by residents who might have alternative use of the materials, or due to sheer destructiveness as a protest to paying user fees. Vandalism can only be minimised through community sensitisation.

d) Generation of solid waste

The mandate of waste collection and disposal is a responsibility of the municipal council within their planning jurisdiction. Given that Mwami border post is still under traditional administration, there is no defined waste collection system. Like in most rural areas Ministry of Health has the responsibility of promoting total sanitation and hygiene practices. The snap survey revealed that the only waste disposal practice promoted is dug out pits. With an envisaged population increase the problem of waste collection and disposal will need redress.

Community Engagement in the Proposed Project

As explained in the 'Outline Business case for water and sanitation project in Mwami Zambia' project economist report, EWSC is in possession of a licence to provide water supply and sanitation services in Eastern Province. Therefore, the company will have to use its well elaborated approaches in delivering water in different contexts. Mwami border post has characteristics of medium, low cost and business premises, peri urban and rural areas, therefore following management approaches can be employed.

Management of Individual piped reticulation

In areas where individual house connections are provided the company will have to use meters and bill each premise. The company would be responsible for maintenance of main lines and any maintenance after the meter falling within the premises would be individual's responsibility.

Management of Communal Water Points and Public Ablution Facility

The company will have to acknowledge the existing water supply management structures to develop and manage communal water points and ablution facilities. The existing water committee is a recognised structure that was established by the Chipata municipal council. The committee should be utilised in siting (with technical advice) and constructing new kiosks. They should also select vendors to manage the kiosks, ablution block and their surroundings. The committee should also be responsible for hygiene education. The company should work hand in hand with the council's public health department and the Ministry of Health officers to promote construction of hygienic sanitary facilities and hygiene education.

Gender Equality Issues

It is expected that this project will have the following distinct gender equality impacts:

- Health Impacts - Woman typically care for their families during illness. The supply of a reliable disinfected water supply will reduce the incidence of water borne diseases. Woman are far more involved with young and immune compromised individuals, exacerbated by poverty or exclusion.

- Food Security – Although the project is not specifically linked to agriculture, a reliable supply of water will allow for subsistence farming, food security and alternative ways to feed families, especially of poor families with limited alternatives.
- Water related impacts - women and girls generally assume primary responsibility for collecting water for drinking, cooking, washing and hygiene. Provision of a reliable, nearby, disinfected water supply will reduce the time for collection of the water supply, which allows time for other activities, e.g. employment and schooling.

Environmental Health Assessment

This section describes some of the Environmental Health challenges faced in the Mwami boarder community, and outlines recommended interventions to address these where possible.

Relevant Legislation & Institutional Arrangements

The Public Health Act (Cap. 303 of the Laws of Zambia) is the key legislative tool defining and enforcing environmental health. Section 67 provides the local authorities and authorised medical officers the mandate for environmental health enforcement against 'nuisances' that threaten the health of the population, such as overflowing toilets and septic tanks that discharge onto the street or other non-approved sites. This is of relevance in Mwami where residents have mentioned limited space to dig new toilets once the old pits are filled, and where liquid waste emptying facilities may be limited. However, the effectiveness of sanitary enforcement in Zambia has been constrained by a number of factors, including a lack of capacity of enforcement, and lack of mobility of the authorised officers (GRZ, 2001).

Regarding port health, despite the statutory instrument No.13 of the 1994 Public Health Act requiring comprehensive port health services at land (such as Mwami), air and sea ports, there is no designated isolation or triage area at the border to allow quarantine and surveillance of cross-border travellers to control epidemics entering the country at Mwami. It was noted that space is available for such facilities, which presumably could be constructed or temporary facility erected during possible epidemics.

At the local level, the local council together with Ministry of Health Environmental Health Technicians (EHTs) are mandated to monitor, advise and enforce issues related to Environmental Health. At the community level, Community Health Workers (CHWs) compliment the work of the EHTs, particularly through undertaking community education regarding the prevention of common communicable diseases. The CHWs are also supported in Mwami by the Neighbourhood Health Committee (NHC) and water committees.

Key Water, Sanitation & Hygiene – Related Diseases in the Area

Access to morbidity statistics specifically for Mwami was a challenge during this study. Some data on key diseases were provided by the local health facilities through the EHTs, however this was not comprehensive of the range of WASH-related diseases in the area, nor provided full multi-annual time-series data to allow detailed analysis. The availed data is presented below, and complimentary information on water-related disease incidence at a lower-resolution (district, provincial and national) was obtained from various internet resources.

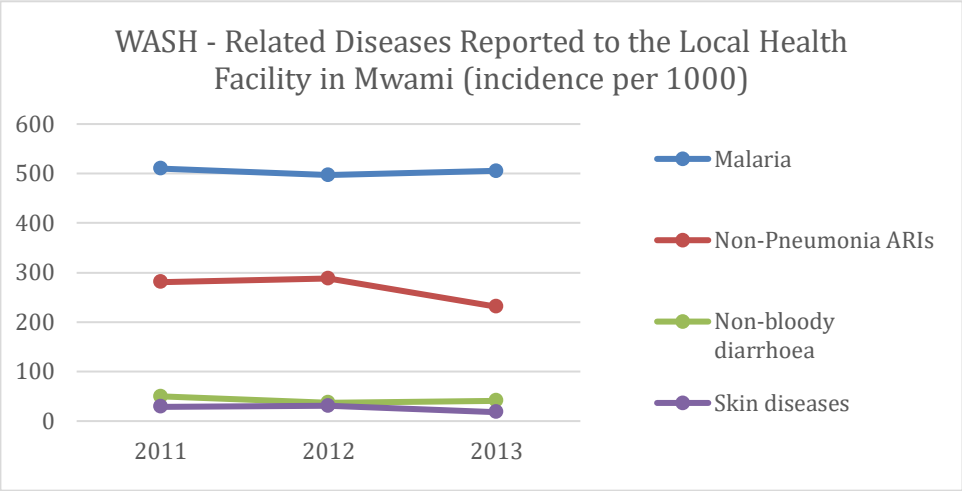


Figure 15 Wash related disease statistics for Mwami

The locally available data for Mwami highlights the vector-transmitted disease Malaria as the most prevalent in the community, followed by Acute Respiratory Infections (ARIs). The incidence of ARI transmission is often associated with poor hygienic practices, particularly handwashing. The incidence of diarrhoea, which is the main indicator for many faecal-oral diseases such as cholera, typhoid fever, dysentery and Hepatitis A, is relatively lower than Malaria and ARIs, but still widespread. However, it is likely that this is under-reported, as the population may often self-treat or be failing to present themselves at the clinic for diarrhoea treatment.

The World Health Organisation (2014) suggest that in 2010, Malaria accounted for 13% of all deaths of children under 5 years in Zambia, with Pneumonia accounting for 14%, and diarrhoea accounting for 9%.

The National Demographic & Health Survey of 2013-14 (GRZ, 2014) indicated 1 in every 22 Zambian children die before their first birthday, and 1 in 13 do not reach their fifth birthday. The study indicated that the Eastern Province (where Mwami is located) has the highest incidence nationwide of infant, child and under-5 mortality. At the time of the study, the Eastern Province had the highest prevalence of ARIs in children aged under 5, and also the highest prevalence of fever (22.6% of households with children <5 years had a child with fever in the two weeks preceding the study). Whilst incidence is high, the health seeking behaviours are relatively good, with 77% and 72% of cases seeking medical treatment for ARIs and fever respectively. This does however mean there is still a significant proportion of the population not treating or following traditional practices. A total of 15% of households with children under-5 in Eastern Province had experienced diarrhoea within the preceding two weeks of the study, including 2.3% with bloody diarrhoea. Whilst 73% reported to go to the clinic for treatment, only 26% reported to give the child extra fluids. Eastern Province also had the

second lowest national average for safe child stool disposal. This data indicates there may be some gaps in knowledge and practices relating to hygiene and sanitation in the area.

Perceived Impact of Interventions on the Incidence of Key WASH-Related Diseases

The National Environmental Health Policy (2001) estimates that up to 80% of the preventable diseases in Zambia are related to poor environmental sanitation. The proposed interventions for Mwami will directly and indirectly contribute to the reduction of a range of water and sanitation related diseases, as indicated in the table below.

Table 15 Perceived Impact of Interventions on the Incidence of Key WASH-Related Diseases

Disease Type	Expected Impact	Comments
Insect vector transmitted diseases (Malaria, denge fever, yellow fever, leishmaniasis)	Reduced	Whilst vector control is not a major focus of the programme, interventions in community hygiene promotion will promote community action around clearing breeding sites, and together with potential interventions in waste management will help to reduce sites of pooled water and waste heaps where the vectors could breed. Moving from handpumps to tap-stands are likely to reduce drainage water that would otherwise pool and contribute to breeding sites.
Faecal-oral diseases (Diarrhoeal diseases, cholera, dysentery, polio, typhoid, Hepatitis A, intestinal parasites)	Reduced	The pipe-borne drinking water provided would be consistently chlorinated with sufficient residual to mitigate post-collection contamination. The widespread promotion of toilet upgrading, vigilance against open defecation (and providing facilities such as ablution blocks), increased availability of water for hygienic practices, together with widespread promotion of handwashing, is aimed to break the major faecal-oral disease transmission pathways.
Water-washed diseases (trachoma, scabies, ringworm, louse-borne typhus/ fever)	Reduced	The increased volumetric availability, together with reduced queuing time and proximal access points provided by the new pipe-borne facility, is expected to considerably increase the per-capita water consumption, allowing improvements in personal and domestic cleaning practices that help to prevent such diseases.

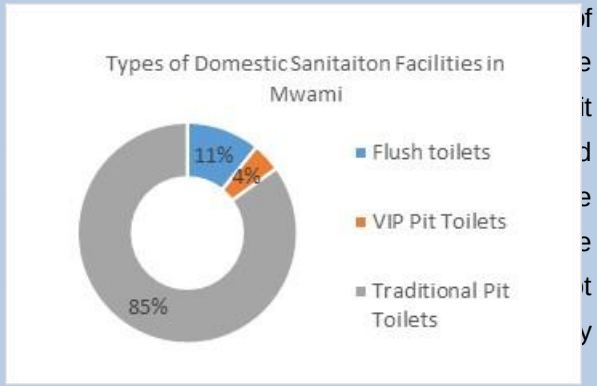
Water-based transmitted diseases (schistosomiasis, hookworm)	Reduced	With the provision of conveniently located water sources with sufficient volumes of treated water available for personal and domestic use, there would be limited need for residents to enter contaminated water bodies where they may encounter such diseases. Shower facilities in the ablution blocks would prevent travellers from washing in unprotected sources and reduce the incidence of skin diseases. The provision and promotion of sanitation facilities would also help to break the life cycle of these diseases.

Key Environmental Health Issues in the Community & Proposed Mitigation

A number of specific Environmental Health related issues have been identified in Mwami boarder post town. These are summarised in the table below, along with proposed interventions to address them. It should be noted that some of the recommendations lie outside the scope of this feasibility study/ensuing project.

Specific Environmental Health Issue	Proposed Intervention
There is a lack of solid waste management facilities for institutions and commercial facilities. Domestic refuse is generally burned on-site in unsorted pits. With the forecasted population increase the waste generation will increase considerably, requiring a more formalised collection and disposal system. The project area is not covered by the Chipata municipal council in terms of waste services.	It is recommended to establish a door-to-door collection scheme for residential, commercial and institutional customers. Dialogue would be needed with the traditional leadership, the Chipata Municipality and residents as to the exact nature of the scheme. It is suggested that a local entrepreneur/group could be contractually engaged on behalf of the local authorities to undertake the collection service, funded by user payments. In the absence of a dumpsite in the immediate locality, the Chipata municipal council would need to extend their service of transferring waste from a temporary transit area in the project area, to the final (likely municipal) dumpsite. This could otherwise be undertaken by the collection group directly if they had the transport capacity. The collection group should be contracted on a competitive basis and have performance based conditions, and periodic renewal to ensure quality of services is maintained. The sanitary operations of the group would be monitored by the local EHT. In addition to the collections, the group could potentially be contracted to do cleaning of public places. Concreted in bins at strategic public locations would be necessary. The council could be provided with, and then lease to the group, items such as push carts, wheel barrows, protective equipment etc. They would also require training on business administration, customer care, and technical issues of waste management and options for recycling/value streams from waste. As a large proportion of the residents are engaged in agriculture, source separation of waste could be promoted, where households are encouraged to compost their organic waste, and only put inorganics in the bins to be collected by the group. This would reduce the total volume of waste to be managed, allow

	a less frequent collection, and contribute towards food security. To facilitate this source separation and customer subscription to the collection scheme, 50l bins should be provided to households via the group in a subsidised arrangement. Hygiene promotion to build resident's demand for waste services, and build vigilance against littering/on-site incineration would be needed to compliment this intervention. Where possible the group would be encouraged to recycle or convert items of value such as aluminium cans, plastics and rubber, depending on the market demand (which may well exist in Chipata town).
Limited water availability/accessibility is reducing the water available for hygienic practices, and water currently used for drinking purposes from the wells/boreholes may be of variable quality. Functionality/sanitary issues with the existing flush toilets due to water shortages.	Construct a piped water supply with adequate storage and requisite chlorination facilities.
The liquid waste disposal method in Mwami is on-site via septic tanks, and pit toilets. Some residents have mentioned space constraints relating to the digging of new toilets once the existing pit is full. There are currently no pit and septic tank emptying services operating in Mwami.	As part of wider capacity building to the community council and EHTs, the authorities would be encouraged to make contacts with locally based liquid waste emptying services (potentially based in Chipata town), and if necessary, mobilise the community and institutions when multiple facilities need to be emptied to share the contract cost, aggregating the demand, and leading to lower-cost service provision.

No designated market site and potentially risky hygiene and sanitation practices of food vendors.	Given the dispersed nature of the trading area, a designated market site and ablution facilities may not be the most appropriate option. However it is recommended that hygiene promotion is undertaken for the food vendors regarding handwashing and safe food preparation and storage.
Open defecation around the border post, particularly at night.	Ablution facilities should be constructed at the border post, to be open 24hrs, and enforcement strengthened against open defecation through community triggering, bylaws and punitive action. Facilities to include shower and handwashing facilities.
Whilst the proportion of households with toilets is  prioritise the construction of a toilet, leading to temporary open defecation.	A community hygiene promotion campaign should be undertaken. This should periodically 're-trigger' residents around the need for total sanitation and build vigilance and community based monitoring for open defecation 'offenders'. To build on the progress made from CLTS, handwashing promotion would be needed with a focus on household-led construction of low-cost facilities such a tippy taps at every toilet. To improve the impact on environmental health from the toilets, sanitation marketing techniques would be used to promote households to upgrade their basic pit toilets, promoting features/products such as improved concrete slabs, ventilation pipes with fly screens, squat-hole lids, and fly traps. With the opportunity of domestic water connections, some households may choose to upgrade straight to flush toilets and septic tanks (which seems to be the aspired ultimate level for many residents). Whilst residents seem willing to spend their own funds to upgrade their toilets, there are currently limited local skills or suppliers to provide such toilet upgrading in the immediate community. Therefore local masons should be identified and trained on the production of low-cost latrine products and installation of higher-grade items such as flush toilets and septic tanks, and should be linked with sanitary material suppliers in nearby Chipata.

Mosquito breeding sites exist within the peri-urban area, particularly along the stream, and in the surrounding manually/mechanically irrigated fields. Shistosomiasis breeding grounds potentially occurring in the stream.	As part of the community hygiene promotion work outlined above, the community council, EHT and the Neighbourhood Health Committee should be encouraged to mobilise the community to identify and take action around the clearing of potential vector breeding sites.
Despite the district being subject to a recent School WASH programme (SPLASH), there are still needs for further WASH facilities in the local schools in the area.	According to the local EHT, the following facilities should be developed in the local schools: • Katadala Basic School – Rehabilitate one VIP toilet, provide pipe water access • Nsanyika Basic School – Complete the construction of 3 VIP toilet superstructures, provide piped water access • Mushachata Community School – Rehabilitate 1 VIP and construct 6 additional VIPs (to be confirmed) in addition to establishing handwashing facilities. Consider the provision of waste bins for the classrooms All of the schools would benefit from further sensitisation on the need to wash hands particularly emphasising the use of soap or ash, which were found to be absent at the time the EHTs visited the schools for this assessment.

Public mobilisation and hygiene promotion would be central to many of the activities supporting Environmental Health improvements. It is proposed that these mobilisation approaches are integrated with the other messaging that promote domestic water connections, and payment for the water supply system. The additional messages would include topics such as: re-triggering to build community commitment towards total sanitation and vigilance against open defecation; handwashing promotion including education on the construction of tippy taps; promotion/education on low-cost upgrades to domestic toilets, and awareness raising on the option of emptying of toilets (if appropriate); promotion of solid waste collection services and development of community vigilance against burning and dumping of waste; community mobilisation to identify and address vector breeding sites in the local area. These mobilisation campaigns would likely be undertaken in operational partnership with local committees (such as the Water Committee and Neighbourhood Health Committee), the traditional leadership, and local officers of the Ministry of Health (such as EHTs).

Environmental Assessment

Introduction

The study reported herein aimed at analysing of the environmental situation of the project site with respect to the implementation of the proposed water supply and sanitation project. The purpose of this report is therefore to objectively assess and evaluate likely environmental and socioeconomic impacts that could result from the implementation of the projects and propose mitigation or enhancement measures for the impacts.

Limitations and Assumptions

The project site, being away from the main district and being a small area presented a challenge in terms of data availability especially on environmental baseline conditions. No baseline data specific to the project site exists. As such, for all meteorological and climatological data, it was assumed that the data for Chipata District applies to this area. Preparation of the Environmental Screening Report (ESR) involved a number of activities which were designed to respond to the objects of the (ESR). A methodology was devised to respond to the objectives and it predominantly addressed aspects of data collection and analysis. A summary description of the methodology is presented in the sections below.

Literature Review/Desk Study

Literature review comprised one of the most important activities in this study and was the main source of information. The activity involved collecting and analysing literature from publications, documents and the internet. The aim of this activity was to:

- Collect and documented data on all aspects of the project;
- Review in detail any existing studies on the project area related to the project (e.g. Deliverable D01: Outline Business Case for Water and Sanitation Project in Mwami, Zambia);
- Review of environmental and other relevant legislation, environmental and social quantitative and/or qualitative surveys/studies;
- Review of technical documents related to the field of water supply and sanitation; and
- Study the ZEMA environmental laws and regulations.

Data Collection

Data collection was mainly through stakeholder interview and field surveys.

Stakeholder Interviews

Stakeholders like the Eastern Water Supply and Sanitation Company Limited (EWSC), Department of Water Affairs (DWA) personnel, the Environmental Health Technician (EHT) stationed at Mwami Border post, representatives of the Paramount Chief (Mr. Zwangendaba Jere), the Ward Development Committee (WDC), the Neighbourhood Health Committee (NHC) and other purposively selected informants were consulted on various aspects concerned with water supply and sanitation in the project area.

Field Surveys

Field surveys involved driving and walking within the project area especially along and around sites earmarked for lying of pipes, construction of water tanks and areas with potential to accommodate the well fields. Observations on the closeness of existing structures to location of proposed infrastructure as well as activities within the area that may be impacted upon by project activities were made. These observations assisted in identifying 'hot spots' with respect to envisaged project impacts. As it is anticipated that the project will make use of ground water, existing boreholes were sampled and analysed in order that the quality can be determined and its suitability for the intended purpose evaluated.

Data analysis

Data analysis involved synthesizing the information collected from interviews, documents, interviews and others to come up with the significance of the anticipated impacts. Significance of the envisioned impacts was ranked by taking into consideration four main factors namely:-

i) *Duration of the Impact*: Which defines whether the impact is temporal or permanent;

ii) *Spatial extent of the impact:* Which defines the area to be affected by the impact;

iii) *Severity of the Impact*: Which is the severity/beneficial or simply the state or extent of the badness of the impact. It takes into consideration among other things, sensitivity of the area being impacted upon; and

iv) *The likelihood of occurrence*: Which looks at the probability of the impact occurring and frequency of occurrence where it occurs.

The four criteria above are ranked with scores assigned to each as presented in Table 13. To come up with the overall significance of the impact, the total scores recorded for the 'effect' and 'likelihood' are read off from the matrix table presented in **Table 16 and 17**. A summary of the scores and overall rating for each of the impacts identified in this study is given in **Tables 18, 19 and 20**. Mitigation measures and Environmental and Social Management Plans (EMPs) were designed based on the consultant's understanding of the identified impacts coupled with the indigenous knowledge and collected information about the project sites.

Table 16 Ranking of evaluation criteria

EFFECT	DURATION OF IMPACT			SCALE
	Short Term	Confined to construction phase		1
	Medium Term	Up to three years		2
	Long Term	3 to 20 years		3
	Permanent	Above 20 years		4
	SPACIAL EXTENT OF THE IMPACT			
	Localised	At localised scale covering a few hectares		1
	Study Area	Project area including immediate environment		2
	Regional	District or provincial level		3
	National	Country level		4
	International	Beyond national boundaries		5
	SEVERITY/BENEFICIAL			
	Slight			1
	Moderate			2
	Severe/beneficial			3
	Very severe/beneficial			4
LIKELIHOOD	**LIKELIHOOD OF OCCURENCE**			
	Unlikely	Will not Occur		1
	May Occur	There is a small chance of this impact		2
	Possible	The likelihood of this impact occurring is probable		3
	Certain	The likelihood is this impact will definitely occur		4

Table 17 Description of overall significance ratings

SIGNIFICANCE RATING	DESCRIPTION	SCORE RANGE
INSIGNIFICANT	This refers to an impact with acceptable effects for which mitigation is desirable but not essential. The impact by itself is insufficient to prevent project approval. Effects from these impacts do not go beyond medium term	4 to 7
MODERATE	Impacts for which mitigation measures are required though impact cannot prevent project approval. The impacts can extend up to long term	8 to 11
SIGNIFICANT	This is a serious impact which, if not mitigated, may prevent project approval (if negative). These impacts can result in major and usually long-term effects to the environment	12 to 14
VERY SIGINIFICANT	This is a very serious impact which if negative may, by itself, be sufficient to prevent project implementation. This type of impact results in permanent change and usually have no mitigation measures	15 to 17

Policy, Legal and Administrative Framework

Introduction

Various pieces of legislation are pertinent to the proposed project and it is the intention of the developer, who is the proponent of this project, to comply fully with all applicable legislation. Legislation which is particularly relevant to the project and which plays a part in the way the project is planned, implemented and operated is identified in this section in order to highlight areas of concern and to assist in the understanding of why certain options are preferred over others. Various aspects of legislation including policy and administrative framework have also been discussed.

