



NORTHERN REGION WATER BOARD

MALAWI NRW WATER EFFICIENCY PROJECT

**ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR 2 RIVER INTAKES ON
LUNYANGWA RIVER**

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EXECUTIVE SUMMARY

INTRODUCTION

The Northern Region Water Board, with support from the European Investment Bank (EIB), intends to carry out quick interventions which will sustain the water supply to Mzuzu City, Ekwendeni Town and the surrounding areas. One of such interventions is construction of intake weirs across the Lunyangwa River at the Mzuzu Water Treatment Plant (WTP) and at the Ekwendeni WTP

The current weir for the Mzuzu system is located downstream of the Lunyangwa Dam and adjacent to the Mzuzu WTP around longitude/latitude location 34° 3' 0.53" E; 11° 27' 13.662" E. The present weir in Mzuzu resembles a temporary structure and uses an arrangement of sandbags to intercept water in the area between the weir and the Lunyangwa Dam. The regular flow past the weir is estimated at 500 l/s; about 50% of this is abstracted via a 150 mm diameter pipe and is pumped to the Mzuzu water treatment works. The wall for the present weir is not water tight because it uses sandbags to trap water, hence there is a significant amount of water which is lost by passing around the weir or under it.

The intake weirs to be constructed in reinforced concrete will enable increased abstraction of water by reducing the amount of flow lost at the present Mzuzu weir and by increasing the supply capacity by about 95% to some 15,000 m³/day for the Ekwendeni weir.

PROJECT DESCRIPTION

The main components of the project are as provided below. To develop the structures, main construction activities are expected to include:

- i. Excavation works for proposed main structures
- ii. Backfilling of excavated areas
- iii. Concrete construction works
- iv. Hydro mechanical installations
- v. Building construction works

Out of the people to find employment during the project construction phase, some 45% are expected to be employed as casual (non-skilled) labourers from the surrounding communities. The rest are expected to be skilled and semi-skilled workers including engineers, surveyors, environmental health and safety workers and foremen

The total costs for implementing the Ekwendeni and Mzuzu weir projects are estimated at €165,000.00 and €65,000.00 respectively but are subject to revision depending on the design review. The cost estimates are taking into account the costs for all the construction works including mobilization costs and they have been prepared based on rates obtained from recently completed similar projects in other countries. The costs are an equivalent of MWK 135,514,500.00 for the Ekwendeni weir and MWK 53,384,500.00 for the Mzuzu weir

METHODOLOGY

The methodology for the ESIA involved the following tasks:

PHASE 1: PROJECT KICK-OFF AND PRODUCTION OF INCEPTION REPORTS

- Task 1.1: Project Kick-off Meeting
- Task 1.2: Reconnaissance site visit
- Task 1.3: Production of Inception Reports
- Task 1.4: Mobilisation of project team
- Task 1.5: Desktop Review
- Task 1.6: Stakeholder mapping and analysis
- Task 1.7: Field work planning

PHASE 2: ESIA REPORT

- Task 2.1: Baseline Studies
- Task 2.2: Stakeholder Consultations
- Task 2.3: Identification and Evaluation of Impacts
 - Task 2.3.1: Impact identification
 - Task 2.3.2: Evaluation of Impacts
 - Task 2.3.3: Analysing and presenting alternatives
 - Task 2.3.4: Determination of impact management measures
- Task 2.4. Preparation of draft Environmental and Social Management and Monitoring Plans
- Task 2.5: Compilation and submission of ESIA report

Phase 3: Final ESIA Report

- Phase 3.1: Additional studies
- Phase 3.2: Compilation of final report

ANTICIPATED ENVIRONMENTAL AND SOCIAL IMPACTS OF THE PROJECT

Analysis of project activities against the baseline data for the project has facilitated the identification of positive impacts, which have been outlined in the ESMP for this ESIA report. The key positive impacts during the implementation of the project include:

a) **Creation of employment opportunities**

Enhancement measure: Introduce the planning team to stakeholders of the project i.e. Community Leaders and sensitizations

b) **Increase in trade opportunities: The project will create demand for construction materials, goods and services by construction workers.**

Enhancement measure: The contractor should willingly consider giving job opportunities to the people living in the surrounding areas of the Lunyangwa Dam and the proposed locations of the river intakes. The contractor should also comply to both the gender policy and the Labour Act

c) **Training Opportunities in Vocational Skills for youth**

Enhancement measure: Contractors to consider high potential women for skills training program and Contractors to consider focused training program to optimize skills transfer to unskilled workers

d) **Improved reservoir capacity of water supply to Mzuzu City, Ekwendeni Town and the Surrounding Areas**

Enhancement measures:

- Ensure water reservoir tanks have adequate water all the time to cover periods of no water pumping
- Sustain the desired performance of the water supply system through timely preventive maintenance.
- Quickly carryout maintenance works and restore water supply when there are problems.
- Adequately treat water at the treatment plant.

e) Improved sanitation, hygiene and health

Recommended enhancement measures:

- Sensitize communities on hygienic practices for handling water to avoid secondary contamination.
- Sensitize the community members to be vigilant in reporting water leakages and broken pipes.
- Promote general sanitation practices amongst communities in the project area.
- Monitor the quality of water and to promote health and hygiene at water points.
- Support initiatives implemented by community-based organizations to promote health, sanitation and hygiene
- Ensure there is adequate drainage within the community water points to avoid accumulation of stagnant waters which lead to rapid mosquito breeding as well as other waterborne parasites.

a) Improved socio-economic situation of the communities

Recommended enhancement measures:

- Provide quality water, with minimal loss of supply, through system monitoring and regular maintenance.
- Support women and other vulnerable groups to start and operate businesses through appropriate training and start-up capital.
- Make water costs affordable.

This ESIA has also identified the following negative impacts, which will occur during planning and designing phase:

a) Unrealistic expectations with regard to lands/compensation/resettlement negotiations:

Mitigation measures: Conduct adequate and thorough public and sensitization meetings in regard to land laws, land acquisition and compensations; observe transparency and accountability when evaluating the land and property and paying the compensations.

Negative impacts identified for the construction phase:

a) Poor water quality:

Mitigation measures:

Provide a schedule for excavation works, encourage use of mortar and debris traps during construction, Strategic stakeholder consultations, mix cement in areas which are not directly connected to natural drainage systems, shutters to be properly erected and monitored

b) Air Pollution:

Mitigation measures: Use new or fairly new machinery that is within the acceptable emission limits, erect safety signboards to warn other road users about the volume of traffic, Timely and effectively maintain vehicles and equipment to prevent exhaust gas emissions above permissible emission limits, Use the water bowsers to spray water along the access roads used by the haulage trucks, provide protective gear (dust masks) to workers and ensure that they wear them.

c) Soil contamination and land degradation:

Mitigation measures: Fuel and oil leaks from construction plant and vehicles, spills from vehicle maintenance operations, and spills from waste oil containers discarded from plant and vehicle maintenance during construction activities; Civil works construction wastes such as packaging materials, cement bags, oils and paints, accidental or deliberate disposal of construction waste and chemicals; improper disposal of soils from excavations and stockpiling; unsustainable sand mining and quarrying – this is likely to result in land degradation outside the project site in sand mining and quarrying areas.

d) Loss of vegetation cover:

Mitigation measures: Limit vegetation clearing and excavations to only those areas specified in the designs to avoid unwarranted clearance of vegetation; plant appropriate trees and grasses in all disturbed area.

e) Accidents and hazards from trenches and burrow pits:

Mitigation measures: limit making deep pits when extracting construction materials, refill all burrow pits to be created during the upgrading; barricade all trenches and open pits and place clear signs to protect animals and people from falling into them.

f) Disruption of water supply

Mitigation measures: Give adequate notice of potential water disruption to the water users that could be affected, provide alternative means of supplying water such as temporary by-pass piping or water bowsers where appropriate, the contractor to Provide a works schedule with strategically staggered activities to avoid total flow disruption during construction

g) Water pollution and siltation:

Mitigation measures; Mix cement in areas, which are not directly connected to natural drainage systems; Provide appropriate barriers to separate worksites from water resources in order to prevent accidental spillage into water courses; Line surfaces where cement, paints and oils will be stored.

h) Occupational incidents and accidents:

Mitigation measures; Induct workers on OSH requirements and repeat reminders on the same; Employ an OSH expert to monitor and ensure that appropriate equipment and acceptable codes of practice for various tasks are followed by workers at all times; Provide appropriate personal protective equipment

i) Disturbances and accidental damage to assets:

Mitigation measures; Provide adequate notice before conducting construction activities at a private or public property; Provide detours and appropriate traffic signs for vehicles and pedestrians where constructions are being conducted across a road; Restore work sites to their state before construction activities where possible.

j) Noise and vibrations:

Mitigation measures; Use appropriate and well-maintained noise mufflers on vehicles and machinery; Regularly service and carry maintenance of equipment; Provide ear muffs for the workers in noisy areas; restrict hours of operation and schedule noisy tasks for periods of low occupancy on the project surroundings; Notify the public of upcoming loud events.

k) Increase in sexual relationships, unplanned pregnancies, breaking up of families:

Mitigation measures; Sensitize all contractors, workers and communities on the STD and HIV/AIDS; Enforce punitive and disciplinary measures on any project workers involved in any social malpractices with surrounding communities; Provide both male and female condoms to workers for appropriate use.

l) Incidence of sexual abuse and harassment:

Mitigation measures; Sensitize workers and surrounding communities to avoid sexual abuse and harassment; Conduct sensitization and awareness campaigns to encourage affected individuals to report cases of sexual harassment in the homes; Enforce punitive and disciplinary measures on any project workers involved sexual abuse and harassment.

m) Increased pressure on community health services:

Mitigation measures; Conduct public awareness and sensitization on community health, HIV and AIDS; Encourage employees to go for voluntary health screening and receive appropriate treatment where it is required; Construct adequate sanitation facilities at the work sites and surrounding area.

n) Unequal employment opportunities:

Mitigation measures; Encourage the contractor to employ 30% women as well; Conduct gender meetings to sensitize and encourage women and to instil confidence that they can also do the work that men do.

Negative impacts during operational phase:

a) Solid waste generation:

Mitigation measures; Sell or recycle metal waste to tinsmiths or vendors for reuse or re-sale; Provide solid waste storage bins and skips; Monitor skips so that they do not

become overfilled; Ensure that collected solid waste is disposed of in an approved disposal site.

b) Increased pollution from wastewater and sludge:

Mitigation measures; Enforce proper excreta and wastewater management especially in the town; Enforce the use of licensed liquid waste handlers for liquid waste.

c) Emergencies:

Mitigation measures; Design and implement an emergency response plan; Install fire hydrants within the proposed development; Regularly monitor and maintain the water supply system; Install a fire extinguisher at the plant and train workers on how use.

d) Potential risks of water leakage and flooding from theft and vandalism:

Mitigation measures; NRWB must periodically conduct consultations and sensitizations with villages and group village heads and security personnel; Reward for reports of vandalism and theft that may lead to capture.

Negative impacts during demobilization phase:

a) Loss of jobs and businesses:

Mitigation measures; Provide adequate notice to employees; Pay severance benefits to leaving workers in line with the labour regulations; Provide alternative employment to employees where possible e.g. as maintenance staff.

b) Abandonment of excavated areas for construction materials:

Mitigation measures; Fill up and close pits after the construction works; Rehabilitate all work site; Construction materials e.g. sand and clay soils should be sourced from licensed suppliers.

The costs for management of the impacts have been determined to be 87,547. USD per year; and the costs for monitoring are estimated to be 9,273 USD per year.

CONCLUSION

The Proposed Malawi NRWB Water Efficiency Project is one of the strategic projects that has been prepared taking into account of the National Water Policy, the Malawi Growth and Development Strategy III. The Project is positive as it will help the Northern Region Water Board to address some of the challenges, which it has been facing in its operations because of inadequate water supply and old infrastructure, resulting in failure to meet the increased demand for social and economic development. However, development of the structures is also expected to generate some negative impacts on the biophysical and socio-economic environment. The ESIA has therefore prepared the Environmental and Social Management and Monitoring Plans, including mitigation and enhancement measures for negative and positive impacts respectively and schedule for implementation. Additionally, to ensure sustainable implementation of the project, the following recommendations are made:

- a) Water abstraction has to be in accordance to the Water Right, which NRWB will be required to obtain before the project can be implemented.

- b) The project should be fully supported by all the relevant institutions;
- c) Adequate financial support should be allocated to realise the full potential to improve the socio-economic wellbeing of the targeted communities;
- d) The environmental and social impacts should be avoided or minimised to the greatest extent possible by fully implementing the enhancement and mitigation measures advanced in this report;
- e) The communities have a negative perception of NRW and how it calculates water tariffs, the NRW must conduct adequate sensitization on water supply pricing and management.
- f) NRW must allocate additional funds in cooperate social responsibilities to improve its image among the communities,
- g) During construction, the contractor should avoid clearing any protected or endangered plant species. Where they are removed, they must be replanted.
- h) Adequate and fair compensation must be given to all the affected people before construction activities start;

NRWB and the respective key stakeholders should support and facilitate employment of women, the youth and vulnerable groups to eliminate potential gender and social imbalances; where possible and appropriate, employment of local people from the project area must be prioritised to encourage community ownership and sustainability of the project.

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LIST OF ACRONYMS

AIDS	Acquired Immuno-Deficiency Syndrome
BBDV	Banana Bunchy Top Virus
BOQ	Bill of quantities
COMSIP	Community Savings and Investment Promotion
DEC	District Executive Committee
DI	Ductile Iron
DLO	District Land Officer
DPD	Director of Planning and Development
EAD	Environmental Affairs Department
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EMA	Environmental Management Plan
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Impact Plan
ESCOM	Electricity Supply Corporation of Malawi
FMB	First Merchant Bank
GI	Galvanised Iron
GoM	Government of Malawi
HIV	Human Immunodeficiency Virus
IAS	Invasive Alien Species
MBS	Malawi Bureau of Standards
MCC	Mzuzu City Council
MGDS	Malawi Growth and Development Strategy
MDHS	Malawi Demographic Health Survey
MIEO	Monitoring, Information and Evaluation Officer
MNREM	Ministry of Natural Resources, Energy and Mines
MP	Monitoring Plan
MPC	Malawi Postal Corporation
mPVC	Modified polyvinyl chloride
MTL	Malawi Telecommunications Limited
MWK	Malawi Kwacha
NAPA	National Adaptation Programme of Action
NBM	National Bank of Malawi
NBS	New Building Society
NEAP	National Environmental Action Plan
NCE	National Council on Environment
NRWB	Northern Region Water Board
NSOER	National State of the Environment and Outlook Report
NSP	National Sanitation Policy
OFID	OPEC Fund for International Development
OPEC	Organisation of the Petroleum exporting countries
OS	Operational Safeguard
OSH	Occupational Safety and Health
OSHW	The Occupational Safety, Health and Welfare
SEP	Social Economic Profile
SOBO	Southern Bottlers
STIs	Sexually Transmitted Infections
TAC	Treatment Action Campaign
TCE	Technical Committee on the Environment
TNM	Telekom Networks Malawi
uPVC	un-plasticised polyvinyl chloride
US	United States Dollars
VNRMCS	Village Natural Resource Management Committee
VSCS	Village Sanitation Committee
VSL	Village Savings and loan
WASH	Water, Sanitation and Hygiene

WHO World Health Organisation
WTP Water Treatment plant
WVEC Water Waste and Environment Consultants

CHAPTER 1 : BACKGROUND AND INTRODUCTION

1.1. PROJECT BACKGROUND

The Northern Region Water Board (NRWB) was created under the under the Laws of Malawi CAP 72:01 to be responsible for the supply of potable water and the disposal of waterborne sanitation in all the urban centers of the Northern Region of Malawi. Mzuzu and Ekwendeni Water Supply Systems in Mzuzu City and Ekwendeni Town respectively are two of the ten schemes within the mandate of the Northern Region Water Board. The water supply systems provide potable water to residents of Mzuzu City and Ekwendeni Town which is located at some 20 km northwest of the Mzuzu City. The current population residing in the service area for the two water supply systems is estimated to be at more than 220,000 (2018 NSO Malawi population and housing census reports).

The two water supply systems rely on three raw water abstraction points from the Lunyangwa River with the Lunyangwa Dam in Mzuzu being the main source having a supply capacity of some 21,200 m³/day. A makeshift type of weir located downstream of the Lunyangwa Dam near the Mzuzu Water Treatment Plant (WTP) has a supply capacity of 4,000 m³/day and is used to abstract water mainly in the rainy season. Another weir is also located on the Lunyangwa River in Ekwendeni near the Ekwendeni WTP with a supply capacity 700 m³/day. The Ekwendeni water supply system has a supply shortfall of approximately 300 m³/day as the current water demand for the Ekwendeni Town stands at some 1,000 m³/day (Hydrological analysis report for proposed Ekwendeni abstraction works, 2016). This supply shortfall is supplemented by water from the reservoir at Lunyangwa Dam in Mzuzu which is currently exerting pressure on the water resources meant to meet the demand for the growing City.

Currently 72% of the total population of Mzuzu City and Ekwendeni Town are provided with water from the two systems. The un-served population gets water from informal and unprotected sources such as boreholes, dug wells and streams. The population in the two urban centres is continuously growing and currently the water demand from the whole service area of the water supply systems stands at some 24,900 m³/day. Plans are also in place to extend the water supply systems particularly the one at Ekwendeni in order to reduce the proportion of populations that are not being served with safe water. As currently the (continuously growing) water demand from the served populations is almost exceeding the available water supply from the two schemes, it is envisaged that the available supply will not be capable of meeting future water demands from the currently served population as well as the population that is to be added as a result of the extensions to the distribution systems. A constant threat of more people utilising unsafe water sources remains in the supply areas due to a possibility of water supply being limited as the water demand continues to grow and exceed the water supply capacity.

In the long term, the solution to this challenge is construction of another dam to supplement the freshwater that is currently supplied by the Lunyangwa Dam. However, being a major undertaking, construction of the additional dam and the associated water supply facilities will take several years. Accordingly, there is need for quick interventions which will sustain the water supply to Mzuzu City, Ekwendeni Town and the surrounding areas while funds for

construction of the new dam and associated facilities are being sourced. One of the interventions that have been identified is the construction of intake weirs across the Lunyangwa River at the Mzuzu (WTP) and at the Ekwendeni (WTP). The construction of the intake weirs will be done as part of the Malawi NRW Water Efficiency Project which is financed by the European Investment Bank (EIB).

The intake weir construction will increase the water supply capacity of the two water supply systems by reducing the amount of water lost at the makeshift weir in Mzuzu and by providing an additional larger abstraction point at Ekwendeni. Through these projects the Ekwendeni scheme will be made self-reliant, relying on water abstracted from intake points in Ekwendeni and no longer depending on sources from Mzuzu. The planning and design phase of the projects, currently on going, is mostly using the existing NRW employees; similarly, during the operation phase, there will be limited direct employment opportunities. However, it is expected that during the construction phase NRW will require to out-source human resource for both skilled and unskilled labour.

To ensure that the project activities are implemented sustainably, the Northern Region Water Board engaged Water, Waste and Environment Consultants (WWEC) to conduct an Environmental and Social Impact Assessment (ESIA). Findings of this baseline study will also feed into the ESIA.

1.2. Existing Mzuzu Weir

The current weir for the Mzuzu system is located downstream of the Lunyangwa Dam and adjacent to the Mzuzu WTP around UTM coordinate location 36L 614549; 8733635. The present weir in Mzuzu resembles a temporary structure and uses an arrangement of sandbags (figure 2.1) to intercept water in the area between the weir and the Lunyangwa Dam. The regular flow past the weir is estimated at 500 l/s, decreasing to about some 50l/s during the dry seasons. About 50% of the regular flow is abstracted via a 150 mm diameter pipe and is pumped to the Mzuzu water treatment works. Due to the fact that the present Mzuzu weir relies on a wall of less water tight sandbags to trap water, there is a significant amount of water which is lost by passing around the weir or under it.



Figure 1.1: Existing makeshift kind of weir near the Mzuzu WTP

1.3. Existing Ekwendeni Weir

The present Ekwendeni weir located near the Ekwendeni WTP around coordinate location 36L 595730; 8741177 extends over a width of about 8m across the Lunyangwa River and has a height of approximately 1m. This low concrete weir at Ekwendeni has a small sand trap chamber and has a 100 mm diameter intake pipe laid on top of one of three chambers located to its right bank. The weir structure is currently facing challenges of having its stilling basin silted over as well as having some cracks on some places. Figure 1.2 shows the existing Ekwendeni weir as viewed from its right bank.



Figure 1.2: Existing low concrete weir at Ekwendeni as viewed from the right bank

1.4. PROJECT OVERVIEW

In view of the growing water demand for the Mzuzu and Ekwendeni Water Supply Systems and the fact that the present water abstraction infrastructure is not of adequate capacity to meet this rising water demand, the projects have been planned to construct new raw water intake weirs on the Lunyangwa River near the Mzuzu and Ekwendeni water treatment plants. The intake weirs are to be constructed in reinforced concrete.

1.4.1. Project for additional Mzuzu Weir

The proposed new Mzuzu weir will enable increased abstraction of water by reducing the amount of flow lost at the present Mzuzu weir. The new Mzuzu weir will be a reinforced concrete structure which will replace the existing sandbag arrangement. This proposed weir at Mzuzu will be completed with a proper reinforced concrete stilling basin and sand-trap channel. It will have a 1m deep cut-off wall which will be built at its upstream end to provide stability and reduce water seepage beneath the structure.

1.4.2. Project for additional Ekwendeni Weir

The new Ekwendeni weir will ensure increased abstraction of water resulting into expanded water supply capacity from 700 m³/day to some 13,200 m³/day for the Ekwendeni supply system.

The proposed weir at Ekwendeni will solve the challenges of the presently existing weir by providing a more robust new structure, better able to resist large floods and with an increased

intake size. The new Ekwendeni weir will also be made to be easier to operate and maintain and will incorporate a more effective sand trap.

1.5. PROJECT LOCATION

The projects will be implemented at locations that are near the Mzuzu WTP and the Ekwendeni WTP for the Mzuzu and Ekwendeni weirs respectively. The new Mzuzu weir is to be located in the area just upstream of the existing makeshift weir structure (around coordinate location 36L 614541.33, 8733642.64); some few metres upstream of the bridge on Sir Martin Road near the Mzuzu WTP.

The proposed Ekwendeni weir is to be constructed at some 80m downstream of the existing weir (coordinate location 36L 595657.79, 8741187.2) where sound rock is exposed in the river bed on the left bank and where a hard formation has been found under the right bank at about river bed level. The Mzuzu WTP is located in Mzuzu City to the east just adjacent to the Sir Martin Road near the Kaning'ina Forest Reserve. Mzuzu City is located in Mzimba District and is the administrative headquarters for the Northern Region of Malawi. The city is located at some 367 km northwards of Lilongwe (Malawi Capital City) and at some 117 km north-eastwards of the Mzimba Boma. Ekwendeni Town (where the Ekwendeni WTP is located) is at some 20km northwest of the Mzuzu City in the same district of Mzimba.

Figure 1.3 shows the location of Mzuzu City and Ekwendeni Town in the Northern Region of Malawi. The proposed project areas are shown in figures 1.4 and 1.5.