The Policy Framework

National Policy on Environment

The National Policy on Environment (NPE) is the principal policy that coordinates environmental management in Zambia. The NPE is designed to create a comprehensive framework for effective natural resource utilization and environmental conservation which will be sensitive to the demands of sustainable development.

The NPE reinforces the strategy to capacitate the MLGH Department of Housing and Infrastructure Development (DHID) and local authorities with adequate resources to rehabilitate and extend water supply sewerage systems and other forms of sanitation and develop and manage solid waste systems.

National Water Policy

The National Water Policy is the overarching policy framework for the water and sanitation sector in Zambia. The National Water Policy envisions “to optimally harness water resources for the efficient and sustainable utilization of this natural resource to enhance economic productivity and reduce poverty”. The policy encourages the use of water resources in an efficient and equitable manner consistent with the social, economic and environmental needs of present and future generations.

Following the adoption of the National Water Sector Policy in 1994, the government implemented several strategies, including:

- Peri-Urban Water Supply and Sanitation Strategy (2000): targets water supply and sanitation services to urban low income communities, and;
- Community Water Supply and Sanitation Strategy (2000): primarily targets rural areas, but also peri-urban areas.

National Conservation Strategy

The National Conservation Strategy (NCS) formulated in 1985 has been the main policy document on the Environment and Natural Resources in Zambia. The NCS was prepared by the Government to manage natural resources and the environment in the context of a centrally planned and controlled economy. The Strategy's main goal is to satisfy the basic needs of all the people of Zambia, both present and the future generations, through the wise management of natural resources.

National Environmental Action Plan

The focus of the National Environmental Action Plan (NEAP) of 1994 is to identify environmental problems and issues, analyse their causes, and recommend necessary interventions. The NEAP was prepared as a comprehensive plan to contain the ever increasing environmental degradation in Zambia.

The NEAP is founded on three fundamental principles:

- the right of citizens to a clean and healthy environment;
- local community and private sector participation in natural resources management; and
- obligatory EIA of major development projects in all sectors.

National Biological Diversity Strategy and Action Plan

In May 1993 Zambia ratified the Convention on Biological Diversity and as part of the commitment to fulfil its objectives; Zambia developed the National Biological Diversity Strategy and Action Plan (NBSAP), which was finalized in 1998. Some of the main goals of the NBSAP are to:

- ensure the conservation of the full range of Zambia's natural ecosystems through a network of protected areas;
- improve the legal and institutional framework and human resources to implement the strategies for conservation, sustainable use and equitable sharing of benefits from biodiversity management; and

National Gender Policy

The government launched the revised National Gender Policy (NGP) in December 2014, which serves as a gender mainstreaming institutional framework for government ministries. The revised NGP seeks to address the persistent feminisation of poverty, rising gender dynamics in the HIV and AIDS pandemic, increased incidences of gender-based violence, human trafficking, negative impact of climate change on women and children, and increase of women in drug trafficking.

In order to resolve the problems pertaining to the provision of safe and clean water, and good sanitation which affects women more than men, government has put the following measures in the National Gender Policy: The Government will:

- promote and encourage the involvement of women in the decision making processes in the provision of safe and clean water and improvement of sanitation facilities;
- encourage partnerships between women and men in the provision of water and sanitation;
- ensure use of gender friendly technology in water supply and sanitation to all members of the community especially persons with disabilities;
- devise a mechanism to ensure that water and sanitation facilities companies provide affordable, clean, and safe water through a regulator; and
- establish investment mechanisms to ensure that water reticulation systems take into account issues of hygiene to prevent water borne diseases.

Sixth National Development Plan

The Ministry of Finance and National Planning (MFNP) developed the Sixth National Development Plan (SNDP), which contains a chapter on water and sanitation. The sector goal is “to achieve 75% accessibility to reliable safe water and 60% adequate sanitation by 2015 in order to enhance economic growth and improve the quality of life”. In order to achieve the SNDP objective of promoting sustainable water resources development and sanitation, the strategic focus of the sector will be to provide water and sanitation infrastructure and develop skills to ensure effective water resource management and the efficient provision of reliable and safe water and sanitation services.

The National Environmental Laws and Regulations

The Environmental Management Act

The Environmental Management Act, 2011:

- provides for integrated environmental management and the protection and conservation of the environment and the sustainable management and use of natural resources; and
- provides for the prevention and control of pollution and environmental degradation; provides for public participation in environmental decision making and access to environmental information.

Part IV of the Act makes provision for control of pollution (land, air and water, ozone depletion), the control of general and hazardous waste and the conduct of EIA.

The Act states that a developer shall not implement a project for which a project brief or an environmental impact statement is required, unless the project brief or an EIA has been concluded in accordance with the Act and the ZEMA has issued a decision letter. The Act also provides for undertaking of an environmental audit of the project.

Statutory Instrument No. 28

Statutory Instrument (SI) No. 28 under the Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997 amongst other requirements sets down the detailed procedures for the preparation of Environmental Project Briefs (EPBs) and Environmental and Social Impact Assessments (ESIAs), consultations, approvals and monitoring.

Water Supply and Sanitation Act

The Water Supply and Sanitation Act, 1997, provides for the establishment of the National Water Supply and Sanitation Council (NWASCO), which acts as a regulator in the provision of water supply and sanitation services. It mandates NWASCO to regulate the sector in a manner leading to improved delivery, efficiency and sustainability. The Act requires NWASCO to disseminate information to the public on matters relating to water supply and sanitation services.

Water Resources Management Act

The Water Resources Management Act, 2011, establishes the Water Resources Management Authority and defines its functions and powers. The use, diversion and apportionment of all water shall be made in terms of this Act. Any person may make an application to the Secretary of the Water Resources Management Authority for permission to impound and store or divert water from a public stream for primary, secondary or tertiary use, and the Water Board may grant such application on such terms and conditions as it may think fit provided that any such grant is made with reasonable regard to the primary use of water and any existing rights lawfully granted for any other purpose.

Public Health Act

The Public Health Act, 1995 (CAP 295) provides for the prevention and suppression of diseases in the general public environment and has provisions for management of sanitation and prevention of pollution of water bodies by local authorities. The Local Authority of any area is empowered by the Act to do and provide all such acts, matters and things as may be necessary for mitigating any disease, or aiding in the execution of regulations, or for executing the same, as the case may require.

National Health Services Act

The National Health Services Act (CAP 315) establishes the Central Board of Health and provides for the procedures for establishing management boards for hospitals and health services. Where any Local Authority fails to deal with any outbreak or prevalence of any infectious, communicable or preventable diseases, the

Board shall take over the function of the Local Authority in relation to public health and shall have all the powers of such Local Authority as provided for under the Public Health Act.

Local Government Act

The Local Government Act (CAP 281) is the enabling legislation governing the establishment, powers and operations of local administration and defines the functions of Local Authorities. Section 61 of the Act provides legal authority for the functions of Councils to be discharged directly, by contract or by separate undertaking. These functions are detailed in the Second Schedule, of which the following are particularly relevant to the Project:

- to establish and maintain sanitary services for the removal and destruction of, or otherwise dealing with, all kinds of refuse and effluent, and compel the use of such services;
- to establish and maintain drains, sewers and works for the disposal of sewage and refuse; and
- to require and control the provision of drains and sewers and to compel the connection of any drains and sewers established by the council.

The Road Traffic Act

The Road Traffic Act (2002) establishes the Road Transport and Safety Agency (RTSA) and defines its functions which include providing for a system of road safety and traffic management, licensing of drivers and motor vehicles, registration of motor vehicles and trailers, licensing and control of public service vehicles, promotion of road safety, and regulation of road transport between Zambia and other countries with which Zambia has concluded cross-border road transport agreements.

Public Roads Act

The Public Roads Act (CAP 12) of 2002 established the Road Development Agency and defines its functions; to provide for the care, maintenance and construction of public roads in Zambia. Section 56 regulates the works of utility companies (undertakers) which includes works for buried pipelines and apparatus.

Registration and Development of Villages Act

The Registration and Development of Villages Act (CAP 289) provides for the registration of villages and of the inhabitants thereof, and the establishment of Village Productivity Committees, Ward Councils and Ward Development Committees (WDCs).

The WDC is the executive committee of the Ward Council, and shall be responsible for the administration and development of the ward as a whole.

Lands and Deeds Act

The Lands and Deeds (Registry) Act provides for: the registration of documents; to provide for the issue of Provisional Certificates of Title and Certificates of Title; and the transfer and transmission of registered land.

Lands Acquisition Act

Sections 3, 5 and 6 of the Lands Acquisition Act empower the President in the interests of the Republic to acquire any property of any description and lay down the procedures whereby the Minister of Lands may do so.

Land Conversions of Titles Act

The Land Conversions Title Act provides for the alienation, transfer and change of land. The Act also provides for compulsory acquisition of land by the President whenever he is of the opinion that it is desirable or expedient to do so in the interest of the Republic.

The Town and Country-Planning Act

The Town and Country Planning Act (CAP 283) provides for: the appointment of planning authorities; the preparation, approval and revocation of development plans; the control of development and subdivision of land; the assessment and payment of compensation in respect of planning decisions; and the preparation, approval and revocation or modification of regional plans.

National Heritage Conservation Commission Act

The National Heritage and Conservation Act of 1989 (CAP 173) is administered by the National Heritage Conservation Commission (NHCC). The Act provides regulatory guidelines for the conservation of ancient, cultural and natural heritage, relics and other objects of aesthetic, historical, prehistoric, archaeological or scientific interest.

Forestry Act

The Forestry Act provides for promotion of methods for sustainability, conservation and preservation of ecosystems and biological diversity in national forests, local forests and open areas.

Factories Act

The Factories Act (CAP 441) makes further and better provision for the regulation of the conditions of employment in factories and other places as regards the safety, health and welfare of persons employed therein and provides for the safety, examination and inspection of certain plant and machinery.

Occupational Health and Safety Act

The Occupational Health and Safety Act, 2010 establishes the Occupational Health and Safety Institute as a body corporate with perpetual succession and defines its composition, powers, and functions. The Act provides for the establishment of health and safety committees at work places and aims to provide for the

health, safety, and welfare of persons at work and persons who may face risks to health or safety arising from the said work, and to establish the duties of manufacturers, importers, and suppliers of items for use at work.

Employment of Children and Young Persons Act

The Employment of Young Persons and Children Act (CAP 274) is the major legal instrument for the protection and regulation of child labour. This Act prohibits the employment of a child under the age of 15 in an industrial undertaking as defined under the Act.

Explosives Act

The Explosives Act (CAP 115) makes provision for regulatory control over the manufacture, use, possession, storage, importation, exportation, transportation and destruction of explosives, and for related matters. Trench excavations in this project may require the use of explosives in which case the use will have to conform to this Act.

Petroleum Act

The Petroleum Act (CAP 435) regulates the importation, conveyance and storage of petroleum and other inflammable oils and liquids. This project will require the use of petroleum products. Transportation, storage and dispensing will have to abide by the stipulations in this Act

Energy Regulation Act

The Energy Regulation Act (CAP 436) allows for the establishment of procedures for the transportation, handling and storage of fuels to minimize negative environmental impacts. Transportation, handling and storage of fuels will have to conform to this Act

Institutional framework of the project

Ministry of Local Government and Housing

The MLGH is the ministry most directly responsible for water supply and sanitation policy, technical and financial supervision as well as resource mobilization from foreign and local sources. The DHID is located within the MLGH and has the overall responsibility for planning, implementation, coordination and monitoring of water supply, sanitation and hygiene promotion.

Ministry of Mines, Energy and Water Development

The MEWD is responsible for initiating overall national water management policies and for setting national standards and priorities for water development and management.

National Water and Sanitation Council

The NWASCO is a statutory body established by the Water Supply and Sanitation Act. According to the Act in Clause 4, NWASCO is mandated to regulate the provision of water supply and sanitation services. The

NWASCO reports through the MEWD, this is in order to keep the regulatory function separate from the water and sanitation implementation function housed under the MLGH.

Zambia Environmental Management Authority

The ZEMA is a statutory body established in 1992 and is mandated to protect the environment and control pollution so as to provide for the health and welfare of persons, and the environment.

National HIV/AIDS/STI/TB Council

The National HIV/AIDS/STI/TB Council (NAC) was established in 2002 under the Ministry of Health to ensure a focused and coordinated national response to HIV and AIDS. The NAC is expected to provide strategic leadership by ensuring effective coordination of the HIV and AIDS related activities.

Eastern Water and Sewerage Company Ltd

The Eastern Water and Sewerage Company Ltd (EWSC) is owned by all the district councils in Eastern province. The EWSC owns and operates water supply and sewerage assets in Chipata district under which Mwami Border Post falls.

Chipata Municipal Council

The CMC is the governing local authority for the town of Chipata, deriving its authority from several Zambian laws, but most immediately, Section 61 of the Local Government Act, which lists 63 functions of local authorities. The CMC responsibilities include, but are not limited to:

- provision and maintenance of supplies of clean water and the establishment of water works and water mains;
- construction and maintenance of sanitary lines; and
- establishment and maintenance of sanitation and drainage systems to facilitate the removal of refuse and effluent.

The two CMC departments most germane to the water supply context in the peri-urban, or unplanned urban settlement, areas are the Planning Department and the Department of Housing and Social Services.

Community organisations and institutions

Both urban and peri-urban areas of Chipata are organized under Ward Development Committees (WDCs) whose main responsibility is to oversee development projects in their respective areas. The WDCs are further sub-divided into Zone Development Committees. WDC does not work in isolation, but undertakes activities in collaboration with various Community Based organizations (CBOs) such as the Neighbourhood Health Committee (NHC), the Water Committees and so on.

Project Description

Background

The over 2000 people at Mwami Border Post are without adequate water supply and access to sanitation is also a challenge. The situation is exacerbated by the travelling public who end up with nowhere to seek these facilities. This is a recipe for enteric and hygiene related disease outbreaks. Being a border town, such outbreaks may easily get transmitted to the bordering country.

Water Supply and Sanitation Situation

Mwami border relies on boreholes for its water supply. There are three boreholes that service the population while the Zambia Revenue Authority (ZRA) has its own borehole. A few households, especially those that are being constructed recently, have managed to sink boreholes. The water sources are inadequate especially for those drawing from the common boreholes. The situation was reported to be even worse in the dry season as the water quantity in the boreholes reduces. This forces people, especially women and children, to spend a lot of time to draw water.

In terms of sanitation, excreta disposal within the project area is predominantly through traditional pit latrines which account for about 85%. The rest is through water borne systems and Ventilated Improved Pit latrines (VIPs) accounting for 11% and 4% respectively. This is according to data from the EHT. However, these facilities mostly serve the residents and the border workforce. Travellers, especially truck drivers do not have access to facilities. From the FGDs held on 4th April 2015, two issues were voiced out concerning truckers as follows:

- Truckers have a challenge with bathing and laundry when they get marooned at the border. This forces them to seek toilet facilities from nearby homes where they are made to pay for the services. It was stated that they pay about K5 each time such services are provided; and
- Whereas during day time the marooned truckers may seek toilets from nearby homes, in the night, they sometimes use nearby areas which are just along the roads. This poses a health risk to both the residents as well as travellers including the truckers themselves.

There are no services on excreta management in this area from the local authority leaving all issues related to excreta treatment and disposal as a matter to be handled by residents themselves and individual institutions. Without a defined management structure for excreta disposal at the site, a lot of challenges arise. Firstly, the travelling public is inconvenienced. Secondly, when excretion is done indiscriminately, the public health of the communities in the area is put at risk. Thirdly, small children are sometimes forced to go and draw water in order to provide the “bathing services” to truckers which may have negative impacts especially with respect to school attendance by these children.

Project Objectives and Justification

The main objective of this project is to improve the water supply and sanitation status of the project area in order that water borne diseases and those that are associated with hygiene related to water supply and sanitation are prevented. This is an important project as it will lead to improved socioeconomic status of the community. The hygiene levels of both the community as well as the travelling public will be improved due to this project.

Main project activities

Activities during the preparation stage

This project has two main distinct activities as follows:

- Construction of a water supply system which will involve the development of the source, construction of the reticulation system and storage facilities; and
- Construction of an ablution block together with the associated septic tank and soakaway.

For both water and sanitation systems, the only anticipated activity during the preparation phase is mobilization involving securing of camp sites (if these will be required) for workers and storage facilities for materials.

Activities during the construction stage

For the water supply system, activities during the construction phase will include the following:

- Setting out according to the design
- Grubbing and site clearing
- Borehole drilling and equipping;
- Transportation of equipment and materials (e.g. pipes and pumps)
- Construction of the distribution system, which will involve laying of pipes. This will require excavations which may require blasting where pipes pass in rocky areas;
- Construction of the storage facilities;
- Construction of pumping stations.
- Haulage of waste from construction sites
- Use of hydrocarbons including fuel and oils for transportation vehicles, plant and machinery
- Construction of camp sites
- Employment of required labour force

For the sanitation part, activities will include:

- Setting out according to the design;
- Grubbing and site clearing;
- Trenching; and
- Transportation of building materials (i.e. blocks, cement, fittings etc.)

Activities during the operation stage

For the water supply systems, activities during the operation phase will be confined to water abstraction from the boreholes, treatment (chlorination) and distribution. For the sanitation component, the only major activity in this phase will be the desludging of the sludge from the septic tank.

Raw Materials

The project's life cycle will comprise the construction and operation phases. The raw and other materials and waste products for each of these phases are presented below.

Construction Phase

During the construction phase, the following will be the raw materials:-

- Water supply pipes of varying sizes;
- Plumbing fittings for the sanitation facility;
- Building construction materials for the toilet (e.g. cement, sand, blocks, roofing materials, etc.);
- Fuel;
- Pumps; and
- Steel for construction of storage facility

The expected waste products in this phase will mainly include rubble and excess spoil from construction activities.

Operational Phase

Raw materials in the operation phase will mainly the water treatment chemicals (chlorine). No waste products are expected from the water supply system. For the sanitation system, no raw materials are anticipated in the operation phase. Sludge will be the only waste product.

Products and by products

The envisaged products from this project include an adequate water supply system satisfying the needs of both the residents and the travelling public and an ablution block which will respond to the needs of the travelling public.

Environmental and Social Baseline Conditions

Introduction

The environmental and social baseline conditions of the study area are presented in this chapter. The methodology used to collect information presented in this section has already been discussed in earlier sections of this report.

The Physical environment

Ecology

The project sites are within the developed areas of Mwami Border and most of the project activities will be confined to this area. These areas, being already developed are devoid of flora and fauna of ecological significance. The area mostly comprises housing units with small gardens/fields occupying the empty spaces (**Figure 16**).


Figure 16 Portions of the project site showing degree of disturbance to the natural flora

Geology

There is no comprehensive geological data for the project site. However, data from a borehole reports indicates that the site is on an area of variable geological formation. Top soil covers the first one meter below which is clay and sandstone. The clay and sandstone sits on schists, which in turn rest on the granitic-quartzite formation. In some cases, the clay sandstone extends to well below 40m.

Air quality

The project site is devoid of limited industrial activities hence there is no industry related air pollution. For areas located away from the highway, traffic volume is low hence pollution due to emissions from motor vehicles is also low. However, along the road, pollution from motor vehicles normally results from the combustion of petrol and diesel fuels. Pollutants from these sources include hydrocarbons (HCs) and Benzopyrene, Particulate Matter (PM), Carbon Monoxide (CO), Oxides of Sulphur (SO_X) and Oxides of Nitrogen (NO_X).

Indoor air pollution resulting from the use of charcoal and other wood fuels obviously affects residents especially in areas where charcoal and wood are the main sources of energy. Almost all rural type of housing units in the area are not connected to electricity and are therefore susceptible to this type of pollution. The fuels emit PM, HCs, CO, SO_X and NO_X. The effects of prolonged exposure to these emissions on humans are Acute Respiratory Infections (ARIs).


Figure 17 Example of rural housing units within the project site not connected to electricity

It is also expected that the area faces air pollution from non-combustive sources mainly in the form of dust. Due to absence of vegetation cover in most areas and the sandy nature of the area, it is expected that this type of pollution is a major issue especially during the months of August and September, which are windy.

Water quality

The project area has no surface water bodies in its immediate vicinity. The only river, located about two kilometres east of the site is the Lutembwe River. However, several boreholes exist within and around the project site. Water samples collected and analysed from three boreholes revealed ground water quality of acceptable standards with respect to potable water. Iron and manganese, which are usually a problem with groundwater, were all below the threshold values. All heavy metals analysed (Copper, Zinc and Arsenic) were below detection limits.

Hydrogeology

The project area lies in an area of variable Hydrogeological characteristics. Borehole yields are reported to range between 0.7l/s to about 1.5 l/s.

Topography

Mwami Border lies at the foot of the hills on the western side whilst the other mountain range is about 4km away on the eastern side. The area slopes eastwards towards the headwaters of the Lutembwe River located about 2km east of the site.

The Potential Environmental Impacts

Introduction

This section presents the environmental impacts expected from the proposed project. The impacts were assessed from the changes likely to be brought about by the project activities on baseline environmental and

social conditions. The impacts are discussed under separate headings namely common impacts; water supply related impacts; and sanitation related impacts. The common impacts are those that apply to both projects while those that are specific to each of the two projects are discussed under the respective heading. At the end of the section, all the impacts discussed are summarised in **Tables 23, 24 and 25**. The definitions of the terms used in the Tables are explained in **Table 22**. The summary explains whether the impact is direct, indirect, reversible, irreversible and/or cumulative. Their significance with respect to the design of the water supply and sanitation components is also discussed.

Positive impacts common to the water supply and sanitation projects

The general environmental impacts associated with the implementation of both the water supply and the sanitation components of the Mwami Water Supply and Sanitation project which may result in changes on the environmental and socioeconomic conditions are discussed below. Many of these activities are those that are always associated with construction activities on a civil engineering construction site. The activities that will result in these common impacts have already been outlined in the preceding sections, which include: delivery of construction materials; haulage of waste from construction sites; use of hydrocarbons including fuel and oils for transportation vehicles, plant and machinery; clearing of vegetation; and construction of camp site. Based on these activities, impacts have been identified which are presented in two different categories namely socio-economic and environmental impacts.

Socio-economic impacts

Employment opportunities

The execution of the projects will require employment of different professionals and casuals at all the different phases of the project. Firstly, there will be creation of job opportunities to the consultants. After the designs, a contractor will be engaged who will employ people for the various aspects of the construction works. The employment may also provide skills and work experience that can lead to long term employment.

Increased revenue base for the water utility (EWSC)

Implementation of the water supply and sanitation projects will result in increased revenue base for the utility. Revenue will be generated from fees for using the ablution block as well as from water tariffs.

Environmental impacts

There are no anticipated positive environmental impacts common to both projects

Socio-economic impacts

Destruction of fields either temporarily or permanently

Construction works, especially if carried out during the rainy season may lead to destruction of fields. This is especially the case for sites where boreholes, tanks and pipe routes will be located.

Impacts associated with worker campsite

Campsites are associated with a number of impacts. Firstly, if constructed from poor quality materials, they may be an aesthetic hazard. If inappropriately sited, the camps may disrupt the local communities and lead to pollution of water sources. They may also pose health hazards to workers if not properly drained especially where the excreta disposal facilities are on-site like pit latrines as the storm water may flood the area leading to excreta and storm water mixing. This can lead to pollution of both surface and ground water sources. Lastly, if left standing after the construction works, the campsites may serve as hiding places for people involved in illicit activities.

Temporary disruption of pedestrian and traffic movement

During construction, there will be excavations and earthworks along the roads and within the residential area. Where the pipes cut across the roads, it will be necessary to close the road. This may disrupt pedestrian and traffic flow. In cases where the pipe trenches are dug in front of households, access to these properties will be restricted.

Increased child labour

The proposed water supply and sanitation projects may lead to contracted construction workers sometimes subcontracting under-aged children to work for them which may lead to adverse effects on the minors like injuries, sexual and physical abuse, and school absenteeism.

Damage/disruption to adjacent services

The project may result in damage or disruption of adjacent services. Although the area has limited services, there are possibilities of excavation works damaging telephone lines and the optic fibre cables which in most cases are buried underground. Therefore, excavation activities may lead to damage and consequently, disruption of some services.

Disruption and/or destruction of sites having archaeological or historical values

Construction activities in this project can lead to disruption and/or destruction of sites having archaeological or historical value. This is especially so for activities involving excavations. However, most of the proposed works in this project are within the already developed area.

Spread of sexually transmitted disease by migrant workforce

During the construction phase, there will be an increase in employment opportunities directly and indirectly arising from these projects. Firstly, standards of living for people who will be employed by the project will be raised due to income mostly in form of wages. Secondly, some people will be forced to relocate from their normal places of residence. This situation may potentially result in casual sexual behavior among workers and between workers and the inhabitants of the surrounding communities. This may lead to increased incidences of sexually transmitted diseases and HIV/AIDS infections.

Noise and vibrations arising from construction activities

During construction, noise may be caused by the operation of construction equipment, installation of equipment and machinery, and transportation of equipment, materials and people. Noise often causes discomfort, pain and noise-induced hearing loss. Similarly, vibrations will arise from machinery and equipment that will be used in construction works. Vibrations may be excessive for borehole drilling activities as well as where explosives may also be used (like in cases where the proposed pipes pass through rocky areas where excavations may only be possible through the use of explosives). Vibrations can damage buildings (e.g. causing cracks especially to weak structures like the ones that dominate the project site), affect vibration-sensitive machinery or equipment, disturb, annoy and affect person's ability to work.

Risks arising from blasting activities

The construction of the proposed water supply and sanitation infrastructure may require blasting (i.e. in rocky areas) which may involve the use of explosives to excavate the rocks. The risks associated with blasting include fly-rock, splinters and debris which may injure community members, construction workers and animals. Damage to buildings, trees and other objects may occur. Blasting also causes vibrations whose effects have been discussed in the preceding section. Damage to property can lead to litigations and delays in execution of work.

Explosives left undetonated at a blast site may injure or kill people especially children. Explosives which are dropped on the ground or left undetonated in the ground can also result in chemicals leaching into ground and surface water.

The noise associated with blasting can startle people in the neighbourhood as well as cause impacts as has already been discussed. Noise caused by blasting can lead to death especially for people suffering from hypertension. Blasting can also cause dust accumulation. The magnitude of all the blasting related impacts depends on the closeness of the blasting activities to the communities.

Injury or/and loss of life

During the construction phase, accidents may occur resulting in injuries, disability and loss of life. Accidents may involve employees working on the project, motorists and pedestrians and in some cases trespassers.

Danger of people and traffic falling into excavated trenches

In most areas where construction will take place, disruption of pedestrian and traffic movements will occur. Laying of pipes requires trenching. The trenches have the potential of increasing accidents; either pedestrians or traffic can fall into them. This impact will be higher in busier areas like the area just around the border where pedestrian and traffic movement is more.

Danger of excavation related accidents like trench collapse

Trenches for water supply pipes and septic tank and soakaway may result in accidents. During deep excavations, if no appropriate safety measures are taken, there is a danger that the trenches can collapse. This may result in injuries and fatalities.

Danger arising from use of access equipment such as ladders and scaffolds

During construction of some infrastructure like the storage and distribution water tanks and the ablution block, people will be required to work off ground. This will make the use of ladders and scaffolds unavoidable. This will result in danger of workers falling from heights which can result in injuries and fatalities.

Traffic safety

Construction activities will lead to increased traffic movement in the area resulting from transportation of the work force as well as materials that will be required. This may lead to increased road traffic related accidents in the project area.

Occupation Health and safety

Over-exertion, and ergonomic injuries and illnesses, slips and falls, fall of materials or tools are some of the accidents expected on construction sites like the water supply and sanitation sites. Vehicle traffic and use of lifting equipment in the movement of machinery and materials on a construction site may pose temporary hazards. Confined spaces and excavations which are associated with pipe laying also pose occupational health and safety hazards such as suffocation. Construction sites may pose a risk of exposure to dust, chemicals, hazardous or flammable materials, and wastes in a combination of liquid, solid, or gaseous forms.

Community health and safety

General site hazards include risks that may arise from inadvertent or intentional trespassing, including potential contact with hazardous materials, contaminated soils and other environmental media, buildings that are vacant or under construction, or excavations and structures which may pose falling and entrapment hazards.

Explosion and fire from fuel storage

The proposed project will require the use of petroleum products. It may also require on-site storage and handling of fuel. This will pose a risk of explosion and fires as the liquid is flammable.

Soil compaction from construction vehicles and equipment

Movement of vehicles and plant equipment during construction will compact the soil thereby changing its characteristics. This may result in reduced vegetation growth and groundwater recharge.

Soil erosion from clearing of vegetation and movement of soil

Construction activities will inevitably result in soil loosening and movement (e.g. excavations that will be required in digging trenches for the pipes). Loosened soil including slopes and stockpiles of earth material may easily be eroded by wind, rain, surface runoff, water and movement of vehicles and equipment. Excessive erosion may lead to destruction of roads and may lead to problems with water quality of receiving water bodies which in this case is the Lutembwe River. This silt may eventually end up in the dams on the river located downstream where it would accelerate the silting of the dams.

Contamination of soils by petroleum products

Construction activities for the proposed project will involve the use of machinery and equipment that will use petroleum products (mainly diesel). In case of leakages or spillages, the products have the potential to contaminate the soil. It is also expected that there will be fuel storage tanks at camp sites to be used for storage of fuel that will be required by the construction vehicles and equipment. There may be leakages or spillages especially during the delivery of the petroleum products. This can result in the pollution of the soil.

Land degradation from disposal of waste

During construction works, solid waste will be generated which if not properly managed can accumulate within the project sites. This has the potential of adversely changing the aesthetic appearance of the surrounding areas and can pollute the soil and water resources.

Mixing of topsoil with subsoil during excavations and back filling thereby reversing the soil profile

Where excavations are carried out, during back-filling there can be mixing of topsoil with subsoil. Where care is not exercised, there may be a complete reversal in the soil profile where the top soil goes in at the bottom and the subsoil ends up on top. This will negatively affect regeneration of vegetation where required.

Increased dust and air pollution

Construction activities in this project will require use of vehicles and machinery. This will result in air pollution in form of dust and exhaust fumes which are major negative impacts expected during this project phase. The primary causes of emissions are contact of construction machinery with bare soil and movement of construction vehicles on unpaved roads. Sources of emissions are exhaust fumes. Exposure to air pollution is associated with numerous effects on human health, including pulmonary, cardiac, vascular, and neurological impairments. Air pollutants such as ozone and nitrogen oxides from vehicles also have harmful effects on natural ecosystems. They can kill plants and trees by destroying their leaves, and can kill animals, especially fish in highly polluted rivers.

Contamination of ground/surface water from petroleum products

Construction activities may pose the potential for release of petroleum-based products during their storage, transfer, or use in equipment. Released products have the potential to contaminate ground and surface water. The pollution will be in form of hydrocarbons and other pollutants usually associated with petroleum products. Hydrocarbons can affect water and consequently soil and plants, which may put the health of the public at risk.

Destruction of vegetation due to construction activities

The construction/installation of water supply and sanitation systems require clearing of vegetation which may disturb the scenic beauty of the areas. Trees and woodlands may be disturbed. This will be more serious where structures and pipelines are being constructed in virgin areas.

Positive Impacts Specific to the Water Supply Project

Socio-economic impacts

Improved water supply to the project area

The new water supply system will lead to adequate and reliable water supply to the project area. During the Focus Group Discussions held with the WDC and NHC, it was revealed that the available water sources where not adequate. The situation was said to worsen in the dry season as the boreholes are not able to sustain the demand. This results in queues at the water points and also forces women to wake up at awkward hours to go and draw water. Increased water availability will entail reduced burden on women and adolescent girls on drawing water. Less time will be 'wasted' on this activity leading to increased time for other activities in and outside the homes and increased school attendance on the part of school girls.

Change in quality of life and increase in self-esteem in communities due to improved services

Provision of water supply systems in the project area will result in improved water supply to the communities within the project site. This will lead to the general improvement in the quality of life in the project area. Availability of water will lead to resuscitation of the waterborne sanitation facilities, which have currently been abandoned. This will lead to increased self-esteem among community members.

Improved quality of life due to associated health benefits from water availability like changes in personal hygiene

Availability of adequate water supply has a positive influence on personal hygiene, which has a direct impact on reduction of diseases. Examples are cases of water-washed diseases commonly referred to as "water-hygiene diseases" which include infectious skin diseases; infectious eye diseases like Trachoma; louse-borne typhus and louse-borne relapse fever. It is documented that diarrhoeal diseases which are also faecal-oral route diseases decrease with increased availability of water for washing. Implementation of the water supply

systems will lead to availability of adequate water supply and consequently, a reduction in the prevalence of water borne diseases

Increased property values due to improved water supply services

The availability of water which in some cases will also lead to resuscitation and installation of in-house sanitary facilities. This will contribute significantly to the value of properties in the project area.

Potential for industrial growth in the district due to availability of water

Adequate water in the project site has the potential to promote industrial growth as availability of water is one of the requirements for most industrial activities. This can in the long run contribute to improved economic status of the project site.

Environmental impacts

No positive environmental impacts specific to the water supply project are envisioned in this project

Negative Impacts Specific to the Water Supply Project

Socio-economic impacts

Displacement and relocation

Inappropriate siting and location of boreholes, water pipes and water storage facilities has the potential to trigger displacement of community members. This would lead to requirements for compensation due to involuntary resettlement and may exaggerate the project cost.

Temporary displacement of people and disruption of business to pave way for construction works of water supply infrastructure

Laying of the water supply infrastructure, especially pipes along the main road may lead to temporary displacement of people and disrupt business activities. For example, when laying pipes along the main road, business along the road may be affected. Traders along the road may also be forced to temporarily shut down their operations in order to pave way for construction activities. Where excavations may require the use of explosives, people may be forced to temporarily vacant their houses as a safety precaution.

Displacement of tenants due to increased rentals arising from improved water supply services

Improved water supply will result in increased value of the properties. Where the property is on rent, this will lead to increased rentals. This may result in some tenants, with limited capacity to pay new rentals, displaced from their rented homes.

Storage, handling and use of disinfection chemicals in water treatment facilities

Water treatment will require usage of chlorine in the disinfection process of the water. Chlorine is a highly toxic substance especially when in gaseous form. It is also a very strong oxidising agent. Inappropriate

storage and use of this chemical may lead to serious health hazards and in some cases can even lead to fatalities.

Environmental impacts

Reduction in ground water due to increased abstraction

As the project will get water from ground water sources, it is expected that an average of 470m^3 will be abstracted on a daily basis. This abstraction will lead to increased ground water abstraction which in the long run can lead to lowering of ground water table. This may result in drying out of boreholes in the area.

Positive Impacts Specific to the Sanitation Project

Socio-economic impacts

Improved access to sanitation facilities by the travelling public and truckers

Provision of an ablution block at the border post is expected to enhance access to sanitation services by the travelling public and truckers who currently do not have access to these facilities.

Improved quality of life for the travelling public due to improved sanitation

The quality of life for the travelling public, especially truckers who get marooned at the border for several days at times will be improved due to improved sanitation. The provision of laundry and showering facilities in addition to the toilets will greatly enhance the quality of life for truckers at the border post.

Improved productivity due to anticipated disease burden reduction arising from provision of sanitation services

Currently, the project site is contaminated from open defaecation practiced by stranded travellers. Open defaecation is a recipe to the outbreak and perpetuation of enteric diseases. Provision of an ablution block will reverse this situation. The reduced diseases burden will translate into higher productivity.

Environmental impacts

Improved environmental aesthetics (i.e. odours and sight) due to reduced indiscriminate defaecation

Where open defaecation is a means of excretion, it is always expected that the area in which it is practiced will be littered with excreta. Odour will also ensue from the excreta thereby compromising the aesthetic quality of the living environment. Provision of an ablution block will reduce or completely eliminate the practice of open defaecation thereby improving the aesthetic quality of the area.

Reduced excreta related contamination from indiscriminate defecation

Provision of an ablution block will reduce or completely eliminate cases of open defaecation. This will reduce/eliminate incidences of contamination of the environment (water, soil or air) from faecal matter.

Negative Impacts Specific to the Sanitation Project

Socio-economic impacts

Nuisance and public health hazards from overflows from the septic tank

Improper operations and maintenance of the ablution block may lead to blockages and overflows of the sewage onto the streets thereby compromising the aesthetics of the surrounding areas and also result in proliferation of enteric disease outbreaks. Situations that can lead to these problems include the use on inappropriate anal cleansing materials and delayed desludging of the facilities.

Environmental impacts

Soil contamination from sludge spillages during transportation and inappropriate disposal

The sludge from the septic tank, if not appropriately transported, can result in soil contamination. Where sludge is indiscriminately dumped on the ground, it may pollute the soil as some of the contaminants contained in it, during leaching will contaminate the soil. This soil will then become a hazard and may promote the transmission of enteric diseases like those associated with helminths and parasitic worms.

Contamination of water resources from inappropriate sludge storage, transportation and disposal

Inappropriate storage, transportation and disposal of sludge can result in contamination of ground and surface water resources. Where sludge is stored inappropriately, it may result in leachate which can end up in ground water aquifers. It can also mix with storm water and end up into surface water bodies. Inappropriate transportation and disposal may also lead to contamination of water resources through leachates and transportation by storm water.

Classification and Significance of impacts

The significance of impacts discussed in the preceding section summarised in Tables 17, 18 and 19 below. The significance of impacts has been determined by combining the perceived frequency of occurrence of the source of the impact, the duration, severity, and spatial extent of the impact and the sensitivity of the area being impacted upon as already explained earlier. The analysis was also aided by using information presented in **Table 18** below which explains the terms used in the impact ranking.

Table 18 Summary explanation of the criterion and classification of impacts

Impact Criterion	Effect On Environment	Classification Of Effect	
		Expression	**Effect Description**
Positive or negative	Will impact be positive or negative?	Positive	A positive impact
		Negative	A negative impact

Likelihood of occurring	What certainty of occurrence is associated with impact?	Unlikely	Probably will not occur
		May occur	Small chance that it will occur
		Possible	Significant chance that it will occur
		Certain	Will occur
Duration	What timeframe or period is effect to be felt or last?	Short-term	Will last up to end construction activity
		Medium-term	Will last as long as operational activity
		Long-term	Will last beyond project operation
		Permanent	Will last a lifetime
Timing	At what stage will the impact occur or be felt?	Immediately	Will occur upon starting project activities
		Near future	Will occur during project operation
		Distant future	Will occur beyond project operation
Severity	How severe will the impact be?	slight	Little impact
		Moderate	Moderate impact
		severe	High impact
		Very severe	Very high impact
Spatial extent	What is the real extent or coverage of impact?	Localised	Impact will be felt at localised scale covering a few hectares
		Study area	Impact will be felt within project area including immediate environment
		Regional	Impact will be felt at district or provincial level
		National	Impact will be felt at country level
		International	Impact will be felt beyond national boundaries
Nature	What type of impact is it?	Direct	Arsing as a direct result of the activity
		Induced	Arising indirectly as a result of an activity
		Cumulative	Arising due to compoundment of several minor impacts
Overall rating	How important is impact in Project design?	Insignificant	Impact not substantial, needs no mitigation/enhancement
		Minor	Impact of little importance, needs limited mitigation/enhancement
		Moderate	Impact has influence and requires mitigating/enhancing
		Significant	Impact of great importance, mitigation/enhancement a must

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Table 19 Category and significance of impacts common to both the water supply and sanitation projects

Item	Potential Impact	Phase	Likelihood of Occurrence	Effect					Total Score	Overall Impact Rating
				Duration	**Timing**	**Severity/ Benefit**	**Extent**	**Nature**		
Positive Socioeconomic Impacts										
1	Employment opportunities	Construction	Certainly	Short term	Immediately	Very beneficial	National	Direct	14	Significant
2	Increased revenue base for the water utility (EWSC)	Operation	Certainly	Long term	Near future	Beneficial	Regional	Induced	12	Significant
Positive Environmental Impacts										
	NIL									
Negative Socioeconomic Impacts										
1	Destruction of fields either temporarily or permanently	Construction	Possible	Short term	Immediately	Slightly	Localised	Direct	8	Moderate
2	Impacts associated with worker campsite	Construction	Possible	Short term	Immediately	slightly	Localised	Direct	8	Moderate
3	Temporary disruption of pedestrian and	Construction	Possible	Short term	Immediately	Moderate	Localised	Direct	12	Significant

	traffic movement									
4	Increased child labour	Construction	May occur	Short term	Immediately	Moderate	Study area	Induced	8	Moderate
5	Damage/disruption to adjacent services	Construction	Possible	Short term	Immediately	Severe	National/ International	Direct	12	Significant
6	Disruption and/or destruction of sites having archaeological or historical values	Construction	May occur	Permanent	Immediately	Moderate	National	Direct	12	Significant
7	Spread of sexually transmitted disease by migrant workforce	Construction	Possible	Short term to Permanent	Immediately	Severe	National	Induced	14	Significant
8	Noise and vibrations arising from construction activities	Construction	Certain	Short term	Immediately	Moderate	Study area	Direct	12	Significant
9	Risks arising from blasting activities	Construction	Possible	Short term	Immediately	Moderate	Study area	Direct	12	Significant
10	Injury or/and loss of life	Construction	May Occur	Short term to	Immediately	Severe	Study area	Induced	15	Very significant

				Permanent						
11	Danger of people and traffic falling into excavated trenches	Construction	May occur	Short term	Immediately	Severe	Localised	Direct	12	Significant
12	Danger of excavation related accidents like trench collapse	Construction	May occur	Short term	Immediately	Severe	Localised	Direct	12	Significant
13	Danger arising from use of access equipment such as ladders and scaffolds	Construction	May occur	Short term	Immediately	Severe	Localised	Direct	13	Significant
14	Traffic safety	Construction	Possible	Short term	Immediately	Severe	Study area	Induced	13	Significant
15	Occupation Health and safety	Construction	Certain	Short term to Permanent	Immediately	Severe	Study area	Direct/Induced	14	Significant
16	Community health and safety	Construction	Certain	Short term to	Immediately	Severe	Study area	Induced	12	Significant