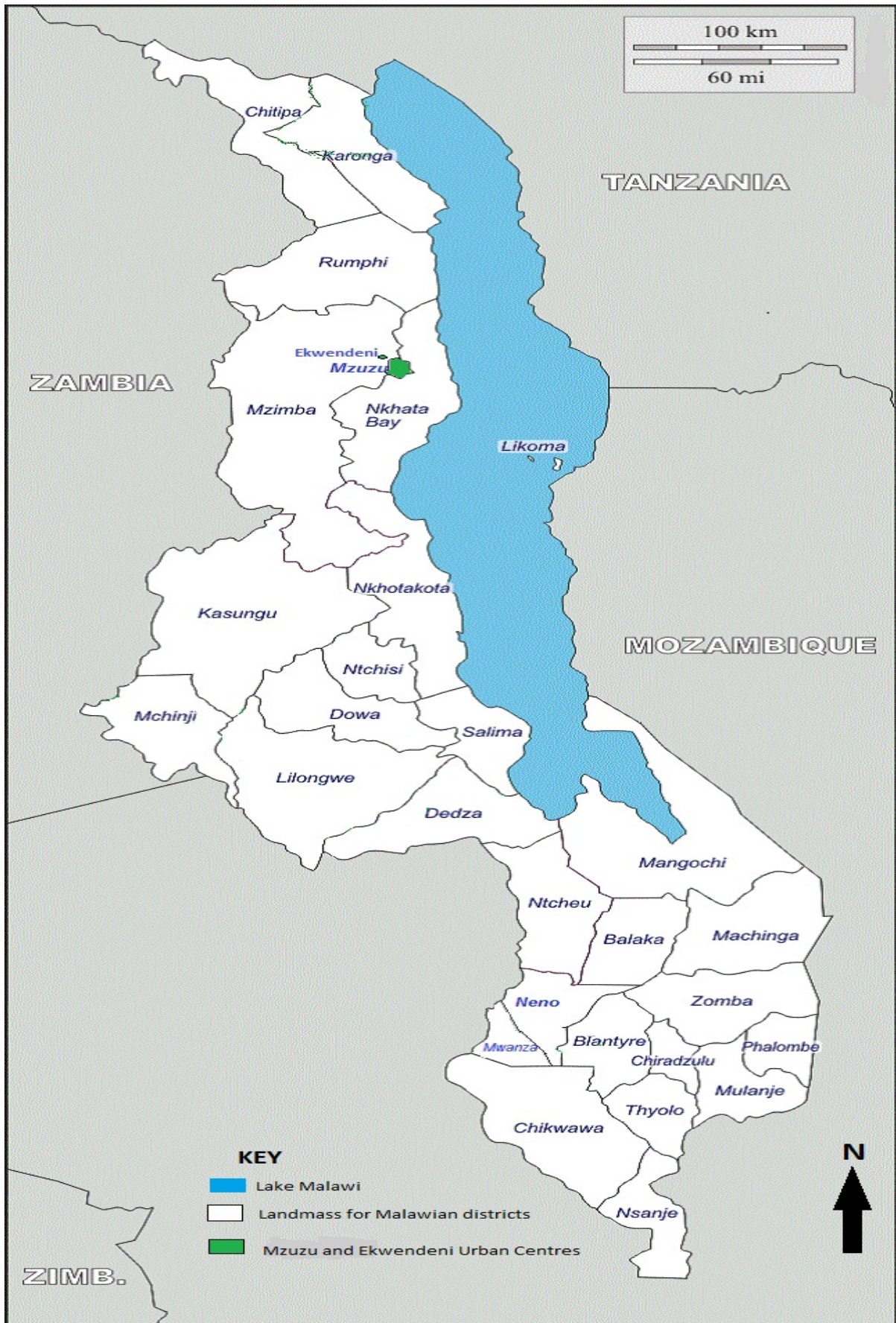


Figure 1.3: Location of Mzuzu City (1) and Ekwendeni Town (2) in the Northern Region of Malawi

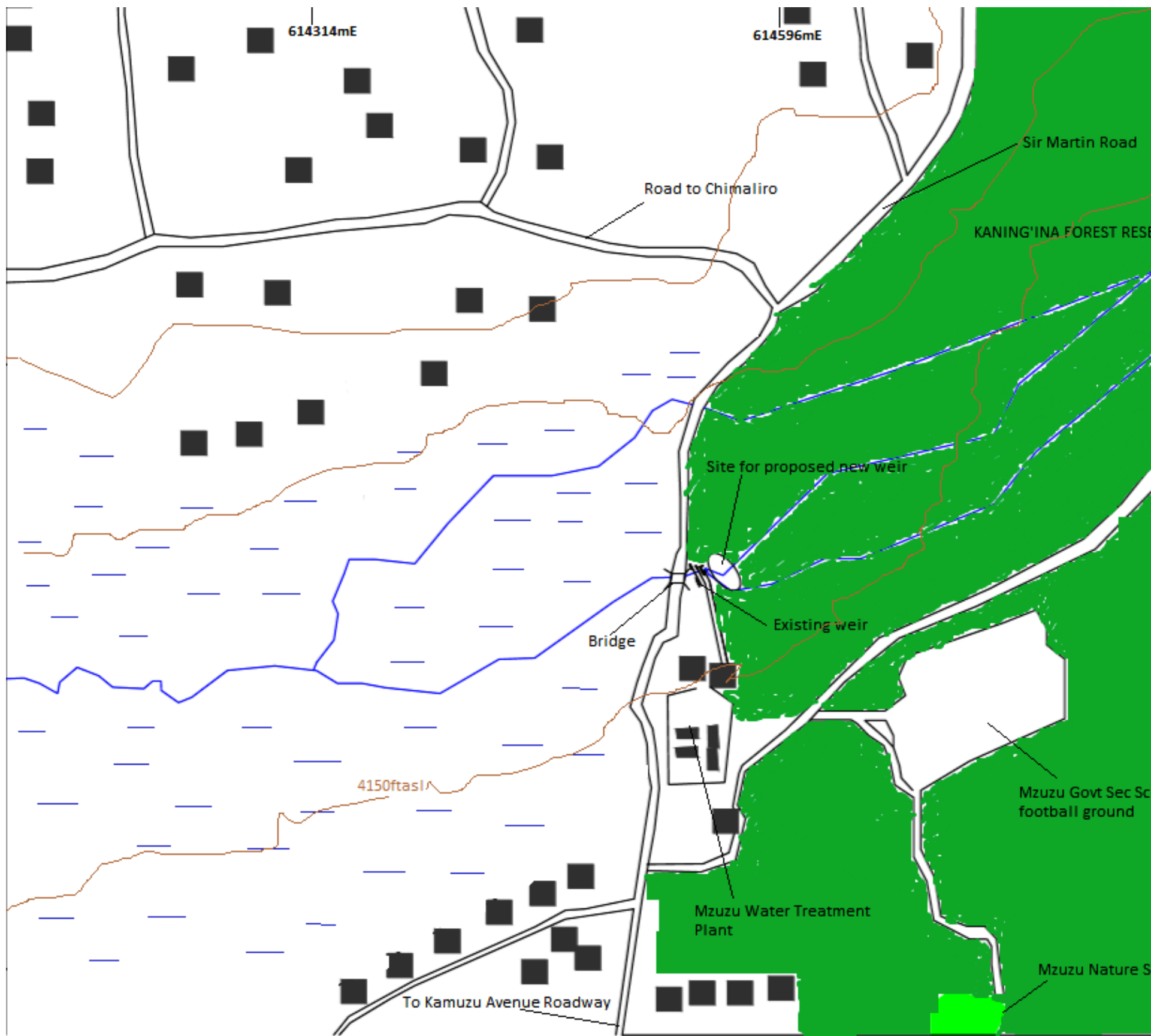


Figure 1.4: Locational map showing the proposed site for the new Mzuzu weir

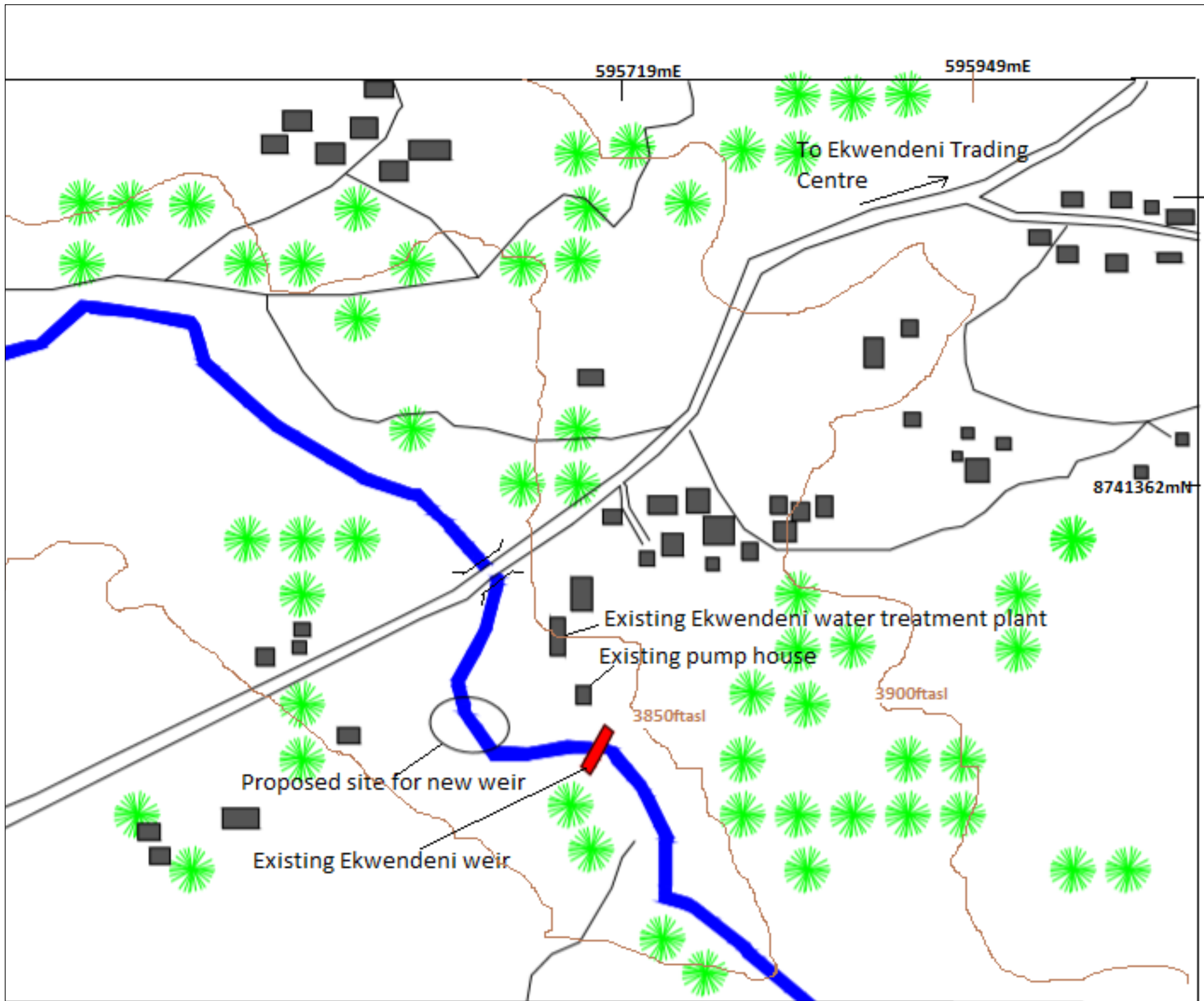


Figure 1.5: Locational map showing the proposed site for the new Ekwendeni weir

1.6. PROJECT PROPONENT

The proponent of the projects is Northern Region Water Board whose contact details are:

Proponent	Northern Region Water Board
Address	Street Address: Bloemwater Street Floor/Room number: 6 Town/City: Mzuzu Private Bag: 94 Country: Malawi
Telephone	01310254/255
Contact Person	Name: Eng. T.C Mtegha Position: Chief Executive Officer

1.7. PURPOSE OF THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

The Environmental and Social Impact Assessment is aimed at improving the overall environmental performance of the project through enhancing positive impacts and minimizing negative impacts. Specifically, the objectives of the ESIA are:

1. To identify potential significant environmental and social impacts of the proposed project, due to the construction and operation of the proposed new water intake, the bulk water transportation and storage infrastructure and the water treatment plant.
2. To recommend mitigation measures for the identified impacts by preparing Environmental and Social Impact Assessment (ESIA) report that will include Environmental and Social Management Plan and Environmental and Social Monitoring Plan, among others.

The ESIA study was to be undertaken in accordance with the Environment Management Act of 1996, Guidelines for Environmental Impact Assessment of 1997 and Environmental Impact Assessment Guidelines for Water Sector Projects of 2006. According to the Malawi EIA Guidelines of 1996, prescribed projects in the water sector include:

- Water pumping stations adjacent to lakes, rivers, and reservoirs which withdraw more than 2 cubic metres per second (Appendix B, Section A3.3);
- Drinking water supply schemes to serve a population of greater than 10,000 people, or expansions of existing schemes to serve a population water reticulation networks with more than 10 kilometres of pipeline (Appendix B, Section A3.4);
- Projects in proximity to or which have the potential to affect water bodies (Appendix B, Section A13), sub-section A13.4.

The proposed project, therefore falls within the above category of prescribed projects and by Malawi standards, requires an ESIA.