				Permanent						
17	Explosion and fire from fuel storage	Construction	May Occur	Short term	Immediately	Severe	Localised	Direct	8	Moderate
NEGATIVE ENVIRONMENTALIMPACTS										
1	Soil compaction from construction vehicles and equipment	Construction	Possible	Short term	Immediately	Slight	Localised	Direct	7	Insignificant
2	Soil erosion from clearing of vegetation and movement of soil	Construction	Possible	Short term	Immediately	Moderate	Study area	Direct	12	Significant
3	Contamination of soils by petroleum products	Construction	May occur	Short term	Immediately	Severe	Study area	Direct	12	Significant
4	Land degradation from disposal of waste	Construction	May occur	Short to long term	Immediately	moderate	Study area	Induced	8	Moderate
5	Mixing of topsoil with subsoil during excavations and back filling thereby reversing the soil	Construction	May occur	Long term	Immediately	Slight	Localised	Direct	7	Insignificant

	profile									
6	Increased dust and air pollution	Construction	Certain	Short term	Immediately	Moderate	Localised	Direct	12	Significant
7	Contamination of ground/surface water from petroleum products	Construction	May occur	Short term	Immediately	Moderate	Study area	Direct	11	Moderate
8	Destruction of vegetation due to construction activities	Construction	Certain	Short to long term	Immediately	Slight	Localised	Direct	7	Insignificant

Table 20 Summary of category and significance of impacts specific to the water supply project

Item	Potential Impact	Phase	Likelihood Of Occurrence	Effect					Total Score	Overall Impact Rating
				Duration	**Timing**	**Severity/ benefit**	**Extent**	**Nature**		
POSITIVE SOCIOECONOMIC IMPACTS										
1	Improved water supply to the project area	Operational	Certain	Long term	Near future	Very beneficial	Localised	Direct	16	Very Significant
2	Change in quality of life and increase in self-esteem in communities due to improved services	Operational	Certain	Long term	Near future	Very beneficial	Study area	Cumulative	15	Very Significant
3	Improved quality of life due to associated health benefits from water availability like changes in personal hygiene	Operational	Certain	Long term	Near future	Very beneficial	Study area	Cumulative	15	Very Significant
4	Increased property values due to	Operational	Certain	Long term	Near future	Very beneficial	Localised	Cumulative	14	Significant

	improved water supply services									
5	Potential for industrial growth in the district due to availability of water	Operational	Possible	Long term	Near future	Very beneficial	Study area	Induced	14	Significant
POSITIVE ENVIRONMENTAL IMPACTS										
1	NIL									
NEGATIVE SOCIOECONOMIC IMPACTS										
1	Displacement and relocation	Construction	May occur	Short term	Immediately	moderate	Localised	Induced	9	Moderate
2	Temporary displacement of people and disruption of business to pave way for construction works of water supply infrastructure	Construction	May occur	Short term	Immediately	moderate	Localised	Induced	8	Moderate
3	Displacement of tenants due to increased rentals arising from	Operational	May occur	Long term	Near future	Moderate	Localised	Induced/cumulative	9	Moderate

	improved water supply services									
6	Storage, handling and use of disinfection chemicals in water treatment facilities	Operation	Possible	Long term	Near future	Severe	Localised	Direct	11	Moderate
NEGATIVE ENVIRONMENTALIMPACTS										
1	Reduction in ground water due to increased abstraction	Operation	Possible	Long term	Near future	Very severe	Study area	Direct	15	Very Significant

Table 21 Summary of category and significance of impacts specific to the sanitation project

Item	Potential Impact	Phase	Likelihood of Occurrence	Effect					Total Score	Overall Impact Rating
				Duration	**Timing**	**Severity/ benefit**	**Extent**	**Nature**		
POSITIVE SOCIOECONOMIC IMPACTS										
1	Improved access to sanitation facilities by the travelling public and truckers	Operational	Certain	Long term	Near future	Very beneficial	International	Direct	15	Very Significant
2	Improved quality of life for the travelling public due to improved sanitation	Operational	Certain	Long term	Near future	Very beneficial	International	Direct/cumulative	15	Very Significant
3	Improved productivity due to anticipated disease burden reduction arising from provision of sanitation services	Operational	Possible	Long term	Near future	Very beneficial	Study area	Direct/cumulative	14	Significant
POSITIVE ENVIRONMENTAL IMPACTS										
1	Improved	Operational	Certain	Long	Near future	Very	Localised	Direct/cumulative	15	Very

	environmental aesthetics (i.e. odours and sight) due to reduced indiscriminate defeacation			term		beneficial				Significant
2	Reduced excreta related contamination from indiscriminate defeacation	Operational	Certain	Long term	Near future	Very beneficial	Localised	Direct/cumulative	15	Very Significant
NEGATIVE SOCIOECONOMIC IMPACTS										
1	Nuisance and public health hazards from overflows from the septic tank	Operational	May occur	Long term	Near future	Severe	Localised	Induced	12	Significant
NEGATIVE ENVIRONMENTALIMPACTS										
1	Soil contamination from sludge spillages during transportation and inappropriate disposal	Operational	May occur	Long term	Near future	Severe	Localised	Direct/cumulative	11	Moderate
2	Contamination of water resources from	Operational	May occur	Long term	Near future	Severe	Localised	Direct/cumulative	11	Moderate

	inappropriate sludge storage, transportation and disposal									

The Environmental Management Plan

Introduction

This section presents the proposed Environmental Management Plans (EMPs) which have been formulated based on impacts predicted above. The EMP is intended provide a link between the impacts predicted, proposed mitigation measures and the proposed framework for their implementation.

Framework for oversight and implementation of the EMPs

In this project, key stakeholders in the environmental management activities include the project proponent which is the MLGH, Eastern Water and sewerage Company Limited (EWSC), the consultants (COWI), contractor(s) yet to be engaged, the Zambia Environmental Management Agency (ZEMA), NWASCO, Chipata Municipal Council (CMC), National Heritage Conservation Commission (NHCC), Zambia Bureau of Standards (ZABS), Mines Safety Agency (MSA), Energy Regulation Board (ERB), RTSA, Labour Office, the general public and communities and institutions within the project area which in this case is the Mwami Border Community. The MLGH through EWSC will assume the overall responsibility for the implementation of the management plans in all phases of the project (Design, construction and operation). However, in the construction phase, implementation of most measures will be done by the contractor through the appointed site engineer (CSE). During this phase, the consultants will assume a supervisory role over the contractor(s) to ensure adherence to the proposed management plans and shall be answerable to MLGH. The consultant shall make checks, from time to time, on the contractor(s) to make sure that the contractor is complying with the stipulations of the EMPs. The contractor will be required to make monthly reports on the implementation of the proposed activities in the EMPs. Implementation of the proposed measures in the plans for activities that will be occurring during the operation phase shall be a responsibility of MLGH through EWSC.

Environmental and Social Management Plan

For sustainability of the biophysical, socio-economic environments and the project itself, the impacts identified must be managed responsibly and effectively. To this effect, MLGH, with the assistance of other relevant stakeholders, will need to implement an EMPs to address the identified impacts on the biophysical and socio-economic environment. The EMPs are presented in **Tables 22, 23 and 24** which summarise proposed measures for common impacts, impacts specific to the water supply project and impacts specific to the sanitation projects respectively.

For all tables, under the heading Time Frame, the terms “Ongoing” and “As required” have been used. “Ongoing” means throughout the project phase and applies to impacts that are continuous. “As required” applies to impacts with no definite time of occurrence but are expected to occur several times during the

project phase. It should be noted that no definite time has been proposed in the EMPs as the project implementation dates have not yet been confirmed as the project is still in its preliminary stages.

Table 22 Environmental Management Plans for impacts common to both projects

Environ Impacted on	Specific Potential Impact	Objective(S) For Addressing Impact	Mitigation/Enhancement	Responsible Entity	Time Frame	Cost (GB £) Per Annum
Socio-economic	Employment opportunities	To maximise on benefits from employment opportunities	Ensure locals are considered as priority and only outsourcing where labour is not locally available.	CSE/Consultant	As required	3000
			Women and the vulnerable groups like widows should be given preference.	CSE/Consultant	As required	
			Where possible, project materials to be sourced locally	CSE/Consultant	As required	
	Increased revenue base for the water utility (EWSC)	To maximise on benefits resulting from increased revenue	Ensure efficient management of the systems	EWSC	On-going	Part of EWSC's operational costs
			Implement WDM measures to reduce on NRW	EWSC	On-going	
	Destruction of fields either temporarily or permanently	To avoid destruction of fields and minimise impacts where unavoidable	Works to be scheduled in the dry season	CSE/Consultant	Pre-Construction	Design costs
			Avoid siting infrastructure in areas reserved for farming activities	Consultant	Pre-Construction	
			Ensure adequate compensation to all people whose fields/crops will be affected	EWSC/MLGH	As Required-Construction	Cost for RAP

					Phase	
	Impacts associated with worker campsite	To minimise/eliminate impacts associated with campsites	Structures to be constructed only of standard material	CSE/Consultant	Pre-Construction phase	5,000
			Locating camps in approved areas which minimize disruption to local population and water courses	CSE/Consultant	Pre-Construction phase	
	Impacts associated with worker campsite cont'	To minimise/eliminate impacts associated with campsites cont'	Provision of adequate drainage facilities	CSE	Pre-Construction phase	
			Provision of adequate on-site excreta treatment and solid waste disposal facilities	CSE/Consultant	As required in Construction phase	
			Ensuring that camp areas are dismantled and rehabilitated at the completion of construction works	CSE/Consultant	Post-construction phase	
	Temporary disruption of pedestrian and traffic movement	To avoid/minimise disruption of pedestrian and traffic movement	Public to be informed through media about planned activities and how they (the activities) will affect movement	CMC/CSE	As required in the construction phase	4,200
			Ensuring adequate space is left for safe passage of both pedestrians and	CSE	As required during the	

			vehicles		construction phase	
			If pipe has to cross the road, considered trenching in segments to avoid total closure of the road.	CSE	As required in the construction phase	
			Ensure provision of adequate safe crossing points for vehicles and people for access to properties	CSE	As required in the construction phase	
	Temporary disruption of pedestrian and traffic movement cont'	To avoid/minimise disruption of pedestrian and traffic movement cont'	Scheduling of works on busy roads (like the Malawi road) during off peak periods	CSE	As required-construction phase	5,200
			Plan advance arrangements of detour routes where roads are to be completely closed off.	CSE/CMC	As required-construction phase	
			Sensitize the workforce on the illegality of child labour	CSE/ Labour Office/NGOs	construction phase	
			Obtaining up-to-date information on the locations of services that can be	CSE	As required-construction	

			disturbed or damaged when works are being implemented		phase	
			Exercising care not to damage or disrupt these services	CSE	As required-construction phase	
			Liaison between contractor and stakeholder where services are disrupted so that adequate measures to cushion the impact are put in place	CSE/Service providers	As required-construction phase	
			Informing customers of impending disruptions through media	CSE/Service providers	As required-construction phase	
			Adequate liaison between contractor and service providers, to ensure that such disruptions are for the shortest possible time	Service providers	As required-construction phase	
	Disruption and/or destruction of sites having archaeological or historical values	To prevent destruction of sites and artefacts with significant archaeological or historical value	Works to be stopped and an officer from the NHCC contacted immediately if deposits/artefacts are found	CSE/NHCC	As required-construction phase	1,000
	Spread of sexually transmitted disease by migrant workforce	To prevent/minimise transmission of sexually transmitted diseases	Sensitizing and educating the workforce	CSE/MLGH/NGOs	Ongoing-construction phase	16,000

			Give preference to locals when employing to minimise on migrant workers	CSE/Consultant	Ongoing-construction phase	
			Organising HIV and AIDS sensitisation meetings for the workers at the sites	CSE /NGOs	Ongoing - construction phase	
			Distribution of literature on HIV/AIDS to the workers	CSE / NGOs	Ongoing - construction phase	
			Making condoms available at camp sites	CSE /NGOs	Ongoing - construction phase	
	Noise and vibrations arising from construction activities	To safeguard workers and neighbouring communities from hazards associated with high noise levels	Using noise control devices, such as temporary noise barriers and deflectors for impact and blasting activities, and exhaust muffling devices for combustion engines	CSE	Ongoing - construction phase	10,500
			Having a routine maintenance program in place for construction vehicles and equipment to ensure they are all in good working condition	CSE	Ongoing - construction phase	
			Confining all noisy activities that are to be carried out near communities to	CSE	As required-construction	

			day time hours		phase	
			Early notification to those affected	CSE	As required-construction phase	
	Noise and vibrations arising from construction activities cont'	To safeguard workers and neighbouring communities from hazards associated with high noise levels cont'	Provision of adequate PPE to all workers involved noisy works	CSE	As required-construction phase	
			Ensuring that all equipment and machinery to be imported adhere to international and/or ZABS regulatory guidelines on noisy levels	Contractor	As required	
	Risks arising from blasting activities	To protect workers and communities from hazards associated with blasting	Accounting for all the explosives in transit, its possession or storage for enhanced safe usage and custody	CSE/MSA	As required-construction phase	7,500
			Conducting blasting operations between sunrise and sunset	CSE/MSA	As required-construction phase	
			All personnel to execute blasting activities will have to be adequately qualified	CSE/MSA	As required-construction phase	
			Surrounding communities to be	CSE	As required-	

			adequately warned about impending blasting activities		construction phase	
			Charging holes to be blasted within a reasonable time before blasting	CSE/MSA	As required-construction phase	
			All blasting works to be adequately reviewed and inspected before and after blasting	CSE/MSA	As required-construction phase	
	Injury or/and loss of life	To prevent site accidents arising from construction traffic	Adopt best transport safety practices across all aspects of project operations	CSE	Ongoing - construction phase	9,000
			Emphasize safety aspects among drivers	CSE	Ongoing - construction phase	
			Improve driving skills and require licensing of drivers	CSE	As required-construction phase	
			Adopt limits for trip duration and arrange driver rosters to avoid fatigue	CSE	Ongoing - construction phase	
			Avoid dangerous routes and times of day to reduce the risk of accidents	CSE	Ongoing - construction	

					phase	
			Use of speed control devices, establishment of speed limits and provision of adequate and proper signage on site	Contractor-Site Engineer	Ongoing - construction phase	
			Regular maintenance of vehicles	CSE	As required-construction phase	
			Regular maintenance of vehicles and use of manufacturer approved parts	CSE	As required-construction phase	
	Danger of people and traffic falling into excavated trenches	To prevent people and traffic from falling into excavated trenches	All works that require trenching in busy areas to be carried out in the shortest possible time	CSE	As required-construction phase	1,700
			All open trenches to be clearly marked with danger signs	CSE	As required-construction phase	
	Danger of people and traffic falling into excavated trenches cont'	To prevent people and traffic from falling into excavated trenches cont'	Where trenches are to be left open for extended periods they should be marked with tape and where possible fenced off	CSE	As required-construction phase	
	Danger of excavation related accidents like	To prevent trench collapse related accidents	Where possible, deep trenching to be avoided	Consultant	Pre-construction	3,000

	trench collapse				phase	
			Deep trenching to be restricted to the dry season	CSE/Consultant	As required-construction phase	
			During excavation of deep trenches, appropriate safety measures like trench stabilisation to be put in place	CSE/Consultant	As required-construction phase	
	Danger arising from use of access equipment such as ladders and scaffolds	To prevent accidents due to falling from heights	Provision of adequate safety attire	CSE	As required-construction phase	3,000
			Provision of fall arrest systems like full body harness, an interconnecting sub system or component designed to arrest a fall from height and a suitable anchorage etc.	CSE	As required-construction phase	
	Traffic safety	To prevent accidents arising from construction vehicles and machinery	Employing measures under Occupational health and safety below	CSE	As required-construction phase	1,600
			Regulating speed by ensuring that speed limits are set and proper road signage is provided	CSE	As required-construction phase	
	Occupation Health and safety	Prevention and control of over-exertion, and	Training workers in lifting and materials handling techniques and	CSE	Ongoing - Construction	4,000

		ergonomic injuries and illnesses	placement of weight		phase	
			Planning work site layout to minimize the need for manual transfer of heavy loads	CSE	Ongoing - Construction phase	
			Selecting tools and designing work stations that reduce force requirements and holding times, having user adjustable work stations	CSE	Ongoing - Construction phase	
			Implementing administrative controls into work processes e.g., job rotations and rest or stretch breaks	CSE	Ongoing - Construction phase	
		Prevention of slips and falls from, or on, the same elevation	Implementing good house-keeping practices e.g., sorting and placing of loose construction materials in established areas away from foot paths	CSE	Ongoing - Construction phase	5,000
			Cleaning up excessive waste debris and liquid spills regularly	CSE	Ongoing - Construction phase	
			Locating electrical cords and ropes in common areas and marked corridors	CSE	Ongoing-construction phase	
			Using of slip retardant footwear	CSE	Ongoing-	

					construction phase	
	Occupation Health and safety cont'	Prevention of slips and falls from, or on, the same elevation	Implementing fall protection e.g., training and use of temporary fall prevention devices, such as rails or other barriers, personal fall arrest systems, control zones and safety monitoring systems to warn workers	CSE	Ongoing-construction phase	
		Prevention and control of being struck by objects	Using a designated and restricted waste drop or discharge zones, and/or a chute for safe movement of wastes from upper to lower levels	CSE	Ongoing-construction phase	7,000
			Conducting sawing, cutting, grinding, sanding, chipping or chiselling with proper guards and anchoring	CSE	Ongoing-construction phase	
			Maintaining clear traffic ways	CSE	Ongoing-construction phase	
			Using temporary fall protection measures in scaffolds and out edges of elevated work surfaces	CSE	Ongoing-construction phase	
			Evacuating work areas during blasting, & using blast mats or other	CSE	Ongoing-construction	

			means of deflection to minimize fly rock, use of micro blasting techniques or chemical splitting		phase	
			Wearing appropriate PPE e.g., safety glasses with side shields, face shields, hard hats, and safety shoes	CSE	Ongoing-construction phase	
	Occupation Health and safety cont'	Prevention of dust	Implementing dust suppression techniques	CSE	Ongoing-construction phase	1,000
			PPE, (i.e. dusk masks), to be used where dust levels are excessive	CSE	Ongoing-construction phase	
		Prevention and control of accidents due to vehicle traffic and use of lifting equipment on worksites	Planning and segregating the location of vehicle traffic, machine operation, and walking areas, using of one-way traffic routes, establishment of speed limits, and on-site trained flag-people wearing high-visibility vests or outer clothing covering	CSE	Ongoing-construction phase	2,000
			Using of high visibility vests by personnel when working in or walking through heavy equipment operating areas, and training of workers to	CSE	Ongoing-construction phase	

			verify eye contact with equipment operators before approaching the operating vehicle			
			Ensuring moving equipment is outfitted with audible back-up alarms	CSE	Ongoing-construction phase	
			Using inspected and well-maintained lifting devices that are appropriate for the load and securing loads when lifting them to higher job-site elevations.	CSE	Ongoing-construction phase	
	Occupation Health and safety cont'	Prevention of hazards related to confined spaces and excavations	Controlling site-specific factors which may contribute to excavation slope instability e.g., excavation dewatering, side-walls support, and slope gradient adjustments that eliminate or minimize the risk of collapse, entrapment, or drowning	CSE	Ongoing-construction phase	3,000
			Providing safe means of access and egress from excavations like graded slopes, graded access route, or stairs and ladders	CSE	Ongoing-construction phase	
			Avoiding the operation of combustion	CSE	Ongoing-	

			equipment for prolonged periods inside excavations areas where other workers are required to enter unless the area is actively ventilated		construction phase	
	Community health and safety	To protect surrounding communities from general site hazards	Restricting access to the site, through a combination of institutional and administrative controls including fencing and signage	CSE	As required-construction phase	3,200
			Removing hazardous conditions on construction sites that cannot be controlled affectively with site access restrictions	Contractor-Site Engineer	As required-construction phase	
	Explosion and fire from fuel storage	To prevent explosion and fire from the use, storage and handling of fuel	Preventing uncontrolled releases of hazardous materials to the environment or uncontrolled reactions that might result in fire or explosion	CSE	Ongoing - construction phase	2,000
	Explosion and fire from fuel storage cont'	To prevent explosion and fire from the use, storage and handling of fuel cont'	Using engineering controls (containment, automatic alarms, and shut-off systems)	CSE	Ongoing - construction phase	4,700
			Implementing management controls (procedures, inspections, communications, training, and drills)	CSE	Ongoing - construction phase	
Environmental	Soil compaction from	To avoid/minimise soil	Restrict heavy construction vehicles	CSE	Ongoing-	1,000

	construction vehicles and equipment	compaction resulting from construction vehicles and machinery	and equipment to prescribed routes		construction phase	
	Soil erosion from clearing of vegetation and movement of soil	To minimize soil erosion	Restrict all works involving soil loosening and movement to the dry season or periods of dry spell	CSE	As required-construction phase	6,400
			Prompt re-vegetation of all areas de-vegetated	CSE	As required-construction phase	
			Reduce or prevent off-site sediment transport by modifying or suspending activities during periods of extreme rainfall and high winds	CSE	As required-construction phase	
			Provide effective, sediment and subsidence control and implementing short term measures for slope stabilization during construction	CSE	As required-construction phase	
	Contamination of soils by petroleum products	To prevent contamination of the soil from petroleum products	Provide adequate and secure containment for petroleum products;	CSE / ERB	Ongoing - construction phase	11,500
			Use impervious surfaces for refuelling and other fluid transfer areas	CSE / ERB	Ongoing - construction phase	