1.8. SCOPE OF THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

To satisfy the requirements of the Terms of References, while also meeting the national regulations and standards for Malawi, the scope for ESIA included the following:

- i. **Baseline assessment:** To identify the extent of the area (s); which will be affected by the proposed developments and to carry out an analysis of the existing condition of the environment and traditional society in order to compare with the situation after implementation of the project.
- ii. **Description of legal requirements:** Outlining the Malawi Government and the financiers' policies and legal instruments related to environmental and social issues that apply to the project at hand. The consultant was also expected to describe how the issues raised in the policies and legal framework shall be addressed in the project.
- iii. **Public Consultations:** Undertaking public consultations to ensure that all interested and affected parties are involved in the Environmental and Social Impact Assessment. Views of the stakeholders shall be incorporated and evidence of consultations shall be provided in the reports.
- iv. **Social Impact Assessment:** Assessing the positive and negative impacts of the proposed project on the traditional society within the influence of the project area.
- v. **Environmental Impact Assessment:** Assessing the impacts of the proposed developments on natural resources including terrestrial wildlife as well as aquatic life within the study area and their consequences on the local as well as on national economy.
- vi. **Preparation of Environmental/Social Management Plan and environmental/Social Monitoring Plan** detailing the positive and negative effects of the proposed developments on the environment and traditional society, and shall recommend appropriate solutions to minimize any undesirable effects resulting from the proposed developments.
- vii. **Cost Estimates:** determine costs for implementing the recommended mitigation measures. The costs shall be based on similar works implemented recently in Malawi.

1.9. METHODOLOGY FOR THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

The Consultant reviewed the feasibility study report which also includes project design and the Environmental and Social Screening information; documents with information and data for the project area including Mzuzu urban profiles and socio-economic profiles from Mzimba District, environmental profiles and maps; and policies and pieces of legislation relevant to the project. The reviewed documents have been included in the reference section.

Field investigations and baseline assessments were conducted for the Consultant to be acquainted with the set-up of the project site. The investigations facilitated verification of information from literature, with what is on the ground. Information was collected through transect walks and observations, onsite consultations and expert assessments. The information included the following:

- Biological environment: plant and animal species likely to be affected by the proposed development in the proposed project areas and surroundings;

- Geo-physical environment: geology, topography, soils, vegetation and surface water bodies;
- Socio-economic and cultural environment: cultural issues and economic activities, current land use and future development activities; and
- Existing physical developments: existing projects such as infrastructure and business enterprises.

Stakeholder consultations with the communities in the proposed water abstraction area and the area of influence were conducted through a household survey and Key Informant Interviews (KII). Consultations were also carried out at the national, regional and district levels. The outcomes of these consultations are provided in Appendix 4; while the list of people consulted is given in Appendix 5.

Identification and analysis of potential impacts of the project involved a review of impacts identified during the environmental and social screening, the use of checklists matrices, review of information collected through consultations, and the use of experts' knowledge. Subsequently, for each negative impact, mitigation measures were identified and recommended for implementation as outlined in the Environmental and Social Management Plan (ESMP) and Monitoring Plan (MP) that have been developed; while positive impacts of the proposed project have been recommended for enhancement.

1.10. STRUCTURE OF THE REPORT

The report has been organised into the following chapters:

Chapter 1: Background and Introduction - provides the background to the project and the ESIA, outlines the objectives of the project, its location and project proponent, land ownership, justification and the methodology for impact assessment of the project. The chapter also gives the objectives, approach and methodology for the ESIA study.

Chapter 2: Detailed description of the proposed project - discusses the main project activities, equipment and materials to be used in the project and environmental considerations in the project.

Chapter 3: Project alternatives considered - It reviews alternative project options and highlights reasons for preferring the recommended option.

Chapter 4: Project relevant policy, legal and administrative framework - provides an outline of the Malawi's policies, procedures and legislation which govern preparation of the ESIA. It also outlines regulatory licences and approvals and environmental standards to be met by the developer to ensure that the project activities are line with sound environmental practices. In addition, relevant Safeguard Policies and international conventions and agreements ratified by Malawi Government have been reviewed.

Chapter 5: Description of the project environment - describes the existing environmental and social conditions including physical, biological and socioeconomic aspects. Physical aspects include spatial location, topography and soils, drainage, climate (rainfall and temperatures),

land use patterns, Geo-hydrological aspect. Biological aspects include flora and fauna. Socioeconomic aspects cover population characteristics, health situations in the project area, agriculture, and degree of gender mainstreaming among others.

Chapter 6: Assessment of environmental and social impacts - outlines the approach and methodology for impact identification. It provides information on affected environmental components, based on the project phases and proposed project activities. The chapter also covers impact assessment and determination of mitigation measures.

Chapter 7: Environmental and social management plan – this provides a tabulated Environmental and Social Management Plan (ESMP) for managing the identified impacts. It also provides a summary of costs for managing the identified impacts and irreversible and unavoidable impacts due to the proposed project.

Chapter 8: Environmental and social monitoring plan - provides a tabulated Environmental and Social monitoring plan (ESMP) for effective implementation of the impacts enhancement and mitigation measures. It also provides a summary of costs for monitoring the implementation of the environmental and social management plan.

Chapter 9: Public Consultations – this chapter discusses the approach, objectives and methods and results of stakeholder consultations during the ESIA process, for the proposed Project.

Chapter 10: Conclusions and recommendations - highlights the conclusions of the report, based on the major findings of the ESIA study and the major positive and negative impacts of the proposed project. The Chapter also outlines the recommendations to be taken into account during project implementation.

Chapter 11: References – Captures the key reference material which was used for the production of the report.

CHAPTER 2 : DETAILED DESCRIPTION OF THE PROPOSED PROJECT

The proposed project to construct intake weirs across the Lunyangwa River at the Mzuzu WTP and at the Ekwendeni WTP has been developed as one of the quick interim interventions aimed at increasing the water supply capacity of the Mzuzu and Ekwendeni Water Supply Systems. After the construction of the two intake weirs, it is expected that there will be an increased water abstraction both at the Mzuzu and Ekwendeni Water Treatment Systems. This increased water abstraction is expected to increase the supply capacity of the two water supply systems to enable them to meet the existing water demands. Additional water that is to be abstracted at the proposed new Ekwendeni intake weir will be able to support water requirements for the supply area of the Ekwendeni WTP. Part of this water (abstracted from this new Ekwendeni weir) will be transmitted to supplement the water delivered to the supply areas of the Mzuzu Water Supply System. After the construction of the two weirs, it is expected that the Ekwendeni system will no longer be reliant on water abstracted from the Lunyangwa Dam.

The development of a new intake weir on the Lunyangwa River for the Ekwendeni Water Supply System will enable the abstraction of a total of approximately 13,200 m³/day up from the current 700 m³/day of water for the system at the Mzuzu WTP, a watertight weir structure that is to be constructed will enable the abstraction of more water which is currently lost through passing around or under the present weir (which is more of a temporary structure).

The proposed construction work for the two projects is planned to be implemented over a period of 4 months for the proposed Ekwendeni weir and 3 months for the proposed Mzuzu weir. The projects are having the following notable activities described as follows in the three phases of planning, construction as well as demobilisation and operation.

2.1. PROJECT COMPONENTS/ACTIVITIES FOR THE PROJECT PLANNING PHASE

Main activities during the planning phase include:

- i. **Feasibility Studies:** The projects are based on the Preliminary Designs and Feasibility Study for the construction of the Mzuzu and Ekwendeni weirs which were prepared by Technical Assistance Consultant. The reports were concluded in January 2019 the studies were aimed at assessing the feasibility of developing the two intake weirs on the Lunyangwa River. Feasibility assessments were conducted from technical, financial as well as environmental perspectives.
- ii. **Site identification and selection:** Identification and selection of sites for access roads to the project site for construction activities is also one of the main activities for this planning phase. The selection of the access road sites is taking into consideration the need to minimize negative impacts on the natural environment as well as the surrounding communities.
- iii. **Technical Design:** The Project has been designed by TAC. Activities during the design included surveying, site planning and preparation of maps.
- iv. **ESIA studies:** WWEC will prepare the ESIA report. WWEC activities in the current phase involved conducting baseline and socioeconomic surveys, desk studies, map preparations and public consultations.

The project is currently in the planning and design phase. Construction works will commence soon after completion of the design studies and after the necessary approvals and certificates have been granted and issued.

Prior to the commencement of the construction works, the following activities are planned for implementation:

- i. Preliminary cleaning out and inspection works; including cleaning out of the weir box at the dam downstream toe and inspections for signs of seepage at the dam, for working conditions of five inspection wells downstream of the dam as well as for conditions of surface settlement points on the dam upstream face near dam crest level.
- ii. Transportation of people and equipment to the site;
- iii. Establishment of on-site access roads;
- iv. Erection of work site signs posts and temporary fences where appropriate.

2.2. PROJECT COMPONENTS/ACTIVITIES FOR THE PROJECT CONSTRUCTION PHASE

2.2.1. Construction works to put up diversion channels to divert water

2.2.1.1 For the proposed Mzuzu weir

For the proposed new weir at the Mzuzu WTP, water flowing in the river downstream of the Lunyangwa Dam will first be diverted to allow for construction works for the new weir. The diversion of the water will be achieved by making it to pass through an existing small channel which drains down the right bank of the current weir as shown in figure 2.1.

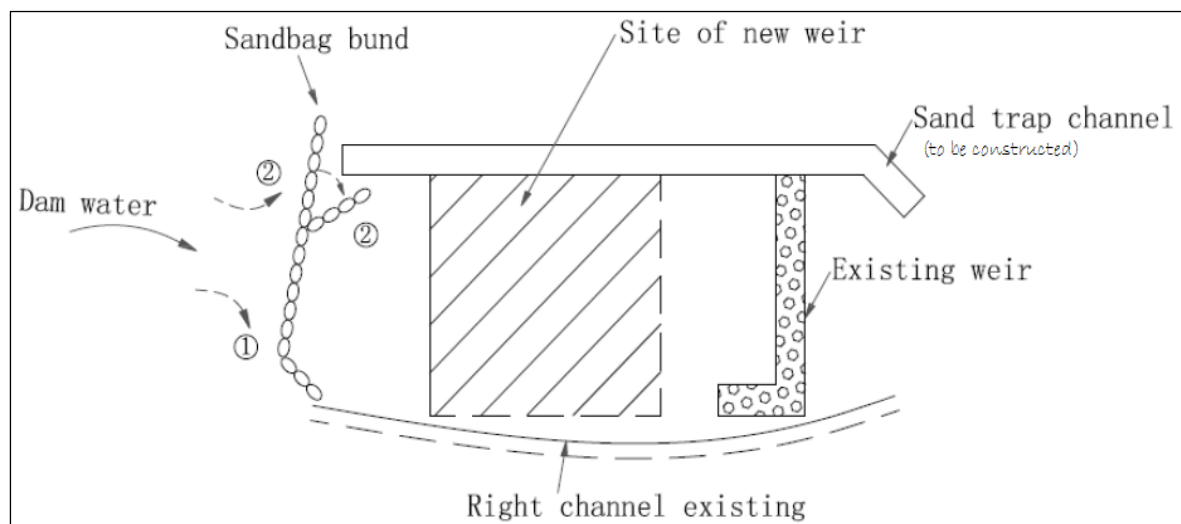


Figure 2.1: Details of proposed stream diversion works for the construction of new weir in Mzuzu

A wall of some estimated 60 sandbags will be laid across the valley at the upstream of the proposed construction site to necessitate the water diversion. The current plan is to use some of the existing sand bags which are part of the existing temporary weir just downstream of the proposed site for the new weir (figure 2.1). Just upstream of the sand bags for the diversion, an earth bund will be placed to support the sandbags. The earth bund is to be developed from earth material excavated for the weir structure. To aid with the water diversion works, a sump will be excavated at a left corner point of the earth-sandbag bund and water will be pumped from the sump through a small pump. Where the water pumped from the sump is deemed clean, it will be directed to the Mzuzu WTP. (Report on construction of new weir at Lunyangwa; NRW,2019).

For the Mzuzu weir, these diversion works will be temporary and the existing small channel on the right bank will be blocked off and all flows will be directed to the left bank as soon as construction of the concrete sand trap channel (in figure 2.1) is concluded. After completion of the whole new weir structure, the sand bags for the temporary diversion works will be removed and levelled out to form a kind of apron or realigned to form extended training walls. (Report on construction of new weir at Lunyangwa; NRW,2019)

2.2.1.2 For the proposed Ekwendeni weir

For the proposed weir in Ekwendeni, a channel to act as a stream water diversion path does not exist at the moment. A sand trap channel will hence be constructed first together with an integral right training wall and this channel will function as a diversion passage for the water during construction of the weir and stilling basin (Report on design of proposed Intake Weir at Ekwendeni; NRW,2019).

2.2.2. Construction excavation works for proposed main structures

2.2.2.1 For the proposed Mzuzu weir

For the Mzuzu weir, an estimated 97m³ of earth material is to be excavated to make room for the construction of a cut-off wall at the upstream end, the weir structure, stilling basin, the sand trap channel as well as a retaining wall on the right river bank. Excavations for the structures to be built with the exception of the cut-off wall are proposed to be made to a depth of some 20cm below formation. If the material to be excavated is seen to be of low strength silty clay, excavations will be taken down a further 30-50 cm or so. For the upstream end cut-off wall, excavation depth is envisaged to be at about some 1m, although the actual depth (which should not be far off from the proposed 1m) will be determined on site (Report on construction of new weir at Lunyangwa; NRW,2019).

2.2.2.2 For the proposed Ekwendeni weir

For the Ekwendeni weir, it is expected that some 200 – 300 m³ of soft material as well as some 50 m³ of weathered rock will be excavated for construction works to erect the weir structures. Excavation depth for the upstream cut-off wall at the Ekwendeni weir site is proposed to reach up to a level of fresh rock, a level of at least 2.5m below ground (Report on design of proposed Intake Weir at Ekwendeni; NRW,2019).

2.2.3. Backfilling of excavated areas

2.2.3.1 For the proposed Mzuzu weir

The trench excavated for the upstream cut-off wall for the Mzuzu weir will be quickly backfilled with plastic low strength concrete. For the rest of the structures to be built for the Mzuzu weir, backfilling of the excavated areas will be with hardcore, or granular road base type material to give a firm working platform. An estimated 256 m³ of backfill material is expected to be required to complete the backfilling for all structures including retaining walls to be built for the Mzuzu weir. All works of backfilling for the weir in Mzuzu will be followed up by levelling and compaction works (Report on construction of new weir at Lunyangwa; NRW,2019).

2.2.3.2 For the proposed Ekwendeni weir

The amount of soft material and weathered rock to be excavated at the site of the proposed Ekwendeni weir is planned to be utilised as backfill to level the area on the right bank of the weir. Downstream of the weir some 100 m³ of rip rap will be needed as backfill material, the rip rap will probably be obtained from any blasting works that may be required at the site or any boulders that may be found. Excavated areas for the foundations of the main weir structure and the stilling basin will be backfilled with some weathered rock. Similarly, the sand trap channel is also planned to be founded on some weathered rock or some kind of firm material. All works of backfilling for the weir in Ekwendeni will be followed up by levelling and compaction works (Report on design of proposed Intake Weir at Ekwendeni; NRW,2019).

2.2.4. Concrete construction works

2.2.4.1 For the proposed Mzuzu weir

For the weir in Mzuzu, a 15m long and 1m wide sand trap channel will be constructed in concrete. The channel will be constructed to allow for a water depth of 0.5m in the conduit. Concrete will be placed for the slab of the sand trap channel as well as for the channel walls which are expected to be at some 15-30 cm thick. The slab for the channel will be laid on a blinding layer of thickness 50mm provided with wire mesh reinforcement. Some 27 m³ of mass concrete of strength 20Mpa is expected to be utilised in the construction of the main weir structure for the Mzuzu weir. The stilling basin for the weir will be lightly reinforced with mesh to prevent cracking and it will utilise some 20 m³ of mass concrete of a higher strength of 24Mpa. 1m high training walls (to be constructed as in figure 2.3) will also be erected in reinforced concrete requiring some 16 m³ of mass concrete (of even a higher strength of 28Mpa). A 1m deep upstream end cut-off wall will also be constructed in reinforced concrete to provide stability and reduce seepage beneath the weir structure. An estimated 5.4 m³ of low strength concrete (strength 10Mpa) will be utilised in the construction of the cut-off wall. An estimated 7.5 tonnes of steel will be required for steel reinforcement works to the proposed concrete structures at the Mzuzu weir. The concrete construction works will include the assembling and erecting of formwork totalling an estimated area of 270m² for the Mzuzu weir (Report on construction of new weir at Lunyangwa; NRW,2019).

2.2.4.2 For the proposed Ekwendeni weir

Similarly, for the Ekwendeni weir, the sand trap channel, main weir structure and its stilling basin as well as training walls will all be constructed in reinforced concrete. The sand trap channel for the Ekwendeni weir will be of dimensions 12 m long by 1.5m wide by 1.1m deep. The weir structure will have a left bank training wall of height 5m and a right bank training

wall of height 3m. The profile of the weir structure will be of an ogee shape of Ogee length 4.15 m. Crest length for the weir will be 15m, the upstream apron length will be at about 5m. The stilling basin for the weir will have a length of 7.72m and its downstream apron length will be at about 11.5m (Report on design of proposed Intake Weir at Ekwendeni; NRW,2019). A plan view of the proposed weir, stilling basin and sand trap structures for the new Ekwendeni weir are presented in figure 2.4.

2.2.5. Hydro mechanical installations

2.2.5.1 For the proposed Mzuzu weir

At the site of the Mzuzu weir, a 1m square penstock type gate will be installed at the upstream end of the weir sand trap channel, and another 40cm square gate will be mounted at the downstream, for flushing the settled sand/silt. The gates will be of the manually operated type (figure 2.2).



Figure 2.2: An illustration of a manually operated penstock type gate with a valve

2 small suction pumps will be installed at the Mzuzu weir, one to be on duty, another one on standby. The pumps to be installed together with 2 control valves will be utilised in the pumping of water diverted during construction works to the water treatment plant at Mzuzu or to downstream of the construction site. A new 150 mm diameter size pipe line of length 100m will also be installed at Mzuzu to lead to the WTP. Electromechanical installations at the Mzuzu weir site will also involve the putting up of one complete electrical switchgear and panel (Report on construction of new weir at Lunyangwa; NRW,2019).

2.2.5.2 For the proposed Ekwendeni weir

At the Ekwendeni weir, mechanical gates will also be provided one at the inlet point and another at the outlet point of the sand trap channel. One other gate will be placed just before the outlet gate to act as a main flushing gate for flushing the settled sand/silt (figure 2.5). A new 400 mm diameter abstraction pipeline will be installed at the Ekwendeni weir to convey water by gravity to a new raw water pump house that is being constructed as part of the Ekwendeni WTP upgrade that is currently under construction. (Report on design of proposed Intake Weir at Ekwendeni; NRW,2019).

2.2.6. Building construction works

These will mainly be for the construction of pump houses at both the sites for the Mzuzu weir as well as the Ekwendeni weir. The pump houses are proposed to be constructed from

concrete blocks and will be built on a concrete slab. They will also be provided with tin roof over, a window and a door. At the Mzuzu weir site, the pump house is planned to be constructed by the side of the sand trap channel (figure 2.3) and is proposed to have the dimensions of 4m length by 3m breadth by 2m height (Report on construction of new weir at Lunyangwa; NRW,2019).

Figures 2.3, 2.4, 2.5 and 2.6 show the sketches for the plan views as well as sectional views for the two proposed weirs in Mzuzu and Ekwendeni. More details concerning the designs for the weirs are attached in annex 7 of this report.

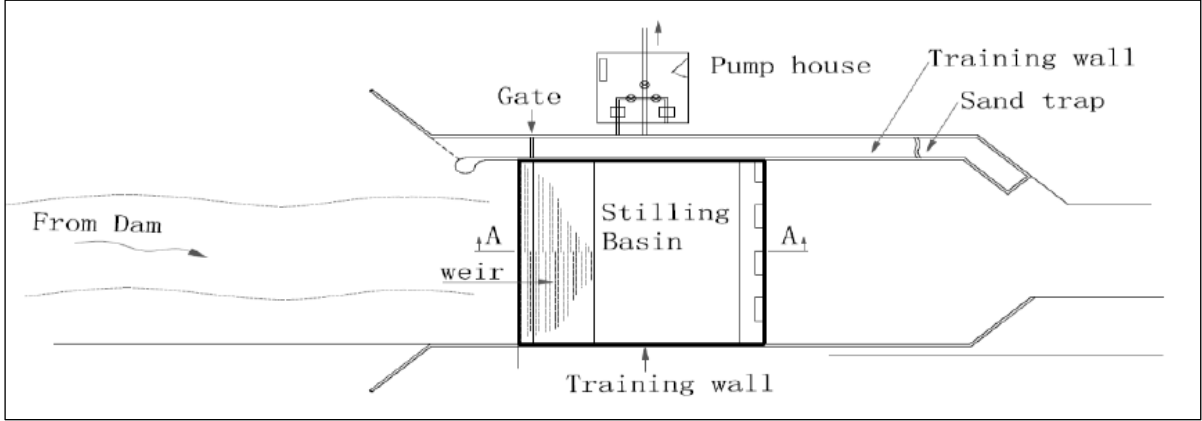


Figure 2.2: Sketch showing plan view of the proposed new Mzuzu weir and its associated facilities

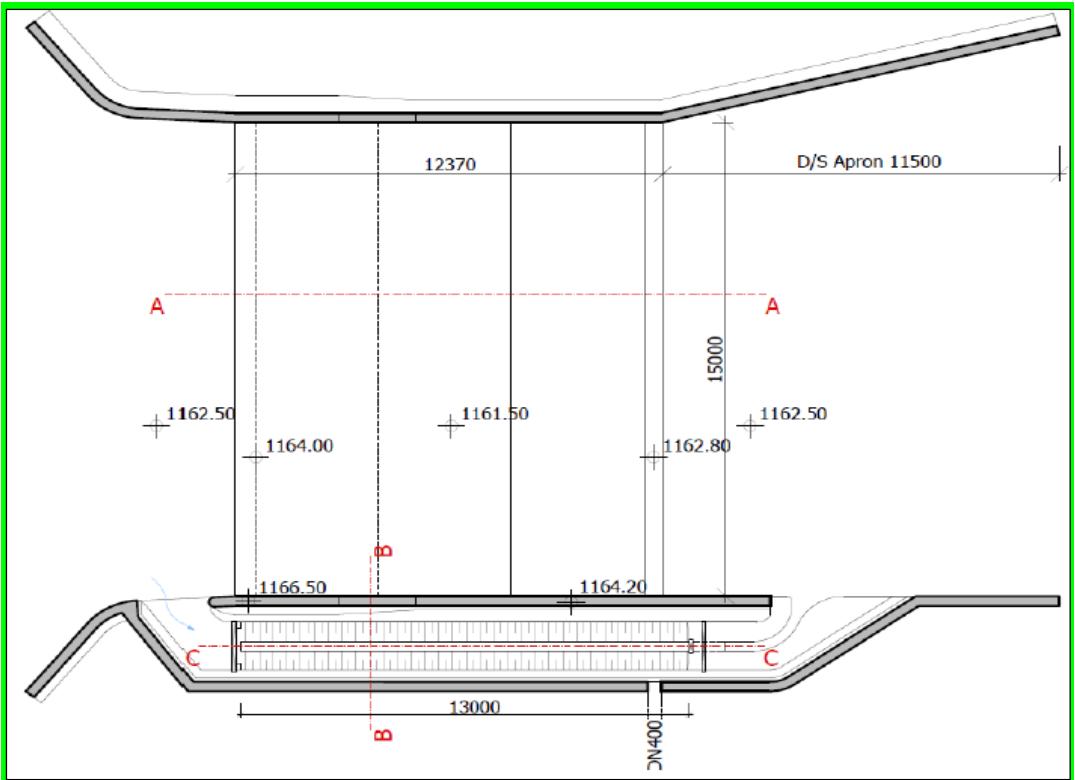


Figure 2.3: Sketch showing plan view of the proposed new Ekwendeni weir and its associated facilities (dimensions in figure are in millimetres. Numbers that have a plus sign beside them are levels measured in metres above sea level)