Environmental	Contamination of soils by petroleum products cont'	To prevent contamination of the soil from petroleum products cont'	Train workers on correct transfer and handling of fuels and the response to spills	CSE	Ongoing - construction phase	
			Provide portable spill containment and cleanup equipment and chemicals	CSE	At inception	
			Use certified tankers to deliver fuel to storage facilities according to the Petroleum Act Cap 424	CSE / ERB	Ongoing - construction phase	
			Use approved dispensing equipment to minimize chances of spillages	CSE / ERB	Ongoing - construction phase	
			Maintain construction equipment adequately to minimize/eliminate chances of spillages/leakages	CSE	As required- construction phase	
	Land degradation from disposal of waste	To prevent land degradation due to inappropriate disposal of solid waste	Establish waste management priorities at the outset of activities based on an understanding of EHS risks and impacts and considering waste generation and its consequences	CSE /ZEMA	In the pre-construction phase	2,000
			Establish a waste management hierarchy that considers prevention,	CSE /ZEMA	In the pre-construction	

			reduction, reuse, recovery, recycling, removal and disposal according to ZEMA guidelines		phase	
	Mixing of topsoil with subsoil during excavations and back filling thereby reversing the soil profile	To avoid reversing the soil profile	Where required, soil clearing to be limited to a maximum depth of 300mm.	CSE	As required-construction phase	1,700
Environmental	Mixing of topsoil with subsoil during excavations and back filling thereby reversing the soil profile cont'	To avoid reversing the soil profile cont'	Where clearing is accompanied by trenching, the excavated material to be placed strategically so that during backfilling, the original soil profile is retained	CSE	As required-construction phase	
	Increased dust and air pollution	To minimise air pollution due to particulate dust and exhaust fumes	Minimize dust from material handling sources, such as haulage trucks, conveyors and bins by using covers and/or control equipment	CSE	As required-construction phase	6,600
			Minimize dust from open area sources, including storage piles, by using control measures such as installing enclosures and covers, and increasing the moisture content	CSE	As required-construction phase	
			Implement dust suppression	CSE	As required-	

			techniques, to minimize dust from vehicle movements		construction phase	
			Implement practices that reduce both the risk of accidents and fuel consumption (i.e., measured acceleration, driving within safe speed limits)	CSE	As required-construction phase	
			Manage emissions from mobile sources by use of cleaner fuels or technologies, implementing the manufacturer recommended engine maintenance programs; drivers complying to safe driving practices that reduce both the risk of accidents and fuel consumption, including measured acceleration	CSE	As required-construction phase	
Environmental	Increased dust and air pollution cont'	To minimise air pollution due to particulate dust and exhaust fumes cont'	installation of an ozone-destroying device at the exhaust of the ozone-reactor (e.g., catalytic oxidation, thermal oxidation, or GAC)	CSE	As required-construction phase	
	Contamination of ground/surface water from petroleum products	To prevent pollution of water resources from spills and leakages of petroleum	Institute a proper and effective maintenance program of equipment	CSE	As required-construction phase	2,800

		products	Application of oil absorbing substances on affected sites to avoid spillage being carried into water bodies	CSE	As required-construction phase	
	Destruction of vegetation due to construction activities	To minimise destruction of vegetation due to construction activities	Route of pipelines and siting of infrastructure to avoid wooded areas	CSE	As required-construction phase	3,700
			Routes for construction vehicles to avoid wooded areas	CSE	As required-construction phase	

Table 23 Environmental Management Plans for impacts specific to the water supply project

Environ Impacted on	Specific Potential Impact	Objective(S) For Addressing Impact	Mitigation/Enhancement Measure	Responsible Entity	Time Frame	Cost (GB £) Per Annum
Socio-economic	Improved water supply to the project area	To ensure sustained improved water supply in the project area	Implement measures for adequate and efficient management of the infrastructure to ensure sustainability	EWSC	Ongoing-operation phase	Operational costs for EWSC
	Change in quality of life and increase in self-esteem in communities due to improved services	To ensure sustained improvement in people's quality of life associated with improved service provision	Implement measures for adequate and efficient management of the infrastructure to ensure sustainability	EWSC	Ongoing-operation phase	Operational costs for EWSC
	Improved quality of life due to associated health benefits from water availability like changes in personal hygiene	To ensure enhanced quality of life due to health benefits associated with water supply is sustained	Implement measures for adequate and efficient management of the infrastructure to ensure sustainability	EWSC	Ongoing-operation phase	Operational costs for EWSC
	Increased property values due to improved water supply services	To ensure improved property values are sustained	Implement measures for adequate and efficient management of the infrastructure to ensure	EWSC	Ongoing-operation phase	Operational costs for EWSC

			sustainability			
	Potential for industrial growth in the district due to availability of water	Ensure water supply is not a hindrance to industrial growth of the area	Implement measures for adequate and efficient management of the infrastructure to ensure sustainability	EWSC	Ongoing-operation phase	Operational costs for EWSC
	Displacement and relocation	To alleviate deterioration of living standards among people who may be affected	Design to avoid displacing structure	Consultants	In Pre-construction phase	8,600
	Displacement and relocation cont'	To alleviate deterioration of living standards among people who may be affected cont'	Early notification to all those to be affected and discuss in advance measures for restitution	MLGH/EWSC	In Pre-construction phase	
			Compensation of all affected people	MLGH/EWSC	In Pre-construction phase	
	Temporary displacement of people and disruption of business to pave way for construction works	To minimise disturbances to residents and avoid disturbing business activities during construction	Where possible, works to be carried out in short sections to reduce on the number of people affected at any one particular time	CSE	As required-Construction phase	4,500
			Works to be executed in the	CSE	As required-	

	of water supply infrastructure		shortest time possible		Construction phase	
			Synchronize the construction works for the Water Supply Project with those for the Sanitation Project to avoid disturbing the same people twice where the two coincide	CSE	As required-Construction phase	
			To the extent practical, all those who will be negatively affected as a result of project activities to be compensated for loss of income in line with government stipulations	MLGH/EWSC	In Pre-construction phase	
	Displacement of tenants due to increased rentals arising from improved water supply services	To minimise displacement of tenants which may be due to high water tariffs	Water tariffs to be in line with NWASCO's recommendations	NWASCO/EWSC	On-going-operation phase	-
	Storage, handling and use of disinfection chemicals (Chlorine) in water treatment facilities	To reduce/avoid hazards associated with chlorine handling	For systems that use gas chlorination - Install alarm and safety systems that are automatically activated	EWSC	On-going-operation phase	Operational costs for EWSC

			when a chlorine release is detected - Install containment and scrubber systems to capture and neutralize chlorine should a leak occur			
			Use corrosion-resistant piping, valves, metering equipment, and any other equipment coming in contact with gaseous or liquid chlorine, and keep this equipment free from contaminants, including oil and grease	Consultant/CSE/EWSC	Construction phase and as required in operation phase	Operational costs for EWSC
			Store chlorine away from all sources of organic chemicals, and protect from sunlight, moisture, and high temperatures	EWSC	On-going-operation phase	Operational costs for EWSC
			Store sodium hypochlorite in cool, dry, and dark conditions for no more than one month, and use equipment constructed of corrosion-resistant materials	EWSC	On-going-operation phase	Operational costs for EWSC

	Storage, handling and use of disinfection chemicals (Chlorine) in water treatment facilities cont'	To reduce/avoid hazards associated with chlorine handling cont'	Store calcium hypochlorite away from any organic materials and protect from moisture; fully empty or re-seal shipping containers to exclude moisture. Calcium hypochlorite not to be stored for more than one year	EWSC	On-going-operation phase	Operational costs for EWSC
			Isolate ammonia storage and feed areas from chlorine and hypochlorite storage and feed areas	Consultant/CSE/EWSC	Construction phase and as required in operation phase	Operational costs for EWSC
			Minimize the amount of chlorination chemicals stored on site while maintaining a sufficient inventory to cover intermittent disruptions in supply	EWSC	On-going-operation phase	Operational costs for EWSC
			Develop and implement a plan for responding to accidental releases	EWSC	As required-operation phase	Operational costs for EWSC
Environmental	Reduction in ground water due to increased	To minimise over abstraction of ground	Implement Water Demand Management (WDM) Measures	EWSC	On-going-operation	Operational costs for

	abstraction	water			phase	EWSC

Table 24 Environmental Management Plans for impacts specific to the sanitation project

Environment Impacted On	Specific Potential Impact	Objective(s) For Addressing Impact	Mitigation/Enhancement Measure	Responsible Entity	Time Frame	Cost (GB £) Per Annum
Socio-economic	Improved access to sanitation facilities by the travelling public and truckers	To ensure sustained access to sanitation facilities by the travelling public and truckers	Implement measures for adequate and efficient management of the infrastructure to ensure sustainability	EWSC	Ongoing-operation phase	Operational costs for EWSC
	Improved quality of life for the travelling public due to improved sanitation	To ensure sustained improved quality of life by travellers at the border in terms of access to sanitation	Implement measures for adequate and efficient management of the infrastructure to ensure sustainability	EWSC	Ongoing-operation phase	Operational costs for EWSC
	Improved productivity due to anticipated disease burden reduction arising from provision of sanitation services	To ensure continued enhanced productivity due to disease burden reduction	Implement measures for adequate and efficient management of the infrastructure to ensure sustainability	EWSC	Ongoing-operation phase	Operational costs for EWSC
	Nuisance and public health hazards from overflows from the septic tank	To avoid/minimise the nuisance and hazards associated with septic tank overflows	Ensure timely desludging of the septic tank	EWSC	Ongoing-operation phase	Operational costs for EWSC
			Devise a quick response plan to attend	EWSC	Ongoing-	Operational

			to problems with the conveyance and treatment systems		operation phase	costs for EWSC
Environmental	Improved environmental aesthetics (i.e. odours and sight) due to reduced indiscriminate defaecation	To perpetuate the improved environmental aesthetics	Ensure sustainable management of the infrastructure	EWSC	Ongoing-operation phase	Operational costs for EWSC
			Ensure facilities are always clean to avoid unsanitary conditions that can discourage users	EWSC	Ongoing-operation phase	Operational costs for EWSC
ENVIRON IMPACTED ON.	**SPECIFIC POTENTIAL IMPACT**	**OBJECTIVE(S) FOR ADDRESSING IMPACT**	**MITIGATION/ENHANCEMENT MEASURE**	**RESPONSI-BLE ENTITY**	**TIME FRAME**	**COST (GB £) PER ANNUM**
Environmental	Reduced excreta related contamination from indiscriminate defaecation	To ensure perpetuation of reduced excreta related contamination due to indiscriminate defaecation	Ensure sustainable management of the infrastructure	EWSC	Ongoing-operation phase	Operational costs for EWSC
			Ensure facilities are always clean to avoid unsanitary conditions that can discourage users	EWSC	Ongoing-operation phase	Operational costs for EWSC
	Soil contamination from sludge spillages during transportation	To prevent contamination of soil due to septic tank spillages during	Ensure usage of appropriate desludging facilities (e.g. use of certified desludging tankers	EWSC	As required-operation phase	Operational costs for EWSC

	and inappropriate disposal	transportation	Disposal of the sludge to ensure adequate treatment (e.g. discharge into anaerobic ponds for stabilization	EWSC	As required-operation phase	Operational costs for EWSC
	Contamination of water resources from inappropriate sludge storage, transportation and disposal		Ensure sludge storage, transportation and disposal is in a manner that does not favour pollution of water resources	EWSC	As required-operation phase	Operational costs for EWSC
			Dispose all sludge in line with ZEMA recommendations for handling of waste	EWSC	As required-operation phase	Operational costs for EWSC
			Unless the quality has been ascertained, assume that sludge is hazardous	EWSC	As required-operation phase	Operational costs for EWSC

Risk Assessment

A detailed assessment of the risks for the Mwami border water supply and sanitation project was undertaken to assess the potential risks that could inhibit project implementation. The assessment has been effected from two particular fronts, namely, inherent risks and external risks which are out of the project team's control. The risks are categorised under technical, operations and maintenance, socio-economic, environmental, political and financial.

Table 25 Risk Assessment Matrix

Risk	Extent of control over the risk identified	Risk Assessment		Summary risk mitigation strategies
		Probability	Impact	
• Technical				
• A lack of understanding of the requirements of the project	CRIDF has fully consulted all the key stakeholders on all ambiguous and potentially contentious issues	Low	High. Increased costs and inadequate service	• Involvement and consulting of all key stakeholders at all stages of the project formulation process. • Recognition of the roles and responsibilities of each stakeholder in the process
• Varying the scope and or project objectives	CRIDF has closely collaborated with all the Stakeholders.	Low	High. Increased costs, delays and reduced service levels.	• Clearly outline the objectives, scope and expected outputs and outcomes to all the stakeholders some of whom communicate the same to the beneficiaries.
• Groundwater availability (or	CRIDF has consulted	Low	High. Can lead to	• Water affairs to avail findings of

Risk	Extent of control over the risk identified	Risk Assessment		Summary risk mitigation strategies
		Probability	Impact	
scarcity)	Department of Water Affairs with regard to ground water yields within the project area of MWAMI		increase in costs and delays	groundwater study conducted for the area
• Groundwater contamination	EWSC to acquire title to land where the boreholes are to be located	High	High. Can compromise the entire water supply installation	• No housing or commercial developments within the protected area • No indiscriminate dumping of household and industrial waste within or in close proximity to the protected area • Conduct awareness campaigns for all stakeholder groups
• Unregulated consumption and wastage of water	The designs for the installations have incorporated mechanisms that deter wastage and unregulated use.	High	High. Can render the entire installation to be unviable and ultimately unsustainable	• Install meters at all water access points • Specify proven good quality fittings that are not easily susceptible to wear and tear • Institute a well refined preventive maintenance programme that

Risk	Extent of control over the risk identified	Risk Assessment		Summary risk mitigation strategies
		Probability	Impact	
				includes a public awareness campaign on the scourges of vandalism, adverse effects of using poor fixtures and optimal use of water
• Denial of construction permits	Planning permission will be sought through EWSC and their shareholder Chipata Council who have jurisdiction over MWAMI. A drilling permit will be sought from WRMA if they institute these measures before commencement of the project	Low	High. Project would not proceed	• Involvement of EWSC during the design process • Adherence to national standards and specifications
• Operation and Maintenance	EWSC have a running operations unit that currently maintains network infrastructure for it's operations in all the	Low	Low. EWSC has demonstrable experience in operating and maintaining	Augment existing operations and maintenance activities of EWSC through this project

Risk	Extent of control over the risk identified	Risk Assessment		Summary risk mitigation strategies
		Probability	Impact	
	towns in Eastern Province		much larger operations than that required at MWAMI	
• Socio-economic				
• Affordability and willingness to pay • Sustainability	The proposed water access options include the kiosk based system and individual household connection which cater for all income groups CRIDF has fostered a sense of ownership from inception by involving all the stakeholders in the project development process especially	Medium Low	High. Adequate quantities to be accessed by all consumers depend on affordability which is greatly influenced by the technological option selected High	• Kiosk access points where tariff will be regulated by NWASCO • Stakeholder meetings have confirmed willingness by community to receive this service in light of the existing situation where supply is erratic • Continued involvement of the stakeholders at all the key stages

Risk	Extent of control over the risk identified	Risk Assessment		Summary risk mitigation strategies
		Probability	Impact	
	EWSC and the Community			
• Environmental	Groundwater source pollution	Medium	High	• Full involvement of the planning authority as a key stakeholder from the onset which shall assure land use practices that will not negatively impact or contaminate the aquifers • Ensure that all plans are in compliance with the Zambia Environmental Management Authority regulations
• Political				
	CRIDF has engaged the Ministry of Local Government and Housing from the onset and has had high level meetings with the Director	High	High	• Regular briefings to Ministry through EWSC • Project objectives to be in compliance with sectoral national policies
• Financial	CRIDF will mobilise the required resources in full collaboration with	High	High	• Constant and regular updates to MLGH and EWSC • Adoption of designs

Risk	Extent of control over the risk identified	Risk Assessment		Summary risk mitigation strategies
		Probability	Impact	
	EWSC and MLGH			that are cost effective and give highest value for money

Summary

This Environmental screening objectively assessed and evaluated impacts that may arise as a consequence of implementing the proposed project by MLGH/EWSC in Chipata at Mwami Border. In-depth analysis of the project and anticipated impacts revealed the following key findings:

1. Proposed projects will mainly be located in an already developed residential areas;
2. Due to the openness of the areas, it is unlikely that the projects will trigger involuntary displacement;
3. Most of the anticipated negative impacts are confined to the construction phase and all of them will be adequately mitigated; and
4. Implementation of the projects will result in very significant socioeconomic and environmental benefits to both the residents and the travelling public including truckers.

Based on the level of detail and depth of the study, all envisaged negative environmental and socio-economic impacts have been fully addressed

Financial and Economic Assessment

Introduction

This section of the report outlines the financial and economic assessment, which forms an input to the feasibility study of the Mwami project. The tool used to determine financial and economic feasibility is the Cost-Benefit Analysis (CBA). CBA is a framework for appraising the viability of capital projects by weighing up financial flows, as well as the explicit and implicit positive and negative socio-economic impacts of the investment. As such, the use of the project CBA is to provide an evidence base for the commercial and social rationale of the project. The CBA is also an invaluable tool for informing and guiding project development in order for the project design to maximise both the commercial and social imperatives of the project.

Approach to the CBA

It is anticipated that a project of this nature is unlikely to attract private-sector investors due to limited returns and the associated risks; however, its broader public-good nature is likely to increase the welfare of the population significantly. CBA is a useful approach in demonstrating this as it is able to weigh up future project costs and benefits in a present value approach, thus helping to give direction to whether the project is desirable and should be implemented.

The report follows the CRIDF CBA Guidance and Template (IF03-006), and consists of the following sections – purpose and context, options appraisal, financial appraisal, economic appraisal, sustainability analysis, risk assessment and conclusions and recommendations. The first two sections serve to clarify the demand for and required scope of the infrastructure intervention and outline the preferred technical solution. These two sections are outlined in more detail in the Technical Assessment section of the Feasibility Report and are thus only briefly summarised in this section.

The main elements of this report includes the core **assumptions** to the CBA, followed by the **financial appraisal** which looks at the financial flows (expenditures and revenues) over the life of the project, to calculate the Financial Net Present Value (FNPV) of the investment, Financial Internal Rate of Return (FIRR) on the project investment, and Financial Benefit-Cost Ratio (BCR). The **economic appraisal** then assesses a wider spectrum of costs and benefits compared to the case of pure profit determination of the financial appraisal. The outcome of the quantitative economic appraisal includes the Economic Net Present Value (ENPV), Economic Rate of Return (ERR), and Economic Benefit-Cost Ratio (BCR) of the project. In addition to these quantitative indicators, a description of the qualitative economic impacts serves to inform an understanding of the expected net socio-economic impact of the project to society.

Based on the results of the financial and economic appraisals, and drawing on a broader understanding of the context, institutional arrangements, and prevailing local socio-economic conditions, a **sustainability analysis** provides an assessment of the on-going financial and economic sustainability of the project, primarily from the perspective of the affordability of the project to the local community. Lastly a high-level **risk assessment** serves to highlight the key risks to the financial and economic viability of the project and discusses associated

recommendations for risk mitigation arrangements, before final conclusions and recommendations of the CBA are put forward.

Purpose and Context

Mwami is a small border post town in Zambia. The town links Zambia with Malawi, and is an important point of transit for steel, cement, cotton, tobacco, bitumen, timber and other goods. It occupies strategic importance for both Zambia and Malawi and for trade between Eastern and Southern Africa in general. It is for these reasons that the town has been identified as a strategic focus for development in the SADC region. Mwami, however, faces severe water supply and sanitation challenges.

Currently, Mwami border post does not have a centralised water supply system. Three boreholes operated by Chipata District Council supply water to the general community, while the Zambia Revenue Authority (ZRA) operates one borehole to supply its staff, as well as other homesteads. While a few households have drilled boreholes for their own private supply, mostly the town's water supply is vastly inadequate. The town's three communal hand pumps are prone to interruption due to a lack of maintenance or drying up of the well in the winter months. With rapid growth in its resident and border patron population, securing an improved water supply and sanitation is of vital importance to the town.

While inadequate water supply results in reduced productive time for the town, with proportionally larger effects felt by women and children, inadequate levels of water can also trigger water-borne disease transmission across borders. This in turn stifles trade and other commercial activities within the sub-region and, at an extreme, may catalyse cross-border conflict. At present, trucks are often required to wait at the Mwami border post for over a day but do not have access to water supply or sanitation services[4]. To date, truckers have made use of an informal market (where truckers either use residents' toilets or pay to stay at a privately owned 'truck-inn' outside the town), or practice open defecation. These all have associated costs on the society, including health and safety concerns for local residents.

Project Objectives

The primary objective of the Mwami project is to provide adequate and safe water supply and sanitation infrastructure to the residents and transient populations of Mwami. The project is aimed at three beneficiary groups, with the appropriate infrastructure for each category. Specifically, the project has the following components:

- Water supply to local residents without household water connections through the use of four water kiosks
- Bulk water supply to houses through metered in-house connections, where these households are expected to pay for their own connection to the water mains

[4] Based on discussions held with Immigration Officials, site visit (June 2015)

- Sanitation for border patrons through an ablution facility whose primary purpose is to provide truck drivers with toilet, shower, laundry and drinking water facilities

Households without in-house water connections

Under the proposed system, households who currently get their water from communal boreholes will now be able to access water from water kiosks. Existing households do not currently pay for water from communal hand pumps; however, if a hand pump breaks they are responsible for the cost of its repair. Additionally, one of the communal hand pumps is prone to stop working in the dry winter months, and while the Lutembwe River is an alternative source of water, water quality can be poor due to livestock use. Additionally, the distance to the river is a strong deterrent of its use. The proposed system involves a per unit charge on water in line with Zambia's National Water Supply and Sanitation Council (NWASCO) tariffs with no additional Operation and Maintenance (O&M) charge attached to water. Demand for the new system is thus heavily dependent on the quality, quantity, cost and ease of access to water in the new system since an alternative currently exists. It is expected that the proposed design will provide treated water of better quality than that of the unprotected hand pumps. Additionally, the new system will allow for faster and more efficient distribution of water, thus lowering the waiting time for water. Important to note, although the existing system provides some alternative to the proposed kiosks, when the current communal hand pumps break, as happens regularly, it is unlikely that the community will pay for them to be fixed once the new proposed system is functional. Thus it has been assumed that demand will shift to the proposed scheme.

It is proposed to construct four water kiosks for the sale of water to these households. Each kiosk will be directly connected to the network, with provisions for the metering of water.

Metered households

The proposed design sees the extension of water supply and infrastructure to the town and the ability of medium and high cost houses to be connected into the water mains through individual connections. At present, housing developments in Mwami have been haphazard, with some houses build with in-house connections, while others rely on communal boreholes. At present, around 4% of existing sanitation facilities is comprised of water-borne systems. However, most of these are dysfunctional as there is no reticulated water supply in Mwami. Some high cost houses must either use pit latrines in the absence of flush toilets, or must collect water manually to be used in this system. There is acute need for water supply to the existing houses with metered water facilities, while the community has high aspirational demand for an expansion in houses with water-borne facilities.

Truck drivers (border patrons)

Border patrons, including trucks and passenger vehicles, constitute a large transitory population in Mwami. It is assumed that on average 200 people pass through Mwami per day.[5] This amounts to 73,000 border patrons annually. It is also assumed that the number of trucks will grow by 5% per year over the next 15 years in line with developments in the Nacala trade corridor and increasing trade between Zambia and the rest of SADC[6].

The sanitation facility that is proposed will provide shower, toilet, laundry and drinking water facilities. It is assumed that 80% of border patrons will use the toilet facilities, 20% will use the shower/laundry facilities, while 80% will use the facility to access drinking water[7]. Additionally, border patrons that visit the facility are conservatively assumed to only access the facility once per day.

Options Appraisal

The technical assessment of the Mwami project reviewed a number of options by which the project could be implemented. The technical options related to five components of the infrastructure design – water supply, pump infrastructure, water storage, the distribution network and sanitation intervention.

1. Water supply

Groundwater, surface water and rainwater are three possible alternatives assessed for the water supply source for the project. The project area has no surface water bodies in its immediate vicinity. The only river, located approximately two kilometres east of the site is the Lutembwe River. The flows in the Lutembwe River are, however, significantly low in the Mwami locality. This is the result of low runoff generated in the small catchment in the area surrounding the town. The surface water resources were therefore not considered as a sustainable option to meet the water supply requirements of the proposed intervention. Rainwater harvesting was also not considered a viable option for the proposed intervention due mainly to the fact that while there is adequate rainfall in the wet months, rainfall in the dry winter months is extremely limited.

Groundwater was identified as the most feasible water source. A rapid assessment of the potential of the ground water resources of the area was conducted using both historical and collected data. Technical staff from the Department of Water Affairs (DWA) were consulted on the ground water potential and availability in the area based on their previously documented experiences with boreholes in the area. While the project area is characterised by low-yielding crystalline aquifers averaging 1 litre per second, it should be possible to draw sufficient water from the operation of four boreholes to meet future water demand from the community.

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[5] Updated Technical Assessment: Mwami (2015)
[6] Nacala Road Corridor Development Project- Phase IV Country: Multinational (Malawi/ Zambia), ADF: Online http://www.afdb.org/fileadmin/uploads/afdb/Documents/Multinational__Malawi-Zambia__-_Nacala_Road_ Corridor_Development_ Project_-_Phase_IV_-_Appraisal_Report.pdf
[7] Adapted from Technical Assessment, Mwami (2015)

2. *Pump infrastructure*

Boreholes require water pumps to be able to draw the water from the ground as well as transport it along the network of pipes or to the water storage tanks. There are various types of pumps, with varying fuel inputs required. The options appraisal on the pump infrastructure focused on the fuel sources required to run the borehole pumps. The main options explored were petrol/diesel or electricity. Given the project's simple design, other fuel types such as solar powered pumps were not considered due to their capital cost and complexity.

The proposed solution makes use of electrical pumps due to the fact that there is electricity in the town already and thus it would be relatively easy to access this power source for the pumps. Additionally, electricity would be a cheaper fuel source than petrol or diesel for the proposed infrastructure. The downside of using electricity to pump water would be that the pumps would not work in the case of a power cut. This is accounted for in the design pump operating time and at least two days water use storage in the system.

3. *Water storage*

Water storage is necessary to account for variability in water demand from the population, as well as in situations where there is a breakdown with the borehole pumps or distribution system. While there are various options for water storage, such as dams or reservoirs, only water storage tanks were considered appropriate in the proposed design. This is because the design requires only a limited amount of water stored at each point in time and the water is required for drinking and needs to be kept disinfected, there the construction of a dam is inappropriate and would be an over-investment. It is proposed that a 250 m^3 brick reservoir is constructed to cater for 2 day storage requirements, based on the 2025 average water demand.[8]

4. *Distribution network*

The distribution network of pipes for Mwami consists of various sizes of PVC pipes. PVC piping is assumed to be the appropriate technical option due to the fact that they are durable (up to 100 years) as well as the fact that they are easy to install. This network has been simplified in the current design of the project in order to limit capital costs. It is proposed that high-cost households pay for their own household connections to the water supply, but that the water distribution system caters for such developments.

5. *Sanitation*

For this project only provision of a sanitation facility for the daily transitory population (border crossing population) will be provided. All households will be responsible for the provision of their own on-site disposal of wastewater, using either a septic tank or VIP (depending on water supply connection and affordability). Support for on-site sanitation systems can be provided in terms of

[8] Updated Technical Assessment: Mwami (2015)

reviewing or providing standard designs for the EWSC to provide households wishing to construct sanitation infrastructure.

The preferred technical solution recommended by the feasibility study is thus to sink four new boreholes which connect to a brick water storage tank. A simple network comprising one ring main has been developed for the project area. This will supply individual connections on application and a total of four water kiosks.

The proposed water supply component of the project includes the following infrastructure:

- The sinking and equipping four boreholes
- The supply and installation of main line to boreholes, with distribution network
- The supply and construction of a water tank together with required fittings
- The construction of four water kiosks
- The construction of a sanitation facility for cross border population.

Key CBA Assumptions

The CBA analysis is premised on a number of key input assumptions. The assumptions are drawn from the Technical Assessment, observations by the project team in the Mwami area, and peer-reviewed publications/international benchmarks. The tables below provide the detail of the assumptions that frame the CBA analysis. The details underlying these assumptions are provided in Appendix A.

Table 26 Financial assumptions

Item	Assumption
Financial Discount Rate	11.5%[9]
Exchange Rate	ZMW 1.00 = GBP 0.088[10]
O&M Costs	5% of capital costs[11]

[9] A real interest rate of 11.5% was used in the financial analysis, suggested by the AfDB in their 2013 study done on irrigation infrastructure in the Kafue sub-basin. African Development Bank (2013). Strengthening Climate Resilience In The Kafue Sub-Basin. Appraisal Report. Online: http://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Zambia_-_Strengthening_Climate_Resilience_in_the_Kafue_Sub-Marin_-_Appraisal_Report.pdf

[10] Updated Technical Assessment: Mwami (2015)

[11] The design of the project necessitates 'tap-assistants' at kiosks and staff at the sanitation facility. These are expected to increase the O&M costs of the scheme. A rate of 5% is suggested by the Swiss Resource Centre for Development (2008), as sufficient for a water supply system. See SKAT (2008). Operation and Maintenance of Rural Water Supplies. Online: www.rural-water-supply.net/_ressources/documents/default/208.pdf

Item	Assumption
Constant Versus Current Prices	All prices are given in constant 2015 terms

Source: CRIDF CBA

Table 27 Revenue generating assumptions

Item	Assumption	
Number of households	300[12]	
Household size	5.2[13]	
Population size	1,560	
Annual population growth	2.2%	
Current proportion of household types[14]	• High-cost (metered access): 30% • Low cost (metered access): 35% • Low cost (communal access): 35%[15]	
Per capita water consumption per day	• High-cost (metered access): 100l per capita/day • Low cost (metered access) and transient population: 40l per capita/day • Low cost (communal access): 25l per capita/day	
Domestic water tariffs (GBP)[16]	*Per m^3*	
	0 – 6	0.24
	6 – 20	0.40
	20 – 40	0.54

[12] Information provided by Ward Development Committee (WDC), the Water point committee and the Neighbourhood Health Committee (NHC)
[13] Census of Population National Analytical Report, Zambia. 2010
[14] Categorised according to size and facilities, as per description in the Technical Assessment: Mwami (2015)
[15] Updated Technical Assessment: Mwami (2015)
[16] Approved NWASCO Tariffs, 2015

Item	Assumption	
	50 +	0.61
	Kiosk	0.22
Ablution tariffs (GBP)[17]	Toilet (per entry)	0.44
	Shower/laundry (per entry)	0.44
	Drinking water (per 25l bucket)	0.09
Number of border patrons per day	200[18]	
Annual growth in truck traffic	5%[19]	
Non-revenue water	20%	

Source: CRIDF CBA

Table 28 Population and household projections

Item	2015	2020	2025	2030	2035
Population	1,560	1,739	1,939	2,162	2,411
High-cost (metered access)	468	522	582	649	723
Low cost (metered access)	546	609	679	757	844
Low cost (communal access)	546	609	679	757	844

Source: CRIDF CBA

[17] Based on current payments in the informal market
[18] Updated Technical Assessment: Mwami (2015)
[19]http://www.afdb.org/fileadmin/uploads/afdb/Documents/Multinational__Malawi-Zambia__-_Nacala_Road_Corridor_Development_Project_-_Phase_IV_-_Appraisal_Report.pdf

Table 29 Economic assumptions

Factor	Discount/conversion factor	
Social Discount Factors	3.5%	10%
Tradable goods	0.8	
Unskilled labour	0.65	
Skilled labour	1.00	
Non tradable goods	1.00	

Source: CRIDF CBA

The CBA is carried out within the context of a with- and without-project basis, and hence includes only incremental values for the costs and benefit inputs. This is in an effort to include only the incremental costs and benefits of the project, including variables such as time spent collecting water in the current system versus time spent in the new system. In terms of the financial appraisal, the current system does not have any formal operations and maintenance costs; although the community is responsible for the repair of the hand-pumps should they break. Hence, the O&M costs are included in their entirety. Revenues from water tariffs are also included in their entirety as reticulated households are currently not connected to a water supply. In terms of the sanitation facilities at the border, the costs and benefits are also included in their entirety as there is no such facility at present.

In the economic appraisal, incremental values are important in calculating the health and time savings. Both health and time savings are expected to increase due to the proposed project, however these benefits are unlikely to be the full health and time savings. In other words, it is unlikely that the project will result in all water-related health concerns being addressed, while there will still be some residual time spent by rural households in collecting water from kiosks. The incremental benefits will be discussed in more detail in the Economic Appraisal below.

Financial Appraisal

The purpose of the financial appraisal is to identify the financial return to the project infrastructure investment and the operational sustainability of the infrastructure. The financial appraisal is conducted from the perspective of Eastern Water and Sewerage Company (EWSC), who will be the project owner, and will be responsible for the operation and maintenance of the infrastructure. EWSC will also be the direct recipient of the water and sewerage service tariffs and charges.

The costs considered in the financial appraisal include the capital investment for the water and sanitation infrastructure, and the operation and maintenance cost for the systems. The revenue considered includes the expected water tariffs that will be charged to domestic customers and the border patrons. Assessing the

financial return of the project over its lifespan against the capital and operational costs yields a financial return to the project. The following indicators represent the key outputs of the financial appraisal:

- Financial net present value – the discounted flow of expected investment and operating costs deducted from expected return
- Financial internal rate of return – the financial return on the project. The financial rate of return should be above the cost of capital (discount rate)
- Financial net benefit cost ratio – the ratio of the present value of the returns on the project set against the project's costs.

Importantly, should the project not be financially viable on its own, the financial appraisal will set out the amount of subsidisation the project will require to make it financially viable and sustainable. The project's costs and revenues are set out below, before the financial appraisal results are outlined.

Project Costs

The total project investment for both the water supply and sanitation components of the design amounts to GBP 300,735. The majority of these costs (GBP 235,810) relates to the water supply component of the project, and the remainder accounts for the sanitation facilities. Project costs for the town are relatively high due to the low base from which the project must build. However, it is notable that the project has been redesigned twice to decrease these costs, including a substantial decrease in the distribution network of pipes. Training of ESWC has also been excluded from the final project cost, this is discussed in more detail under the section on project risks.

Table 30 Water supply capital investment requirements (GBP)

Item	Description	Amount
1	Allow for 20% Contractor's P&Gs	43,585
2	Investigation and Development of groundwater source	18,480
3	Raw water delivery system	61,409
4	Storage Reservoirs	31,334
5	Distribution Network	51,074
6	Water Kiosks	8,580
7	Sanitation facilities	47,047
8	**Subtotal Cost**	**261,509**
9	Add 15% contingencies	39,226
	TOTAL PROJECT COST	**300,735**

Source: CRIDF CBA

Annual Operation and Maintenance Costs

Operation costs for the water supply infrastructure include electricity to pump water from the boreholes, chlorine to treat the water and labour to man the kiosks and ablution block. Operation costs for the ablution block include electricity costs of running the building, cleaning materials, labour and regular desludging.[20] Applying the O&M assumptions outlined above, the annual O&M costs for both the water supply and sanitation infrastructure amounts to GBP 15,037. O&M costs are assumed to be constant across the project life span as inflation is excluded from the financial appraisal.

Revenues

Revenue streams are expected to flow from the three groups of users – households who access water from communal kiosks, metered households (both low cost and high cost households with household connections) and border patrons. The revenue analysis is based on estimations of water demand by the three usage groups and the corresponding tariffs charged per usage. Tariff rates are based on the NWASCO 2015 approved domestic block rates for the Eastern Province, and vary from low cost per unit charges at low levels

[20] Technical Assessment: Mwami (2015) suggests that desludging will be required every three years

of consumptions and then escalate to higher charges at higher levels of consumption. Mapping demand over the project's lifespan is derived from population growth figures and the evolution of consumption patterns between communal water kiosks and household connections.

The project is highly dependent on the revenue that is derived from the ablution facilities at the border post. This makes up over 70% of revenue in 2016. This is an important finding as the sanitation facilities make up a small component of the capital investment requirements. The water supply infrastructure, which forms the bulk of the capital investment, provides approximately 20% of revenue in the first year.

Table 31 Projected revenue from water tariffs (GBP)

Revenue category	2016	2020	2025	2030	2035
High-cost (metered access)	5,623	6,135	6,840	7,626	8,503
Low cost (metered access)	1,586	1,730	1,929	2,151	2,398
Low cost (communal access)	901	983	1,096	1,222	1,363
Border ablution patrons	39,340	47,818	61,029	77,891	99,410
Total	**47,450**	**56,666**	**70,894**	**88,890**	**111,647**

Source: CRIDF CBA

Estimated monthly water demand for rural households is 3.95m^3, this works out to an annual water demand for unmetered households of 4,982m^3 in 2016. Functionally, these low-cost households under the proposed system will collect their water from kiosks rather than hand pumps from unprotected shallow wells. Kiosks will consist of small buildings, manned by tap assistants, where rural households pay per 20 litre bucket of water the collect[21]. A flat tariff of GBP 0.22 per cubic meter of water supplied is applied. This tariff is set lower than tariffs for the high cost households in consideration of the affordability for these poorer households.

[21] Discussions with Dr Banda during site visit (2015)

Table 32 Expected revenue from unmetered households

Demand	Monthly household demand	Tariff rate (GBP/m^3)	2016	2020	2025	2030	2035
Households			107	117	130	146	162
Water demand (m^3)	3.95	0.22	5,092	5,555	6,193	6,905	7,699
Non-revenue water[22]		20%	20%	20%	20%	20%	20%
Total projected water tariff revenue (GBP/year)			**901**	**983**	**1,096**	**1,222**	**1,363**

Source: CRIDF CBA

There are both low costs and high cost households in Mwami which have in-house water connections. Metered low-cost households are expected to use approximately 6.33m^3 per month, with an annual demand of 7,972m^3 in 2016. Both high cost and low cost housing includes metered water tariffs and sewerage treatment charges associated with water supply and sewerage service provision.

Table 33 Expected revenue from low-cost metered households

Demand	Monthly household demand	Tariff rate (GBP/m^3)	2016	2020	2025	2030	2035
Households			107	117	130	146	162
Water demand (m^3)	6.33	0.24	7,972	8,888	9,910	11,049	12,319
Non-revenue water[23]		20%	20%	20%	20%	20%	20%
Projected water tariff revenue (GBP/year)			1,586	1,693	1,888	2,105	2,398
Sewerage charges (GBP/year)			159	173	193	215	240

[22] Technical Assessment: Mwami (2015)
[23] Technical Assessment: Mwami (2015)

Demand	Monthly household demand	Tariff rate (GBP/m^3)	2016	2020	2025	2030	2035
Total revenue			**1,745**	**1,903**	**2,122**	**2,366**	**2,638**

Source: CRIDF CBA

High cost households have a much higher monthly water demand than rural households (about 3 times more), and thus pay a higher tariff. As expected, most of the revenue is generated through the water tariffs, with the sewerage treatment and fixed costs contributing approximately 10% of the revenue generated from high cost households.

Table 34 Expected revenue from high cost households

Demand	Monthly household demand	Tariff rate (GBP/m^3)	2016	2020	2025	2030	2035
Households			92	102	114	127	139
Annual water demand (m^3)	15.82	0.40	17,458	19,046	21,235	23,676	26,397
Non-revenue water[24]		20%	20%	20%	20%	20%	20%
Total projected water tariff revenue (GBP/year)			5,623	6,135	6,840	7,626	8,503
Sewerage charges (GBP/year)			562	613	684	763	850
Total revenue			**6,186**	**6,748**	**7,524**	**8,289**	**9,353**

Source: CRIDF CBA

Border patrons are charged for the use of the facility rather than per unit of water. There are two separate charges associated with the ablution block: GBP 0.44 for use of flush toilet facilities and shower/laundry facilities and GBP 0.9 for 20 litre drinking water. Values used in the CBA are based on the current charges that truck drivers face in Mwami's informal water supply system. It is expected that a higher willingness to pay exists for these services in an efficient and formal water supply network.

[24] Technical Assessment: Mwami (2015)

The notable revenue from the border sanitation facilities is driven by the large number of border patrons per year. The high daily volume of traffic going through the border post daily, coupled with delays at the border, implies that the ablution facilities will be used by most truck drivers.

Table 35 Expected revenue from border patrons

Demand	Tariff rate (GBP/m^3)	2016	2020	2025	2030	2035
Toilet facilities	0.44	27,131	32,978	42,089	53,718	68,559
Shower and laundry facilities	0.44	6,783	8,244	10,522	13,429	17,140
Drinking water facilities	0.09	5 426	6 596	8 418	10 744	13 712
Total revenue from border patrons (GBP/yr)		**39,340**	**50,209**	**64,081**	**81,785**	**99,410**

Source: CRIDF CBA

Financial Appraisal Results

The results of the appraisal indicate that the project is financially viable: at a discount rate of 11.5% the FNPV is GBP 94,215; the FIRR (15%) is above the discount rate; and the FBCR (1.23) is above 1. These results show that the revenues generated by the project are sufficient to cover the full investment costs over the project life, but that this return will only accrue after the full 20 years of operation. This has important implications for the funding of the project, which will be discussed below under Funding Scenarios.

Table 36 Financial appraisal results

Indicator	Results (11.5% discount rate)
FNPV (GBP)	94,215
FIRR (%)	15%
FBCR	1.23
N/K Ratio	0.31

Source: CRIDF CBA

In terms of its ongoing financial sustainability, the projected operational cost-recovery of the infrastructure is positive. Net cash-flows (annual revenues less annual O&M costs) have a positive FNPV of GBP 440,369, implying that EWSC will be able to recover its yearly operational costs and make a small return. This is substantiated by the BCR of the ongoing cash-flows of 4.

However, the project is unlikely to attract commercial funding due to a return which is not sufficient to warrant taking on high levels of risk. Concessional finance (e.g. interest-free loans) paid back over the life of the project are also not feasible given the significant capital costs relative to revenues from tariff collection. The project will therefore require grant funding to proceed. However, should external financing be secure for the required initial capital investment be accessed, the project infrastructure should be operationally sustainable.

Funding Scenarios

Table 37 indicates the financial return on the project investment when external grant funding is leveraged. It is suggested that a donor funder is sought for the full capital investment of the project as the FIRR is too low to warrant private investment. While the government, or EWSC as the legislated water utility in the Eastern Province, may be willing to cover the upfront investment cost over and above the break even investment value, the quick-win nature of this project suggests that is suitable as a donor-driven project.

Additionally, if additional capital is sought from the Zambian state budget, it is expected that there will be a delay in the project's implementation. As will be argued under the Economic Appraisal section of this report, Mwami is facing a critical juncture in its development from a small rural village to a growing border town. Without improved water supply and sanitation infrastructure the town is at significant risk of serious health concerns. Being a strategic border town suggests that this risk is more acute and that the cost of a water-related health epidemic would be significantly harmful to Zambia in terms of a loss in trade, productivity and potential cross border conflict.

Table 37 Project funding scenarios

Description	FNPV (GBP)	FIRR (%)
Project alone	94,215	15%
Full grant funding	363,933	43.5%

Source: CRIDF CBA

Sensitivity Analysis

A sensitivity analysis is an important way to analyse whether the key input assumptions for the project have a material impact on its outcomes, particularly those of its overall viability. The objective is to identify the factors that have the biggest impact on the project's sustainability and returns. The sensitivity assessment looks at the main factors that could impact the project's costs, as well as the factors affecting the project's revenue generation.

The project's operational sustainability is dwarfed by the significant upfront costs, leading to a poor overall financial outlook. Increasing the upfront costs of the project by 10% sees a material impact on the project's NPV from GBP 94,215 to GBP 52,548. The associated change in the FIRR is from 15% to 13%. The increase

required in upfront investment would have to be 25% of the total cost in order to elicit a negative NPV (GBP 9,951), with an associated IRR of 11.2% and BCR of 0.98. While these results suggest that capital costs play a fundamental role in the overall financial viability of this project, a relatively large change would be required to make the project financially unviable.