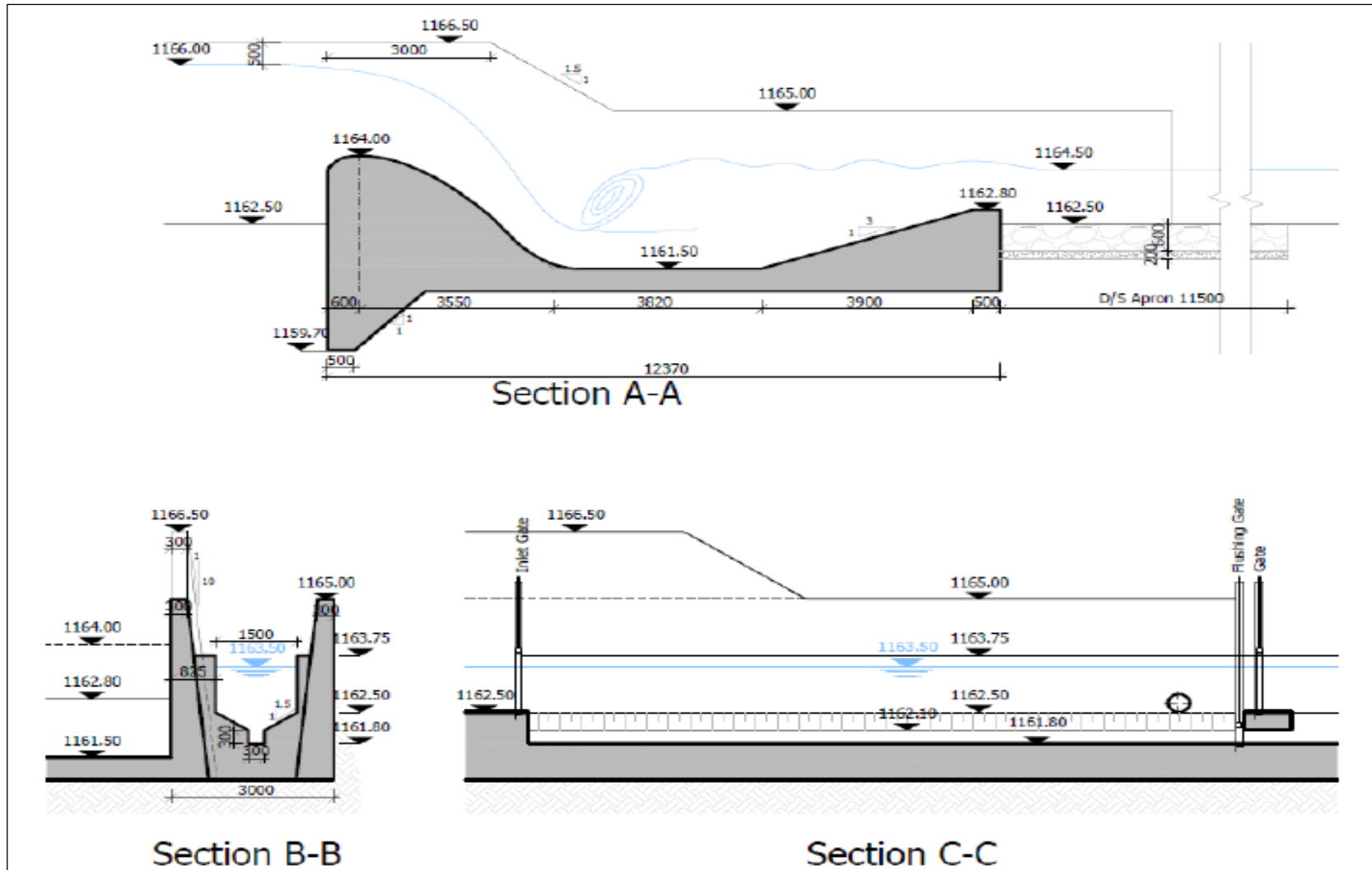


Figure 2.4: Sketches showing three sectional views of the proposed new Ekwendeni weir and its associated facilities (dimensions in figure are in millimetres. Numbers that have an arrow sign beside them are levels measured in metres above sea level)

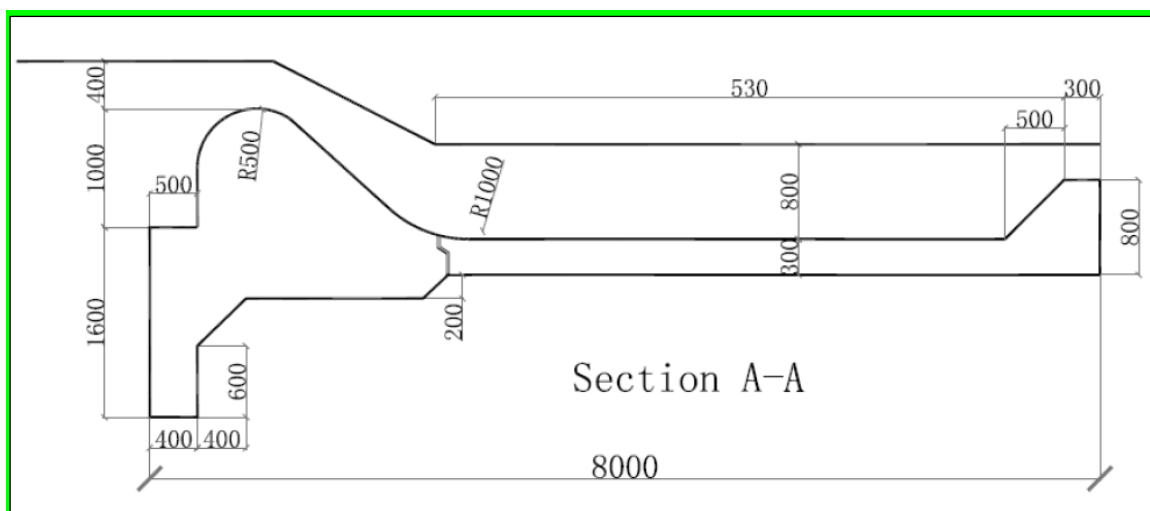


Figure 2.6: Sketch showing sectional view (section A-A) of the proposed new Mzuzu weir and its associated facilities (dimensions in figure are in millimetres.)

2.3. PROJECT COMPONENTS/ACTIVITIES FOR THE DEMOBILISATION AND OPERATION PHASE

For the demobilisation phase, all temporary works and structures will be removed as soon as possible after their use. These include temporary fences and barriers, workers' camp, scaffolding materials, work site signs post, steel cuttings and materials stockpiles among others. The construction sites will be cleared and the affected areas will be appropriately restored. Negative impacts might arise from the modes of removal of the temporary structures and their disposal upon the completion of the construction works.

During the operation phase of the proposed projects, the general expected major activity is that of increased abstraction of water from the Lunyangwa River at both the sites of the Mzuzu and Ekwendeni weirs. At the Mzuzu weir, it is expected that the water being abstracted will increase from the current 250 l/s as the more watertight concrete structure to be built will reduce the current losses of captured flow occurring due to water passing around or under the present sand bag weir. At the Ekwendeni weir, the abstraction of water from the river is expected to be increased to some 13,200 m³/day to allow for the supplying of raw water requirements of an extension to the Ekwendeni WTP which is expected to be implemented in the near future.

Apart from the increased water abstraction, all the other activities during the operation phase of the projects will be the normal routine activities of monitoring of river water flows, responding to emergencies such as abnormally high or low water flows and conducting of minor maintenances including cleaning up of debris and accumulated sands/silts as well as repairing of cracked areas of built structures and replacement of worn out mechanical parts.

2.4. LABOUR AND MATERIAL REQUIREMENTS FOR PROJECT ACTIVITIES

On the projects, there will be a significant amount of excavation, backfilling and compaction works. Mechanical excavators and compactors will hence be used significantly on the projects and will require operators and their assistants to be employed by the contractor who will be engaged for the projects. The contractor is also expected to employ some labourers to provide the necessary man power assistance on the construction activities. Offering of employment opportunities will consider where possible the recommendation of the national gender policy to ensure that a ratio limit of 40-60% employed female workers against 60-40% employed male workers is observed. Out of the people to find employment during the project construction phase, some 45% are expected to be employed as casual (non-skilled) labourers from the surrounding communities. The rest are expected to be skilled and semi-skilled workers including engineers, surveyors, environmental health and safety workers and foremen as well as plumbers.

Construction of reinforced concrete walls, beams and slabs will require machinery such as concrete mixers and vibrator pokers. In addition, labourers will be required to perform some functions including shaping the foundations and concrete works. Tippers will be used for hauling of materials such as soils, gravel and sand.

It is expected that there will be some very limited new employments during the operation phase after completion of the project construction works. Approximately some 2 new plant operators are expected to be employed at the Ekwendeni WTP after the upgrading of the system which will be done after the commissioning of the new weir. Otherwise no major changes to the operation activities at the water treatment plants are anticipated hence job opportunities for operation phase are limited.

Table 2.1 presents some of the major plant, equipment and materials that will be required for the construction works to develop the two intake weirs. The table also gives the project outputs and by-products that are to be expected from use of the equipment and material.

Table 2.1: Major equipment and materials

SN	Equipment or material	Use of the equipment or material	Source of the material	Output or product/by-product
1.	Backhoe loader	Excavation of trenches	To be provided by the contractor	Compacted trenches, firm foundation bases, dust and noise
2.	Trench compactor	Compaction of trenches	To be provided by the contractor	Compacted beds for foundations, noise
3.	Concrete mixer	Mixing concrete	To be provided by the contractor	Well mixed concrete, noise
4.	Tippers and trucks	Transportation of construction materials such as earth material, fine/course	To be provided by the contractor	Various construction materials, dust and noise

SN	Equipment or material	Use of the equipment or material	Source of the material	Output or product/ by-product
		aggregate, sand and cement.		
5.	Vibrating pokers	Concrete compaction	To be provided by the contractor	Well mixed concrete, noise
6.	Carpentry tools	For carpentry works during construction	To be provided by the contractor	Complete constructed timber structures (formworks, wooden rafters, ...)
7.	Fine and course aggregate	For concrete formulation	To be sourced locally. Course aggregate could be sourced from the nearby quarry which is the Zunguziwa Quarry located within the Mzuzu City.	Completed structures
8.	River sand and gravel	For concrete formulation and other construction works including placing as fill on embankment	To be bought from suppliers. Probable areas where gravel and sand will be sourced locally are mostly located along the Mzuzu-Ekwendeni Road but the actual source sites will be identified during the construction phase.	Completed structures
9.	Cement	For concrete formulation and other construction works	To be sourced locally or outside the country depending on quantity, quality and cost factors.	Completed concrete structures
10.	Water	<ul style="list-style-type: none"> For concrete formulation and other construction works 	To be sourced from approved suppliers	Potable water Polluted water
11.	Reinforcement metal bars	For concrete reinforcement	To be provided by the contractor	Reinforced concrete structures walls, beams and ogee structure of spillway

SN	Equipment or material	Use of the equipment or material	Source of the material	Output or product/by-product
12.	Concrete blocks	For construction of pump houses	To be provided by the contractor	Completed built walls for pump houses, waste from broken blocks

The activities mentioned above and all the other activities related to implementation of the project may cause positive and negative environmental impacts for which the enhancement and mitigation measures are discussed in chapter 6.

2.5. PROJECT COST

The total costs for implementing the Ekwendeni and Mzuzu weir projects are estimated at €165,000.00 and €65,000.00 respectively and are subject to change after design review. The cost estimates are taking into account the costs for all the construction works including mobilisation costs and they have been prepared based on rates obtained from recently completed similar projects in other countries. The costs are an equivalent of MWK 144,201,750.00 for the Ekwendeni weir and MWK 56,806,750.00 for the Mzuzu weir, converting using a rate of €1= MWK 873.95, quoted on the Reserve Bank of Malawi website on 5 July, 2019.

2.6. ENVIRONMENTAL CONSIDERATIONS

The design of the two intake weirs has considered the need to achieve a flow regime or a pattern in the Lunyangwa River, which provides for human uses and maintains the essential process required to support healthy river ecosystems. Consideration has hence been made in the designs for the weirs to the recommendation of the Malawi Department of Water Resources that 8% of the water flow in a river should be maintained in order to maintain the river regime and ecological habitat at an acceptable level. An average flow of 1600m³/day will hence be secured in the river (as 8% of average annual minimum daily flow for the Lunyangwa River) to ensure that the river does not dry up and that there is continued ecosystem functioning downstream of the weirs.

2.7. WASTE MANAGEMENT

The table 2.2 below details how various kinds of wastes generated due to the proposed project will be managed:

Table 2.2: Management of wastes generated from the proposed project

Waste type	Management
Concrete	<ul style="list-style-type: none"> ✓ Concrete wastes will not be allowed to enter any nearby watercourses. ✓ Concrete wastes will be dumped into temporary concrete washout facilities/pits.