While capital costs play a role in determining the overall financial viability of the project, it is also necessary to do a sensitivity analysis on the operational sustainability of the project. This is particularly the case for project's which are funded by an external source but which will need to rely on operational sustainability for their on-going success. In the case of Mwami, a sensitivity analysis was carried out on the operational flows of the proposed intervention in isolation of the capital costs.

As reflected in the tables below, changes in the O&M costs have some bearing on the BCR; however the BCR remains strongly positive with a 10% increase in the O&M costs. This is indicative of the strong revenues generated by the project which far outweigh the operational costs. On the revenue side, the project parameters have a minimal impact on the project viability, with the project's NPV and BCR remaining strongly positive. However, the project is sensitive to the number of border patrons due to the fact that much of the revenue of the project is generated through their use of the sanitation facility. A 50% decline in border traffic sees a change in the operational BCR from 4.41 to 2.58.

Table 38 Sensitivity analysis – cost parameters (GBP)

Parameter	Change	FNPV before change	FNPV after change	BCR before change	BCR after change
Increase in O&M costs	+10%	440,369	57,930	4.4	4.0
Decrease in O&M costs	-10%	440,369	47,397	4.4	4.9

Source: CRIDF CBA

Table 39 Sensitivity analysis – revenue parameters

Parameter	Change	FNPV before change	FNPV after change	BCR before change	BCR after change
Increase in number of households	+10%	440,369	450,150	4.41	4.48
Decrease in number of households	-10%	440,369	430,590	4.41	4.33
Increase in	+10%	440,369	487,553	4.41	4.77

Parameter	Change	FNPV before change	FNPV after change	BCR before change	BCR after change
border traffic					
Decrease in border traffic	-10%	440,369	393,186	4.41	4.02
Decrease in border traffic	-50%	440,369	204,450	4.41	2.58

Source: CRIDF CBA

The sensitivity analysis confirms that operational sustainability of the project is robust – with a benefit cost ratio significantly higher than four, the project is able to recover its operation and maintenance costs. When altering the key parameters in the operational viability of the project, i.e. the O&M costs and the revenue generating parameters, a change in the O&M costs has a slightly smaller impact on the operational sustainability of the project than traffic at the border post.

Economic Appraisal

The economic appraisal is conducted from the perspective of the economy as a whole and is done in order to assess to what extent the project has net positive socio-economic impacts on the population of Mwami. The economic appraisal assesses cost and benefits beyond the financial returns alone, and does so at prices equal to their real value to society rather than financial/market prices. Due to the fact that such a project is expected to have intangible benefits not captured in the financial model, such as productivity savings, the economic appraisal is key in understanding the value of these benefits.

The economic benefits of the Mwami water supply and sanitation project include impacts which that can be quantified into monetary terms as well as those which can only be captured qualitatively. The CBA aims to capture both the quantitative and qualitative benefits which stem from the project, although the economic appraisal is limited to the inclusion of the latter.

Project costs

The costs included in the economic analysis are the capital and O&M costs adjusted by appropriate conversion factors to account for market distortions, as discussed in the assumptions section. The resultant economic costs are summarised in the following tables (see **Appendix A** for a more detailed breakdown of these costs). For both the capital investment and operational costs, the economic costs are slightly lower than the financial factors after adjustments by the conversion factors.

Table 40 Economic capital investment and operational costs (GBP)

Item	Capital costs	O&M costs
Water supply and sanitation infrastructure	265,504	12,706

Source: CRIDF CBA

Quantitative benefits

Financial revenues are a poor indication of the true value of water supply and sanitation infrastructure to the town of Mwami. While they capture some of the willingness-to-pay for these water services, financial values are often moderated to account for the human right to water, incentive structures and affordability concerns. Essentially, the tariffs charged for water in Zambia do not reflect the full associated costs of providing sustainable services.

The real value of water supply and sanitation is commonly estimated through an estimation of the maximum willingness to pay (WTP) of consumers for the service rather than the market tariff. WTP includes the full benefit of water and sanitation to a consumer – in terms of health, time savings, productivity, preference of supply, etc. It is usually assessed through stated preference (contingent valuation) methodologies, which can be resource intensive and misleading where there is significant asymmetry of information.

In this economic appraisal (in lieu of a WTP survey and analysis), the following expected project benefits are assigned a monetary value in order to estimate the real (economic) value of the project:

- Time savings (and productivity gains)
- Health benefits

Time Savings

At present, the community has three hand pumps, one of which dries up over winter. The supply from these shallow wells is said to be inadequate in that in addition to the time taken to walk to the hand pump, their slow yields result in long queues. Fetching water is predominantly a woman and children's role in Mwami and long waiting periods are spent queuing at hand-pumps. The community asserted that some households can spend up to five hours per day collecting water. Children are expected to collect water in the afternoon, upon returning from school, and they spend about 45-60 minutes daily on this activity.[25] Children do not miss school as a result of the task, but they can be late for school in the morning or home late after school as a result.

Assigning a monetary value to the time that can be saved for households collecting water for domestic purposes as a result of the project is subjective, given that it depends on how much time households currently spend fetching water and the expected time savings associated with the new project infrastructure. Time savings was thus broken down into the two types of households in the town, namely households which have in-house water connections and those who do not (i.e. those who fetch water from communal access points).

[25] CRIDF: Outline Business Case Mwami (2015)

The monetary value of time savings can be calculated as the opportunity cost of the time spent fetching water. The economic value of one hour saved is expected to be less than the minimum wage per hour in the community due to the high levels of unemployment in the town, especially for women who are usually tasked with water collection for the household. A conversion factor 65% was applied to the minimum wage.[26]

Metered households are expected to have the larger time savings of the two dwelling types due to the fact the entire time that used to be spent on fetching water is now avoided due to household water connections. They will no longer have to travel to fetch water nor wait for slow yielding hand pumps. It is assumed that each household would make approximately one trip per household member per day to fetch water and would spend 45 minutes per trip.[27] Assuming that 75% of this time is saved (which accounts for the fact that some households may have yard connections rather than in-house connections), the total opportunity cost of time for metered households is equal to GBP 30,176 in 2016.

As this CBA includes only the incremental benefits of the project, only the additional savings brought about from the proposed intervention are included. In the current system, low-cost unmetered households collect water from communal stand pipes, whereas in the new system they will collect water from kiosks. Four kiosks have been proposed in the new design, and it is assumed that households will save 20% of the time taken to fetch water due to the new infrastructure. This is attributable to a number of factors which will decrease the collection time for water, including lower demand per kiosk as high cost housing will now be supplied with metered water, faster supply of water due to electric pumping and a more efficient collection process. The total annual opportunity cost of time saved for rural households is equal to GBP 4,333 in 2016.

The combined time savings is valued at GBP 34,509 in the first year of the project. Time savings is assumed to grow proportionally to the size of the population. Refer to **Table 51** in **Appendix B** for a detailed breakdown of these calculations. Overall, metered households save more time per household at an individual level as well as at an aggregate level than communal access households.

Table 41 Time savings benefits (GBP)

Annual value of time savings	2016	2020	2025	2030	2035
Metered households	30,176	32,920	36,705	40,924	45,628
Communal access households	4,333	4,727	5,270	3,616	2,912
Total time savings	**34,509**	**37,647**	**41,975**	**44, 540**	**48,540**

Source: CRIDF CBA

[26] FAO (2002). Sub-Regional Office for East and Southern Africa

[27] Updated Technical Assessment: Mwami (2015)

Health improvements associated with water supply and sanitation

The World Health Organisation (WHO) (2004) asserts that 1.8 million people die every year from diarrhoeal diseases; 90% of which are children under five, mostly in developing countries. The National Environmental Health Policy (2001) estimates that up to 80% of the preventable diseases in Zambia are related to poor sanitation. The proposed interventions for Mwami will directly and indirectly contribute to the reduction of a range of water and sanitation related diseases, such as cholera, dysentery and trachoma.[28]

Eastern Province of Zambia has the highest incidence nationwide of infant, child and under-5 mortality[29]. Diarrhoea is the primary initial indicator of many sanitation related diseases, current figures for Mwami show an incidence of about 270 cases of diarrhoea per month in 2015. This equates to a monthly prevalence of 17% of the total population of the town. These figures are significantly high and pose a severe burden on the economy of Mwami. Exposure to diarrhoea-causing agents is frequently related to the use of contaminated water and to unhygienic practices in the preparation of food and disposal of excreta.[30] WHO and SIWI find that improved water supply can decrease diarrhoea morbidity by up to 45%.[31]

The town of Mwami relies heavily on untreated water from the three communal taps. When these break or run dry, some members of the community use water from the nearby wetland, adjacent to the Lutembwe River. This water is of poor quality due to the fact that it is also used for livestock watering. Sanitation in the town is also of concern; while many of the community use pit latrines which have the risk of contaminating water supplies in the event of a flood, the most significant concern is that of the open defecation practiced by truck drivers while waiting to cross the border. This is due to the fact that this transitory population in the town does not have a formal water supply or ablution block at present.

It is therefore expected that the Mwami community would benefit greatly from both better access to water and sanitation interventions.

The World Bank Water and Sanitation Program (WSP) has calculated the economic costs of poor sanitation in Zambia[32]; it found that Zambia loses USD 194 million annually – or GBP 11 per person annually – due to poor water supply and sanitation, which include health impacts of poor water supply and sanitation, the cost of premature death due to illness caused by diarrhoea and the cost of productivity losses while sick or accessing health care.

The economic cost estimate of poor sanitation is used as a basis to estimate the health benefits (or avoided cost) of the project on the resident population. It is assumed that the project intervention will result in a 45%

[28] Technical Assessment: Mwami (2015)
[29] Updated Technical Assessment: Mwami (2015)
[30] Central Statistics Office (CSO), Ministry of Health (MOH), Tropical Diseases Research Centre (TDRC), University of Zambia, and Macro International Inc. (2009) “Zambia Demographic and Health Survey 2007”, CSO & Macro International Inc., Calverton, Maryland, USA
[31] WHO & SIWI, “ Making Water a Part of Economic Development” , Govt Norway & Sweden as input into Commission on Sustainable Development (CSD) (2004-2005)
[32] WSP Africa (2012) “Economic Impacts of Poor Sanitation in Zambia” Water and Sanitation Program, World Bank, http://www.wsp.org/sites/wsp.org/files/publications/WSP-ESI-Zambia.pdf

reduction in diarrhoea-related health concerns at the clinic.[33] The total annual cost savings to the state is thus GBP 8,545 for local residents in 2016**.** The health savings increase in proportion with population growth in the local resident population. This is a conservative estimate as the water-related incidence of health concerns may in fact increase exponentially if population pressures increase in the absence of any improvements to water supply and sanitation.

Border patrons, specifically truck drivers, currently use an informal system to access water in Mwami. They are vulnerable to health risks associated with unprotected water as well as inadequate supply of water and sanitation. In order to calculate the total cost savings for the State from this population, it was assumed that the incidence of water-related health concerns was similar to that of the local population (17%) and that 73% of these would seek medical attention at the clinic. Following the figures provided in the updated Technical Report, the cost of GBP 3.5 per incident is used to treat these cases at the local clinic. Assuming conservatively that sanitation improvements would reduce their incidence of diarrhoea-related cases by 25%, the estimated cost savings to the state would be GBP 944 in 2016. This cost would not fall on the patients as this cost is subsidised by government in the Mwami clinic. The value of health savings for the transitory population increases in proportion with the growth in border traffic passing through the town (i.e. 5%).

There are other health savings associated with the transient population, including the cost of getting to the local clinic or hospital, as well as productivity losses. These could be valued at the cost of one day of sick leave per water-related incident at the clinic reflected in terms of its shadow price, however, due to a lack of information on these costs and impacts they are excluded from the quantification of benefits.

Table 42 Economic benefits (GBP)

Item	2016	2020	2025	2030	2035
Total time savings	34,509	37,647	41,975	44,540	48,540
Total health savings	8,545	9,440	10,711	12,178	13,879
Total economic benefits	**43,054**	**47,088**	**52,685**	**55,718**	**62,419**

Source: CRIDF CBA

While the health benefits estimated in this CBA are calculated on the quantifiable health savings due to the proposed intervention, it is expected that they are significantly less than the full cost to society. This is because they ignore a number of benefits that are difficult to quantify and monetise. These are listed below:

- The cost of reduced long-term cognitive development which is a result of early childhood diarrhoea and associated under-nutrition, stunting and wasting

[33] World Health Organization (2004) "Water, Sanitation and Hygiene Links to Health Facts and Figures" http://www.who.int/water_sanitation_health/publications/factsfigures04/en/ [2015, July 07]

- The cost of funerals, which are borne directly by households and are particularly significant in African culture. A study in South Africa found that on average, households spend the equivalent of year's total expenditure on food and groceries on funerals.
- The cost of epidemic outbreaks, of which faecal contamination of the environment is the root cause of an annual average 3,200 cases of cholera affecting Zambia. Mwami is particularly vulnerable to epidemic outbreaks due to the large number of border patrons that pass through the town on a daily basis. An epidemic outbreak of cholera would pose a severe cost to the economy due to productivity losses, premature death, diversion of expenditure to health, and losses in trade and tourism.

Quantitative results

The results of the quantitative economic appraisal, as summarised in the table below, indicate that the project is economically desirable at both a 3.5% and 10% discount rate, with positive ENPVs and an ERR which is higher than both discount rates.

Table 43 Economic appraisal results

Indicator	3.5 % discount rate	10 % discount rate
ENPV (GBP)	285,455	48,785
ERR (%)	12%	12%
EBCR	1.38	1.02

Source: CRIDF CBA

Sensitivity Analysis

Two important factors in the estimation of economic benefits are that of the length of time taken to fetch water as well as the percentage of diarrhoea-related illness cases avoided due to the intervention. The impact of these assumptions is investigated in **Table 44**.

Table 44 Economic Sensitivity Analysis (GBP, 10% SDR)

Parameter	Change	ENPV before change	ENPV after change	BCR before change	BCR after change
Increase in time taken to collect water	+10%	48,785	82,381	1.02	1.10

Decrease time taken to collect water	-10%	48,785	15,189	1.02	0.94
Increase in ability to reduce incidence of diarrhoea-related cases	+10%	48,785	57,438	1.02	1.04
Decrease in ability to reduce incidence of diarrhoea-related cases	-10%	48,785	40,134	1.02	1.00

Source: CRIDF CBA

Changing the time taken to fetch water has a proportionally larger impact on the economic results of the project than the ability of the intervention to reduce in water-related illness. The project is not significantly affected by changes in the latter; however, a decrease in the assumed time taken to fetch water by 10% shifts the BCR to below 1.

Qualitative Project Benefits

While the economic appraisal above aims to capture the main components of the economic benefits of the project, it is likely that they are an understatement of the true value of the water and sanitation services supplied by the project. Thus, the qualitative description of the full spectrum of benefits is an important aspect of this economic analysis. The likely qualitative economic benefits associated with improved water and sanitation includes: positive impacts on gender equality, educational outcomes, economic development, and regional dividends. In particular, benefits to education, regional development and climate resilience are particularly important to Mwami and are discussed below.

Education & labour productivity

The economic benefits of improved access to safe water are both immediate and long term. Immediate benefits include averted health-related costs and time savings associated with having water facilities with shorter waiting times. In the longer term however, these benefits compound one other: sufficient supply of treated water will translate into long-run health benefits, which in turn will relate into more productive populations. In terms of educational outcomes, decreased illness due to improved water supply is likely to result in better attendance and ability to learn.

Additionally, time savings will result in additional productivity in the town, felt especially by women and children who are usually tasked with fetching water. While it is difficult to quantify the value of one hour spent

fetching water by children due to the fact that there is no obvious (monetary) opportunity cost to this time, increased productive time for children can be spent playing or studying for school, both of which have important positive impacts on cognitive ability in the long run.

Regional Dividends

Mwami's holds a strategic position on the trade route between Malawi and Zambia and has been identified for its strategic importance to both Zambia and the SADC region in general. A total of 73,000 truck passengers pass through the border town each year, carrying a variety of commodities between the two countries. This substantial number of vehicles is expected to increase as trade within SADC grows. The number of truck drivers passing through the Mwami border depends on the amount of time that it takes to cross the border, as well as a range of other amenities available to them while they wait. Water supply and sanitation infrastructure is one of these basic and fundamental amenities.

Improved water supply and sanitation will enable increased and smoother regional connectivity, trade and ultimately regional integration. With a high standard of basic infrastructure, Mwami will remain a primary conduit for traffic crossing the Zambezi on the Regional Transport Corridors.

Without water supply and sanitation improvements, truck drivers will continue putting strain on the town's already limited water supplies. The fact that Mwami is a border town means that the chance of these epidemics spreading throughout the region is significant. Additionally, much of Mwami's economy is based around border activities, and for the town to continue functioning as a successful border, an adequate water supply is fundamental to its progress and development. The WSP[34] estimate that the cost of an epidemic outbreak – of which faecal contamination of the environment is the root cause – will cost Zambia approximately USD 2 million per year. Should an epidemic break out in Mwami, there is a high likelihood that it will spread to surrounding countries.

Climate Resilience

At present the population of Mwami has limited resilience to climate shocks such as floods or droughts. The three communal shallow wells are prone to water supply variability, with the reported drying up of the one well in winter. Additionally, 85% of the population uses traditional pit latrines.[35] Open defecation is practiced by some of the local community, as well as by the truck drivers passing through the border posts who do not have an ablution facility. In the case of a flood, these ablution practices are severely detrimental to the health of the population through their contamination of the water supply.

[34] WSP Africa (2012) "Economic Impacts of Poor Sanitation in Zambia" Water and Sanitation Program, World Bank, http://www.wsp.org/sites/wsp.org/files/publications/WSP-ESI-Zambia.pdf [2015, July 14]
[35] Technical Assessment: Mwami (2015)

The compounding pressures of growing populations, increasing number of border patrons and climate change, which sees a decrease in the average rainfall[36] to the area while simultaneously more variable rainfall, suggests the urgent need for better water infrastructure.

Selection of the Social Discount Rate

DFID uses a standard rate of 3.5% for climate-related projects, in part due to the fact that the costs of climate change on communities and the environment will be felt in the long run, with compounding severity. A high discount rate can discount these long run costs to almost nothing within a relevant timespan of 20 years.[37] On the other hand, a low discount rate favours projects with high initial costs and low future costs.

In this particular project, the upfront costs are high due to the fact that the town currently has almost no water supply or sanitation infrastructure. The redesign of the project has meant that all of the proposed infrastructure will be in use by the end of the project life span, and its expense can be attributed to the fact that it is providing the community with a fundamental service. Additionally, its benefits will be long-term in nature. Without the project it is likely that health concerns will be exacerbated in the border post, particularly by the burgeoning truck driver population and is compounded by climate pressures such as droughts and floods. A strong argument can thus be made that the 3.5% social discount factor should be used in the analysis of the project, suggesting a strong BCR of 1.38.

Sustainability Analysis

The economic appraisal shows that the project is justified from a socio-economic perspective. The financial appraisal shows that with external funding support for capital investment costs, there is adequate cash flow to maintain operations at the assumed current tariff levels. The remaining issue for a sustainability analysis is to assess the affordability of the project for its intended beneficiaries. The analysis assesses the affordability of the current tariff levels that will be charged for the services provided in the Mwami project, based on the average monthly income of the population.[38]

Benchmarks are a useful source of affordability standards for water and sanitation services. Hutton (2012)[39] finds that in Africa, the affordability index for median households is around 2.8% of monthly income, and for poor households connected to public water supply can easily reach 7.5%. International agencies have provided their own affordability thresholds – UNDP (3%), World Bank (5%), OECD unofficial (4%), and African Development Bank (5%).

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[36] CEEPA (2006). The economic impacts of climate change on agriculture in Zambia. http://www.ceepa.co.za/uploads/files/POLICY%20NOTE%2027.pdf [2015, July 14]
[37] Conningarth Economists (2007) "A Manual for Cost-Benefit Analysis in South Africa with Specific reference to Water Resource Development" Water Research Commission
[38] We have conservatively assumed that tariffs will remain fixed at 2015 prices
[39] Hutton, G. (2012) " Monitoring "Affordability" of water and sanitation services after 2015: Review of global indicator options", PhD – A paper submitted to the United Nations Office of the High Commission for Human Rights, http://www.wssinfo.org/fileadmin/user_upload/resources/END-WASH-Affordability-Review.pdf

The average monthly spend for a rural household in Mwami is equal to GBP 0.87 per month (based on an average monthly water consumption of 3.95m^3 and an associated tariff of GBP 0.22). Using the average monthly wage in the agriculture of GBP 33.2 (600 ZMW), rural households will spend roughly 2% of their household budget, assuming that only one household member works. For high-cost households, the average monthly usage of water is 15.82 m^3. This translates into a monthly cost of roughly GBP 6. Using the average monthly wage for formal employment of GBP 305 (5,512 ZMW), these households are spending roughly 1.3% of their monthly household income, assuming only one member of the family works.

At the current assumed income levels, the tariffs appear to be affordable for both rural and high cost households. Comparing these with the benchmarks outlined above, the project will be affordable to the Mwami population.

As discussed in the Financial Appraisal section above, tariffs for border patrons are based on current charges in the informal market for water and sanitation services. They thus represent sufficient willingness to pay for the water supply and sanitation services proposed in the project design.

Financial / Economic Risk Analysis

The sensitivity analysis on the financial and economic appraisals indicated that none of the core project parameters were extremely critical to the financial and economic feasibility of the projects. A high level risk analysis is outlined below, reflecting possible technical, financial and operational risks that might impact on the project's viability.

Table 45 Identified project risks and mitigation measures

Risk	Level	Mitigation Level
Groundwater abstraction Groundwater abstraction occurs at unsustainable rates, causing water quality concerns in the aquifer with associated environmental and social costs	High	• Do a pump test on the groundwater yield of each proposed borehole and make sure that monthly abstraction does not rise above the recommended level • Continue to monitor groundwater yield from each proposed borehole and be aware of the dangers of unsustainable yield • Embark on a public awareness campaign if residents are using more water than the system is designed to cater for in order to control demand side pressures
Septic tanks spill overs Soil contamination from sludge spillages as well as inappropriate use of septic	High	• Invest in awareness-raising about the costs of inappropriate use of your septic tank. This is especially important given the fact that some of

Risk	Level	Mitigation Level
tanks by households and border patrons		the septic tanks have not been used before by houses who are yet to be connected to the water mains
Domestic Demand Population may not grow as predicted. This will impact revenues generated by the project and thus its operational sustainability. O&M costs will then be serviced by small number of persons which will challenge the affordability or cost recovery of the intervention. Additionally, if Mwami's development happens outside of the proposed design, this will mean that the target population will not be served by the infrastructure. In turn this will result in the socio-economic benefits and financial revenues of the project not being realised.	Medium	• Ensure adequate collaboration with the Distict Council as well as the Chief of the Ngoni people, His Royal Highness Mpezeni – The Inkhosi Ya ma Nkhosi of the Ngoni tribe – before project implementation. Stress the importance of town planning in collaboration meetings. • Ensure detailed designs are based on realistic projections of current and future water demand. This includes a review of the number of boreholes needed, the number of kiosks needed and the size of the water tank.
Water kiosk demand Rural households unable or not willing to pay for consumption at kiosks due to the fact that until now they only pay when a hand-pump needs repair	Medium	• Involve the community from the beginning and raise awareness on need to pay for the service. Involve the District Council in this. Devise strategies to encourage and assist with costs of connections • Stress the benefits of using safe water (that which is treated) over water from unprotected wells and the wetland area • Make full use of the budget set aside in the upfront investment costs for training community based organisations. If possible, set out a plan with key performance indicators to monitor how this money is spent
Vandalism of the system	Medium	• Facilitate establishment of community water supply committee(s) • Promote community education, awareness

Risk	Level	Mitigation Level
		campaigns and promotion of social capital
Community to continue to rely on unsafe sources	Medium	• Work with the town's health workers to educate the community on the dangers of using unsafe water • Emphasize the ease, time savings and reliability of using the proposed system • Consider disconnecting current hand pumps to encourage community members to switch to the new water supply
Metered household collections EWSC finds it difficult to collect monthly tariffs from metered households	Low	• Invest in public awareness raising of why water is charged per unit in metered housing • Emphasize that this cost covers the O & M costs of the infrastructure so that if it breaks there will not be additional costs to the metered households • EWSC has a good track record with collections in Chipata town. If it can avoid unnecessarily large water bills to houses due to leakages then it is likely to be successful at collections in the town of Mwami
Sanitation facilities Border patrons unwilling to pay for ablution facility	Low	• Base tariffs charged in the ablution block on those charged in the informal market for water supply and sanitation as these represent observed willingness to pay in this market. • Keep ablution facilities functional and clean so that border patrons continue to value its services
Inadequate O&M invested by EWSC	Low	• EWSC to commit to deploy adequate and appropriate staff on site and regular supervision and oversight visits by senior staff • Include EWSC training and capacity building during project management

Risk	Level	Mitigation Level
Wastewater Proposed design results in higher levels of waste water produced by the population	Low	• Continue to charge people per unit of water • Invest in awareness raising about the value of water

Source: CRIDF CBA

Conclusions and Recommendations

The CBA of the Mwami border town project has assessed the project's financial and economic viability. Three components of the project – water supply to rural households through kiosks, metered water supply to high-cost households and ablution facilities for border patrons were assessed holistically as one project. The financial appraisal analysed the required capital investment and ongoing O&M costs, compared with the expected revenue. While the project is marginally financially viable, it is unlikely that EWSC has the funds to implement it, given that revenues will be accrued only over long periods of time. Consequently, an up-front capital grant would be required after which the project is able to support itself financially.

The financial appraisal reveals that the project is operationally sustainable if a capital grant is secured. Annual revenues exceed ongoing operational costs. This implies that should external grant financing be made available to cover the capital investment, the project will be viable. There is a strong economic justification for the project when both the quantitative and qualitative benefits of the project are included. This is in part due to the fact that there are large social benefits to the project intervention which are difficult to monetise and are thus left out of the economic appraisal. A sustainability analysis indicated that the assumed tariff rates for the services to be provided appear to be well within international benchmarks.

It is important to consider this project in comparison with a similar initiative in the nearby town of Chanida. The Chanida project has a similar design and caters for the same groups of users – namely metered households, households who access water through kiosks, and the border patron population. However the Chanida project serves a smaller population (estimated to be 975 in 2015, versus 1560 in Mwami). A CBA conducted of the Chanida project showed that it had a far weaker economic outcome, an outcome driven mainly due to the fact that there are fewer border patrons passing through Chanida on a daily basis (80 versus 200 in Mwami), coupled with higher capital and O&M costs (GBP 412,362 versus GBP 300,735 in Mwami). The Chanida project is marginally economically unviable at a discount rate of 10%. It can therefore be inferred that the Mwami project is comparatively less expensive on a per capita basis.

However, it is also important to bear in mind that both projects have significant benefits which cannot be monetised. These benefits have tangible and meaningful impacts for the community – including education, productivity and welfare benefits associated with access to basic human rights such as safe water and sanitation. These would increase the BCR ratios of both projects and would most likely result in net benefits exceeding their costs, even in the case of Chanida.

In terms of the key Value for Money (VfM) indicators, Mwami is significantly less per beneficiary than the infrastructure proposed in Chanida.

Table 46 Value for Money indicators (2015, GBP)

Indicator	Mwami	Chanida
Cost per beneficiary (excluding border patrons)	193	425
Cost per beneficiary (including border patrons)	170	391

Source: CRIDF CBA

The following recommendations arise from the CBA:

- There is the urgent need for improved water and sanitation in the town, the absence of which is expected to have significantly negative impacts on the local community through health and welfare impacts, as well as on the larger Zambian economy due to the town's strategic location within SADC.
- The project clearly demonstrates operational sustainability and economic viability, particularly when qualitative benefits are considered. Grant funding of GBP 300,735 should be secured for the project to go ahead.
- Mwami demonstrates **"healthy" economic BCRs**, capturing the fact that the project provides significant social benefits to the community. The project displays strong **additionality** in that it is unlikely that funding from the private sector would provide an alternative to grant funding. It also displays higher VfM than Chanida.
- Additionally, the project supports the climate resilience of the community, with a particular emphasis on improving the lives of woman and children on which the burden of water collection and water-related illness falls disproportionately.

Appendices

Appendix A - CBA Assumptions

Appendix B - Financial / Economic Analysis

Appendix A – CBA Assumptions

Technical assumptions

Population

Population figures as given by the Ward Development Committee (WDC) and supported by primary observation indicate that there are currently 300 households in Mwami[40]. A growth rate of 2.2% was used for the town, in line with the 2010 census in Zambia (Chipata district).

Mwami is distinct from many of the surrounding villages in that it has a combination of rural households and what is known as high-cost housing. High cost housing refers to relatively larger plot sizes which are built with taps, a water closet and water borne sanitation. In Mwami, due to a lack of piped water mains, these systems are not functional; however, they are expected to become functional with the proposed water supply system. Many of these high cost houses are owned by state employees employed at the immigration offices of the Zambian Revenue Authority (ZRA).

The project is built to take both the current population and usage type into account as well as growth in the population and demand for high-cost housing. Rural housing and high cost housing are assumed to both grow at 2.2%.

Housing types and water demand

The type of housing is an important determinant of water demand as houses with reticulated water systems are expected to use significantly more water than those of 'rural' households where water must be carried home. Rural households in this CBA refer to households that are not connected to water mains and have to use communal water points to access their daily water needs.

Table 47 Water consumption per household group

Household type	Actual demand[41] (litres per capita per person)	Zambian Standard[42] (litres per capita per person)
Rural/peri-urban	25	40
High-cost	100	255 - 150

The per capital consumption of water differs significantly between the Zambian standard and what is actually consumed. The Zambian Standard can be interpreted as the aspirational water supply of the government and not actual water usage. While it is useful to do a sensitivity analysis on water consumption using these figures,

[40] Information provided by Ward Development Committee (WDC), the Water point committee and the Neighbourhood Health Committee (NHC)
[41] AWIRU (2005). Domestic Water Provision. Available http://www.acwr.co.za/pdf_files/02.pdf [2015,07 July], supported by observations of how many trips a household makes to fetch water per day
[42] The Zambian Standard (ZS 361 of 2009)

using the lower per capita consumption figures is preferable as they translate into conservative revenue estimation. If the project is viable at the lower figures then it will be viable at the higher demand estimates.

Non-revenue water

While Mr Kanowa, Managing Director of Eastern Water and Sewage Company (EWSC), states that currently 46%[43] of water is unaccounted for in Chipata city, non-revenue water (NRW) is assumed to be 20% for the proposed design. This is because the proposed design involves the construction of entirely new infrastructure which is assumed to have far fewer leakages than a refurbishment of old infrastructure. Projected water tariff revenues included in the CBA are net of the projected level of NRW.

Financial assumptions

Constant versus current prices

Inflation represents a change in prices and does not represent an actual change in the value of a good. Thus, both the financial and economic appraisal of the project seeks to use constant prices in order to assess the true costs and benefits of the proposed project. Accordingly, all prices are stated in 2015 levels. Discounted rates, as discussed next, are, consequently, adjusted for inflation.

Financial discount rate

In order to compare present capital outflows with future costs and benefits, applying a discount rate is necessary. The discount rate represents society's time preference for money, reflecting a higher value for present benefits than those expected in the future. The discount rate represents the rate at which the value of costs and benefits decrease in the future compared to the present. The rate can be based on the opportunity cost of a resource which is equal to its value in its next best use or on society's preference for benefits today rather than later.[44]

In the financial appraisal, the discount rate is taken as the long run real interest rate in Zambia of 11.5%. The real interest is the nominal interest rate adjusted for inflation and represents the return on the capital investment if it were saved rather than spent on this intervention. The long run interest rate is thus a good proxy for the opportunity cost of capital.

Economic assumptions

Economic discount rates

For the economic analyses, two social discount rates are used as recommended by the CRIDF CBA guidelines. The rate of 3.5% is used, in line with DFID's standard rate for climate related projects, reflecting a low time preference for money. This discount rate represents the fact that project's with social benefits have

[43] Discussions with Mr Kanowa during site visit (2015)
[44] Asian Development Bank (1999) "Handbook for the Economic Analysis of Water Supply Projects", http://www.adb.org/Documents/Handbooks/Water_Supply_Projects

long run benefits to communities and ecosystems and should be carried out with cognisance of trans-generational equity.

A 10% discount rate was chosen in line with the World Bank and European Bank for Research and Development's standard conventional cut-off rate[45]. The cut-off rate is the rate of return below which a project is considered unacceptable. This rate is already adjusted for inflation.

Conversion Factors

The purpose of the economic appraisal is to determine whether there is an economic rationale for the project based on its net positive benefits to society as a whole and regardless of its commercial profitability. To this end, in order to measure economic value, financial (market) prices should be adjusted to correct for market distortions. These adjustments are termed 'shadow pricing' and ensure that economic prices applied to inputs and outputs in the economic appraisal reflect their opportunity cost in society. Shadow pricing is achieved through the application of standard conversion factors (SCF) to financial prices.

A wide literature exists on the use and magnitude of conversation factors, suggesting that they are heavily context specific.

For this CBA, conversion factors are applied in brackets:

Table 48 Economic conversion factors

Input / Output	Conversion factor	Rationale
Tradable goods	0.8	This conversion factor represents the fact that the real value of these goods is lower than the price paid for them. This is due to the fact that many of the project inputs will be imported and will thus be subject to tariffs and other market distortions such as exchange rate commissions. These additional costs to the price of capital are not true reflections of additional value and are thus removed. This conversion factor was developed by the African Development Bank (AfDB) for the Kazungula Bridge Project in 2011[46]. Kazungula is a similar, although larger, border town in Zambia, which faces the same price distortions on its tradable capital goods.
Unskilled labour	0.65	In the derivation of the economic price of labour, again the principle of shadow pricing is applied. This is done to reflect the

[45] Economic Commission for Africa (2012) "Cost-Benefit Analysis for Regional Infrastructure in Water and Power Sectors in Southern Africa" ECA Publications, Addis Ababa

[46] African Development Fund (2011) Project: Kazungula Bridge Project (SADC North-South Transport Corridor Improvement), Project Appraisal Report, AfDB

		high levels of unemployment in Mwami. The opportunity cost of labour is thus below the market wage due to its over-supply[47]. In line with the Rural Infrastructure Development Programme, an SCF of 65% is assumed in this CBA. This SCF is calculated using agricultural work as the opportunity cost of unskilled labour, and represents the fact that, on average, unskilled labour is usefully employed for approximately 65% of their available time (90% during wet seasons and about 30-40% during dry seasons[48]). It is fitting in that a large portion of the population in Mwami is engaged in agriculture. This SCF is similar to that of the Asian Development Bank, which estimates the opportunity cost of time used for collecting water to be 64% of the relevant minimum wage.
Skilled labour	1.00	Skilled labour is assumed to have a conversion factor equal to one reflecting its relative scarcity and due to the fact that its opportunity cost is not less than its wage.
Non tradable goods	1.00	There are no conversion factors available for the remaining inputs and it is assumed for the sake of the analyses that their market prices are adequately reflective of the real value to the economy. This assumption is justified in that many of the inputs to the economic appraisal are services rather than goods and do not face the market distortions that tradable goods do.

[47] EU (2014). Rural Infrastructure Development Programme. Detailed Design Report for the South Rukuru Irrigation Scheme. Volume 1: Main Report.
[48] Ibid.

Appendix B – Financial / Economic Analysis

Table 49 Financial appraisal summary table

	2 015	2 016	2 017	2 018	2 019	2 020	2 021	2 022	2 023	2 024	2 025	2 026	2 027	2 028	2 029	2 030	2 031	2 032	2 033	2 034	2 035
YEAR	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Capital investment	300 735																				
Residual value																					
O&M	-	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037
TOTAL COSTS	300 735	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037
High cost (pa)		5 623	5 747	5 873	6 003	6 135	6 270	6 408	6 548	6 693	6 840	6 990	7 144	7 301	7 462	7 626	7 794	7 965	8 140	8 320	8 503
Low cost household(pa)		1586	1621	1657	1693	1730	1768	1807	1847	1888	1929	1972	2 015	2 059	2 105	2 151	2 198	2 247	2 296	2 347	2 398
Low cost communal (pa)		901	921	941	962	983	1005	1027	1049	1073	1096	1120	1145	1170	1196	1222	1249	1276	1305	1333	1363
Transiet users (pa)		39 340	41 307	43 372	45 541	47 818	50 209	52 719	55 355	58 123	61 029	64 081	67 285	70 649	74 181	77 891	81 785	85 874	90 168	94 676	99 410
Sewage charge		721	737	753	770	786	804	821	840	858	877	896	916	936	957	978	999	1021	1044	1067	1090
Fixed charge		1058	1081	1105	1129	1154	1180	1206	1232	1259	1287	1315	1344	1374	1404	1435	1467	1499	1532	1565	1600
TOTAL REVENUES	-	49 229	51 414	53 702	56 098	58 607	61 235	63 988	66 872	69 893	73 058	76 374	79 849	83 490	87 304	91 302	95 492	99 883	104 485	109 308	114 364
Net Revenues (incl. water costs)	(300 735)	34 193	36 377	38 665	41 061	43 570	46 198	48 951	51 835	54 856	58 022	61 338	64 812	68 453	72 268	76 265	80 455	84 846	89 448	94 271	99 327
NPV	94 215																				
IRR (C)	15.2%																				
B/C	1.23																				
N/K Ratio	0.31	369 883	PV positive net benefits																		
			PV negative net benefits																		

Capital Grant

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
YEAR	2 015	2 016	2 017	2 018	2 019	2 020	2 021	2 022	2 023	2 024	2 025	2 026	2 027	2 028	2 029	2 030	2 031	2 032	2 033	2 034	2 035
TOTAL COSTS	300 735	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037	15 037
Grant investment		300 735																			
Revenues	-	49 229	51 414	53 702	56 098	58 607	61 235	63 988	66 872	69 893	73 058	76 374	79 849	83 490	87 304	91 302	95 492	99 883	104 485	109 308	114 364
TOTAL REVENUES	-	**349 965**	**51 414**	**53 702**	**56 098**	**58 607**	**61 235**	**63 988**	**66 872**	**69 893**	**73 058**	**76 374**	**79 849**	**83 490**	**87 304**	**91 302**	#####	#####	#####	#####	**114 364**
NET REVENUE	(300 735)	334 928	36 377	38 665	41 061	43 570	46 198	48 951	51 835	54 856	58 022	61 338	64 812	68 453	72 268	76 265	80 455	84 846	89 448	94 271	99 327
NPV	363 933																				
IRR	43.55%																				
B/C	1.87																				
N/K Ratio	1.21																				

Table 50 Economic Appraisal Summary Table

Discount rate:																					
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
YEAR	2 015	2 016	2 017	2 018	2 019	2 020	2 021	2 022	2 023	2 024	2 025	2 026	2 027	2 028	2 029	2 030	2 031	2 032	2 033	2 034	2 035
Capital investment	265 504																				
O&M		12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706
TOTAL COSTS	265 504	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706

BENEFITS																					
Time		34 509	35 268	36 044	36 837	37 647	38 476	39 322	40 187	41071	41975	42 300	42 741	43 272	43 876	44 540	45 256	46 017	46 821	47 662	48 540
Health		8 545	8 760	8 980	9 207	9 440	9 680	9 927	10 181	10 442	10 711	10 987	11 272	11 565	11 867	12 178	12 498	12 828	13 168	13 518	13 879
TOTAL		43 054	44 028	45 024	46 044	47 088	48 156	49 249	50 368	51513	52 685	53 287	54 013	54 837	55 743	56 718	57 754	58 846	59 989	61 181	62 419
Net Revenues (incl. water costs)	(265 504)	30 348	31 322	32 318	33 338	34 382	35 450	36 543	37 662	38 807	39 979	40 581	41 307	42 131	43 037	44 012	45 048	46 140	47 283	48 475	49 713
NPV	285 455																				
IRR	12%																				
B/C	1.38																				
N/K Ratio	2.15	423 617	PV positive net benefits																		
		(265 504)	PV negative net benefits																		

Discount rate:																					
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	15	15	15	15	15
YEAR	2 015	2 016	2 017	2 018	2 019	2 020	2 021	2 022	2 023	2 024	2 025	2 026	2 027	2 028	2 029	2 030	2 030	2 030	2 030	2 030	2 030
Capital investment	265 504																				
O&M		12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706
TOTAL COSTS	265 504	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706	12 706

BENEFITS																					
Revenue																					
Time		34 509	35 268	36 044	36 837	37 647	38 476	39 322	40 187	41071	41975	42 300	42 741	43 272	43 876	44 540	45 256	46 017	46 821	47 662	48 540
Health		8 545	8 760	8 980	9 207	9 440	9 680	9 927	10 181	10 442	10 711	10 987	11 272	11 565	11 867	12 178	12 498	12 828	13 168	13 518	13 879
TOTAL		43 054	44 028	45 024	46 044	47 088	48 156	49 249	50 368	51513	52 685	53 287	54 013	54 837	55 743	56 718	57 754	58 846	59 989	61 181	62 419
Net Revenues (incl. water costs)	(265 504)	30 348	31 322	32 318	33 338	34 382	35 450	36 543	37 662	38 807	39 979	40 581	41 307	42 131	43 037	44 012	45 048	46 140	47 283	48 475	49 713
NPV	48 785																				
IRR	12%																				
B/C	1.02																				
N/K Ratio	1.39	561 216	PV positive net benefits																		
		(265 504)	PV negative net benefits																		

Table 51 Time and Health Savings

Opportunity cost of water

POPULATION

	Year (number)	0	1	2	3	4	5	6
	Year (date)	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Existing population	Population	1560	1594	1629	1665	1702	1739	1778
	High cost	468	478	489	500	511	522	533
	Low cost connected	546	558	570	583	596	609	622
	Low cost communal	546	558	570	583	596	609	622
Ablution block	Border patrons (truckers) per year	73 000	76 650	80 483	84 507	88 732	93 169	97 827

Time Savings

	Lowest minimum wage	53	53	53	53	53	53	53
	Assuming a discounted CF for labour, monthly opportunity cost	34.51	34.51	34.51	34.51	34.51	34.51	34.51
	Assuming 20 days worked per month (opportunity cost per day)	1.73	1.73	1.73	1.73	1.73	1.73	1.73
RETICULATED HOUSES	Assuming time spent to collect 20 lires	0.75	0.75	0.75	0.75	0.75	0.75	0.75
assumeing 75% time savings	Time spent per household per day (hr)	3.90	3.90	3.90	3.90	3.90	3.90	3.90
assuming that new developments are used by rural household	Cumulative household time spent collecting per day (hr)	761	777	794	812	830	848	867
	Hours in work day	8.00	8.00	8.00	8.00	8.00	8.00	8.00
	Work days spent collecting	95	97	99	101	104	106	108
	Total opportunity cost per day	164	168	171	175	179	183	187
	Total opportunity cost per month	3 281	3 353	3 427	3 502	3 579	3 658	3 738
	Assuming 240 wrking days in a year							
	Total opportunity cost per year	39 369	40 235	41 120	42 024	42 949	43 894	44 860
	75% of this value	**29 526**	**30 176**	**30 840**	**31 518**	**32 212**	**32 920**	**33 645**