Waste type	Management
	<ul style="list-style-type: none"> ✓ A sign will be installed adjacent to each temporary concrete washout facility to inform concrete equipment operators to utilize the proper facility. ✓ Concrete wastes will also be used to backfill burrow pits.
Oils	<ul style="list-style-type: none"> ✓ Used oil will be kept for oiling shutters during other constructions.
Steel	<ul style="list-style-type: none"> ✓ All steel cut-offs will be stockpiled on one protected area. ✓ After sometime the steel cut-offs will be sold to other companies which can use them.
Tyres	<ul style="list-style-type: none"> ✓ Broken tyres will be kept for recycling. ✓ If the tyres cannot be recycled, they will be sold off to other potential users (i.e. shoe makers).
Saw Dust	<ul style="list-style-type: none"> ✓ Saw dust will be used as an absorber where leaking oils will be made to fall to avoid soil contamination. ✓ Other saw dust will be thrown into waste collection skips and arrangements will be in place to get the collected waste disposed at the waste management facility for the Mzuzu City Council. ✓ At Ekwendeni, skips will also be utilised. The project construction contractor will hold discussions with officers from the Mbelwa District Council as well as local leaders to identify appropriate sites for dumping the collected waste at Ekwendeni.
Plastic and office Papers	<ul style="list-style-type: none"> ✓ These will be recycled where possible. Otherwise they will be put in bins then thrown into waste collection skips and arrangements will be in place to get the collected waste disposed at the waste management facility for the Mzuzu City Council. ✓ At Ekwendeni, skips will also be utilised. The project construction contractor will hold discussions with officers from the Mbelwa District Council as well as local leaders to identify appropriate sites for dumping the collected waste at Ekwendeni.
Foods	<ul style="list-style-type: none"> ✓ All food wastes will be deposited into a nearby dust bin and later into a rubbish pit. ✓ After some time the rubbish pit will be covered with a layer of soil to avoid flies and to facilitate decomposition.
Waste Water	<ul style="list-style-type: none"> ✓ Waste water from latrine facilities at the project site will be drained into a septic tank. The waste from the septic tanks will be emptied when full using vacuum tankers. They will then be transported to sewage sludge ponds at Nkhorongo in the Mzuzu City for disposal.
Exhaust Fumes	<ul style="list-style-type: none"> ✓ Machinery will be well maintained and the most modern machines will be used, where possible.

CHAPTER 3 : PROJECT ALTERNATIVES CONSIDERED

3.1. THE “NO ACTION” OPTION

Since there is already clean water supply infrastructure serving the areas of Mzuzu City and Ekwendeni Town, there are no other feasible/cost effective alternatives identified other than the upgrading and rehabilitation of the existing water supply facilities. This is necessary so that the systems will not only have the capacity to supply clean water to the people that are currently being served in the two urban areas, but also those residing in immediate surrounding communities that are to be served once the distribution systems are upgraded. Upgrading of the systems is an absolute necessity in light of the growing demands for water in the project areas.

With this said, the environmental and social consequences of a “no action” option are that:

- a) People of Mzuzu City and Ekwendeni Town as well as immediate surrounding areas would not have access to adequate and efficient potable water supply services.
- b) Those that do not have piped water would continue to utilize unsafe, and at times unreliable water supply sources.
- c) Women would continue to bear the burdens of fetching water from long distances and girls would have to spend more time helping their mothers to fetch water, consequently limiting their time that would have otherwise been utilized for school.
- d) Due to increased water shortages that may come as water supply becomes inadequate to meet the growing demand, adolescent girls who are in school may be absconding from school during their menstrual periods as they may not have enough water for washing.
- e) Many people would be exposed to water related ailments stemming from the use of unsafe water.

On the other hand, the “no action” option would mean that the project-associated environmental and social impacts would not be felt by the communities in the project and surrounding areas. Also, the environment, as well as natural resources would be spared from the project negative effects.

3.1 TECHNICAL ALTERNATIVES

These mainly include options for the location of the proposed intake weirs as well as for materials to be used in the construction of the intake weirs.

In terms of location for the Mzuzu weir, three possible locations were considered being:

- a. Between the current makeshift weir and the Sir Martin Road crossing
- b. Upstream of the current makeshift weir
- c. At the Sir Martin Road crossing

The location option (a) for the location of the Mzuzu weir would involve using the existing makeshift weir to divert water while the foundations of the new weir structure are being formed during construction. Two problems are associated with this being that:

- the current weir is not very watertight, and it would be impossible to get a dry formation on which to build the new structure;
- There are 3 existing pipes of diameter 400mm, 200mm and 150mm which are crossing the river at this point between the current weir and the road crossing. These pipes will interfere with construction and in the long term will be vulnerable during high flows.

For the locational option (b) of the Mzuzu weir (which is the preferred location), there are no obstructions in this case, but the biggest problem will be to divert water away during construction. The water diversion could be made by use of a sheet pile wall across the water course and excavating a sump at the left corner. Water could be pumped from the sump to the WTP and any excess pumped via a temporary pipeline round the construction works to downstream. Since the installing of a sheet pile wall needs access and special equipment; a cheaper solution is to use sandbags and an earth bund upstream of them using material excavated for the new weir structure.

Locational option (c) for the Mzuzu weir would put the new weir downstream of the pipes traversing the site. The immediate advantage would be that the side walls for the weir could be designed to act as abutments for a new bridge forming the road crossing. For water diversion during construction, the present weir and canals could be used. Main disadvantage is that the pipes crossing the site would need to be accommodated in the weir training walls and will be submerged during high flows.

In terms of materials to be used for construction, in the designs, there was consideration of alternative materials to use to divert water when construction works for the new Mzuzu Weir will be taking place. The options were either to use steel sheet piles or a combination of existing sandbags and a bund of earth to divert the stream for construction works. The use of steel sheet piles would have the following advantages over the sandbag-earth bund arrangement:

- Provision of high resistance to driving stresses.
- Light weight
- Can be reused on several other projects after the diversion works are done.
- They have longer service lifespan above or below water.
- They are easier to adapt to the pile length through either welding or bolting

The sandbag-earth bund arrangement is however the selected option in the design due to the following advantages over the steel sheet piles:

- It is less costly to implement
- The materials to create the arrangement are available locally, with the sandbags obtained from those being used for the current makeshift weir and the earth from excavations at the site
- There is avoidance of disturbances such as settlement of adjacent properties which could have come about due to vibrations from sheet pile driving.

3.2 ECONOMICAL ALTERNATIVES

The upgrading of the Mzuzu and Ekwendeni schemes through construction of new proper river intakes will result to increased amounts of potable water supplied to the service areas. This will lead to increased revenue for the NRWB, taxes for the government, job and associated business creation ultimately contributing to the improvement of the national economy. Safe water will contribute to the reduction in demand for medical health services and medicine. In addition, the burden on women and school girls, associated with fetching water will be reduced and the women will be able to participate and contribute better to economic development. School girls will have the opportunity to do better in school and qualify for better jobs. All this will translate to improved economic development of the country.

CHAPTER 4 PROJECT RELEVANT POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

This chapter summarizes the policy, legal and administrative framework within which the ESIA was carried out. It also identifies relevant international environmental/social agreements that may be related to the project.

4.1. ENVIRONMENTAL MANAGEMENT IN MALAWI

Malawi is a signatory to the 1992 Rio Declaration on Environment and Development. Principle 17 of the declaration commits Malawi to undertaking environmental impact assessments (as a national instrument for environment management), subject to a decision of a competent authority, on all proposed activities likely to have significant negative impact on the environment. Following the declaration, several policies and legislations on environmental management have been developed, of which the overarching legislation is the Environment Management Act (EMA) of 1996. From the same The Malawi Guidelines for Environmental Impact Assessment were developed in 1997 and are under revision.

The Environmental Affairs Department (EAD) in the Ministry of Natural Resources, Energy and Mines (MNREM), is the responsible authority for development and enforcement of environmental policy and legislation. The EAD, with support from the Technical Committee on the Environment (TCE), and in line with the provisions of the EMA as well as the Environmental Impact Assessment Guidelines of 1997, determines whether an ESIA is required or not, for all projects. The TCE reviews environmental and social impact assessment reports for proposed projects and makes recommendations to the Director of Environmental Affairs, who reports to the National Council for the Environment (NCE). The NCE considers the recommendations from the DEA and advises the Minister for approval and issuance of the environmental certificate for the project to proceed.

4.2. POLICY FRAMEWORK

4.2.1. The National Water Policy (2005)

This policy provides an enabling framework for integrated management and utilization of water resources in order to provide water of acceptable quality and sufficient quantities in Malawi. The policy also intends to ensure availability of efficient and effective water and sanitation services that satisfy the basic requirements of every Malawian; and for the enhancement of the country's natural ecosystem. Realising the challenges, threats and opportunities associated with implementation of activities in the water and sanitation sector similar to the proposed project, the GoM through the Ministry of Water Development established the policy tailored at tackling any issues in the sector in an integrated manner, through involvement of all concerned stakeholders, including communities.

In general, the policy advocates for protection of water resources from unsustainable utilization, which may result in its depletion and degradation through pollution. Northern Region Water Board will ensure that the river from which the water is abstracted is not

depleted or degraded because of the water abstraction by following the mitigation measures and recommendation that are provided in this ESIA report.

The National Environmental Policy (NEP, 2004)

The NEP is a central guide for all environmental and natural resources sectoral activities. Hence, the EIA Guideline for Water Sector Projects (GoM, 2006), recognises the National Environmental Policy (NEP) as a key instrument that provides standards or benchmarks for water policies and legislation in Malawi.

The overall goal of the NEP is *“The promotion of sustainable social and economic development through sound management of the environment in Malawi”* and some of the goals that the NEP seeks to accomplish are:

- a) Securing for all person’s resident in Malawi now and in future, an environment suitable for their health and well-being;
- b) Promoting efficient utilisation and management of the country’s natural resources;
- c) Facilitating the restoration, maintenance and enhancement of the ecosystems and ecological processes essential for the functioning of the biosphere and prudent use of renewable resources.

In view of the above, the NEP relates significantly and directly to the activities of the proposed river intakes for improvement of water supply system in Ekwendeni town considering that water is a natural resource that must be managed and utilised sustainably for the betterment of both present and future generations. Section 5.5 of the NEP clearly stipulates that a cross-sectoral objective of the water sector is to manage and use water resources efficiently and effectively, so as to promote its conservation and availability in sufficient quantity and acceptable quality.

4.2.2. Guidelines for Environmental Impact Assessment (1997)

The Guidelines for Environmental Impact Assessment (EIA) 1997 outline the process for conducting EIAs and facilitate compliance to the EIA process by developers, as provided for in the Environment Management Act, 1996. They act as a tool for integrating environmental concerns into development plans at all levels. The guidelines also provide a list of prescribed projects for which EIA is mandatory.

According to these guidelines, the proposed project falls in the category of which an ESIA is mandatory (list A) due to the following provisions:

- **A3.4:** Drinking water supply schemes to serve a population of greater than 10000 people, or expansions of existing schemes to serve a population water reticulation networks with more than 10 kilometres of pipeline.

The guidelines act as a tool for integrating environmental concerns into development plans at all levels.

It is a requirement under section 29 of EMA that developers submit EIA Reports to EAD for review and approval for all prescribed projects, hence, the preparation of this report.

4.2.3. EIA Guidelines for Water Sector Projects (2006)

The purpose of these guidelines is to ensure and facilitate compliance with the Environment Management Act of 1996; by Government agencies, project developers and the general public. The guidelines follow the same principles outlined in the Malawi Guidelines on Environmental Impact Assessment (1997), with the addition of more technical detail applicable specifically to water projects. The guidelines are distributed and administered by the Environmental Affairs Department (EAD) in the Ministry responsible for Environment. This project will be implemented in relation to the EIA guidelines for water sector projects so that negative and positive impacts are mitigated or enhanced respectively.

4.2.4. The Malawi Growth and Development Strategy III (MGDS III) 2017-2022

The Malawi Growth and Development Strategy III recognises that water is an important resource for a health living and agricultural development. On health, the strategy advocates the promotion or adoption of safe water and sanitation practices at individual and household level. The policy also emphasises the need for promotion of community-based management of rural water supply facilities, strengthening of monitoring and evaluation systems for water utilization and management; and the improvement of water supply in rural and urban areas for both agriculture and irrigation.

The proposed 2 rivers intakes project with the aim of improving water supply are in line with the goals of the MGDS III to meet the challenge of water supply, sanitation and hygiene services provision at household level and whole country.

4.2.5. The National Gender Policy (2005)

The National Gender Policy was developed and adopted to address persistent gender inequalities, under representation of women in decision-making positions at all levels and other related issues. The policy provides guidelines for mainstreaming gender issues in various sectors of the economy to reduce gender inequalities and enhance participation of women, men and the youth for sustainable and equitable development, as well as poverty eradication in the country.

In line with the Gender Policy, gender should be mainstreamed in all stages of the proposed project. Some of the measures that will be taken to ensure that there is gender mainstreaming in this project include involving women in the consultations, awareness and sensitization process, natural resources management, providing equal employment opportunities to women and men and close monitoring of gender related impacts.

4.2.6. The National HIV and AIDS Policy (2016)

The goal of this policy is to prevent HIV infections, to reduce vulnerability to HIV, to improve the provision of treatment, care and support for people living with HIV/AIDS and to mitigate the socio-economic impact of HIV/AIDS on individuals, families, communities and the nation.

The policy recognizes that social, political and economic conditions create and sustain vulnerability to the risk of HIV infection which include unequal position of girls and women in society and the fact that, due to biological, social, cultural and economic factors women are more likely to become infected and can be more negatively affected by HIV/AIDS than men.

In line with this policy, NRW has HIV and AIDs Policy at an organisation level. During the project implementation period, the developer will conduct civic awareness meetings in the project area that will help in disseminating information to women and girls on STI and AIDs issues. In addition, the developer will also consider employing women that are capable to do the work throughout the project to reduce economic stress which is one of the factors that make most women more likely to become infected and affected by HIV.

4.2.7. Malawi State of Environment and Outlook Report (2010)

The State of the Environment and Outlook Report (NSOER) 2010 recognises that despite efforts made in environment management, degradation of natural resources continues to be a major threat to the social and economic development of Malawi. High population density and dependence on agricultural production have led to alarming rates of environmental degradation. The result has been deforestation; decreasing soil fertility and increasing erosion; water depletion, loss of biodiversity; and increasing pollution.

The State of the Environment and Outlook Report 2010 aims to address these challenges by providing a knowledge resource for researchers and the general public, to serve as the baseline for monitoring trends in environmental change in Malawi, and to inform policy-makers about the challenges facing Malawi. The Malawi State of Environment and Outlook Report provides the status of the environment at national level. The main problems highlighted in the NSOER include:

- High silt loads, during the rainy season, causing sedimentation;
- High water treatment costs and frequent pump wear;
- Soil erosion in catchments caused by deforestation and unsustainable cultivation practices;
- Sediment loading into the rivers due to irrigation farming along the rivers, river banks and river bed;
- Soil erosion and chemical pollution due to intensive cultivation in water catchment areas, without adequate conservation measures;
- Presence and extent of human settlement in catchment areas; and
- Discharge of effluents into the rivers.

The NSOER therefore provides a basis for environmental planning and development of the proposed project. The project will make sure that there is no discharge of effluents into the rivers in especially in the operation. Wastewater will be treated and tested before discharging it into the river on anywhere. During the construction phase, the project developer will make sure that the sediments or soil piles are not deposited into the river. This will be achieved by following the mitigation measures that have been provided in this report.

4.2.8. The Malawi National Land Policy (2002)

The intent of the Malawi National Land Policy (2002) is to provide guidance on the management of land in Malawi, to promote optimal utilisation of the country's land resources for sustainable socio-economic development. With due recognition that land is a basic resource common to all people in Malawi, the Policy provides for procedures aimed at protecting and regulating land tenure rights, land-based investments and developments at all societal levels. Some of the objectives of the policy include: promotion of land tenure practices that guarantee security and fairness in any land related transactions and enhancement of conservation and management of land resources by communities.

The objectives above are aimed to ensure that local communities do not become victims of developments that may target their land and that where their land or themselves are affected negatively by development projects, they shall be compensated through transparent land administration procedures.

This ESIA, therefore, has taken into consideration; any potential land use related conflicts and any affected communities, in an endeavour to provide sustainable solutions for advancement of development, without infringing on rights of the affected communities over land ownership. Where land belonging to individuals is required, the project developer will compensate the people for the land loss.

4.3. LEGAL FRAMEWORK

4.3.1. Constitution of the Republic of Malawi (1995)

Section 13, part d, accords for managing the environment and sustainable development of natural resources to prevent degradation; provide a healthy living and working environment for the people of Malawi; accord full recognition to the rights of future generations; and to conserve and enhance the biological diversity of Malawi. Thus, it paves the way for the Environment Management Act. The project developer must comply with the "section" through adhering to the provisions of the Environment Management Act and implementation of the Environmental Management Plan (ESMP) as provided in this ESIA report.

Regarding protection of property rights, the Constitution has three key sections on the subject (Section 28, 24 and 44). Section 28 entrenches the right to property. It provides that *"every person shall be able to acquire property alone or in association with others, and that no person shall be arbitrarily deprived of property. According to s. 44(2), "expropriation of property shall be permissible only when done for public utility and only when there has been adequate notification and appropriate compensation, provided that there shall always be a right to appeal to a court of law"*. In Malawi, the courts have held that this constitutional protection of property rights avails to customary and registered land alike.

Under Section 13 (e), it is the responsibility of the state to achieve gender equality for women through: full participation of women in all spheres of the Malawian society, on the basis of equality with men; implementation of principles of non-discrimination and such other measures as may be required; and implementation of policies to address social issues such as

domestic violence, security of the person, maternal benefits, economic exploitation and rights to property.

The project developer will have to ensure that activities during all phases of the project promote environmental protection and sustainable development of natural resources, including water and biological diversity resources. The project also has to promote gender equality and human rights as stipulated in the constitution of Malawi.

4.3.2. The Environment Management Act (EMA, 1996)

The Environment Management Act (EMA), as an overarching legislation for environmental management in Malawi, accords specific responsibilities to various sectoral authorities on matters pertaining to environmental planning and management. The Act requires the Director for Environmental Affairs to ensure that, prior to implementation, all projects prescribed for environmental impact assessment shall undergo comprehensive assessment in order to enhance positive impacts and mitigate for negative impacts.

In response to section 24 of the EMA, Guidelines for Environmental Impact Assessment (EIA) were published in 1997, as a benchmark for environmental planning and management of any proposed and existing prescribed EIA projects. Hence the preparation of this ESIA before the implementation of the project.

4.3.3. Land Act (2016)

The Land Act of 2016 was enacted to provide for land administration and management in Malawi. The Act groups land into two categories, "private land" and "public land". Public land comprises of Government land and unallocated customary land. The Land Act also makes provisions for land acquisition which includes compensation of people affected by any project.

Section 13 under section (1), (2) and (3), states that;

- "any person who by reason of any acquisition suffers any disturbance or loss or damage to any interest which he may have or immediately prior to the occurrence of any of the events referred to in this section, may have had in such land shall be paid such compensation for such disturbance, loss or damage as is reasonable."

The land to be used for this project is private and it belongs to the Northern Region Water Board. However, in case some land is acquire from people, the NRWB will have to pay compensation to the affected people before proceeding with the project.

4.3.4. Water Works Act (1995)

The Water Works Act provides for the establishment of Water Boards and water-areas; and for the administration of such water-areas as well as for the development, operation and maintenance of waterworks and water-borne sewerage sanitation systems in Malawi; and for matters incidental thereto or connected therewith. The Act is thus relevant for the development of the water supply infrastructure including the pipelines, tanks and all other related structures for the project.

Part III, section 11 of the Act gives powers to the Northern Region Water Board to develop, construct and maintain all works as are necessary and convenient for the purpose of creating, maintaining and extending water supply for domestic, public and business purposes. The proposed construction of the two river intakes is in line with this act as it aims at extending the water supply in Mzuzu City for domestic and business purposes.

4.3.5. The Water Resources Act (2013)

The Water Resources Act of 2013 supersedes the 1969 Water Resources Act and aims to provide for the management, conservation, use and control of water resources; for the acquisition and regulation of the rights to use water; and for matters connected therewith or incidental therefore.

Part iv, section 39 (1) stipulates that no person shall abstract and use water unless authorised to do so and (2a) a licence under this Part shall be required for the abstraction, impoundment and use of water from a water resource.

Part viii, section 92 (1) requires that a person request for a discharge permit for projects that discharge effluents in water surfaces.

Northern Region Water Board will require to get licence for water abstraction and an effluent discharge permit from the Malawi National Water Resource Authority, Mbelwa District Council and Mzuzu City Council.

4.3.6. Local Government Act (1998)

The Act mandates all local authorities to regulate planning and development within their jurisdiction and also empowers them to have by-laws that specify how development projects should minimize and avoid environmental degradation. This Act also devolves decision-making authority from central government to local authorities, through the process of decentralization. The Act has concrete provisions for participation of rural communities in development planning, implementation and monitoring.

The proposed project will adhere to the requirements of the Act by fully involving the Mzuzu City council, Mbelwa District Council and rural communities and ensuring that any by-laws set by the Council are followed throughout the project cycle.

4.3.7. The Occupational Safety Health and Welfare Act (1997)

The Occupational Safety Health and Welfare Act (OSHW Act) stipulates the provisions for a safe working environment for the people of Malawi. The OSHW Act therefore was established to provide for the regulation of employee safety, health and welfare in the workplace and to provide for enablers for prevention and regulation of accidents in the workplace.

It is envisaged that various occupational safety and health (OSH) issues will be encountered during implementation of the proposed project. Hence, it is imperative for NRWB to ensure that OSHW requirements are adhered to at all times. This ESIA has outlined the interventions

that will be required for implementation and monitoring during the lifespan of the project to make sure that workers have safe working environment.

4.3.8. Forestry Act (1997)

This Act provides for participatory forestry, forest management and protection and rehabilitation of environmentally fragile areas. The Act, among other things, seeks to: augment, protect and manage trees and forests on customary land, in order to meet basic needs of local communities and for conservation of soil and water; promote community involvement in the conservation of trees and forests in reserves and protected areas; prevent resources degradation to increase socio-economic benefits; promote community involvement in trees and forests conservation; promote optimal land use practices through agro-forestry in small holders farming systems; protect fragile areas such as steep slopes, river banks, water catchment and conserve and enhance biodiversity. Hence, NRW will ensure that biodiversity and ecosystems are conserved throughout all the project stages by adhering to the recommendations; and implementing the mitigation measures in this report.

4.3.9. Gender Equality Act (2013)

The Gender Equality Act of 2013 reflects the Government of Malawi's commitment to implementing the Gender Policy and makes provisions for the Human Rights Commission to:

- Monitor and evaluate the state organs, state agencies and public bodies including the private sector to promote gender equality and make recommendations that the Commission deems necessary;
- Carry out investigations and conduct search in relation to any gender issues on receipt of complaints or on its own accord;
- Make recommendations to the Minister on any gender issues;
- Provide information to any party in a gender dispute on rights, remedies or obligations; and
- Perform functions on implementation of the Gender Equality Act.

In line with this act, the project will be implemented in a such a way that women are also given an opportunity in both skilled and unskilled labour. Another way is that different institutions (table 8.1) will monitor the project in different stages to make sure that women are not hindered from benefiting/ participating from the project.

4.4. REGULATORY FRAMEWORK

Table 4.1 summarises all regulatory licences, approvals and standards that have to be obtained or met for the proposed project to ensure that the project activities are in line with sound environmental management practices and comply with the relevant legislation.

Table 4.1: Regulatory licences and approvals relevant for the project

No	Regulations/ Standards/Approvals	Description	Reference	Issuing Institution
1.	Environmental Certificate	The certificate is provided after approval of the ESIA report.	EMA, 1996 and EIA Guidelines 1997	EAD
2.	Water Abstraction Permit	Allows the abstraction of groundwater or surface water	Water Resources Act 2013	National Water Resource Authority
3.	Effluent discharge permit	Environmental Management Act (1996), Water Resources Act (2013)	To comply with effluent standards and avoid environmental pollution.	Mzuzu City Council and Mbelwa District Council
4.	Planning permit	To ensure that project is implemented within the city council development plans.	Local government	Mzuzu City Council And Mbelwa District Council
5.	Workplace Registration Certificate	This regulates workers safety and health	Occupational Safety Health and Welfare Act (1997)	Ministry of Labour Youth Sports Manpower Development

4.5. ENVIRONMENTAL STANDARDS IN MALAWI

During the construction and operation phase, the project will also trigger a number of Environmental Standards set by the Malawi Bureau of Standards as provided in Table 4.2. The NRWB and the contractor must ensure that the standards are met.

Table 4.2: Relevant Environmental Standards

Standard	Title	Year of Implementation
MS 214:2013 (second Revision)	Drinking Water – Specification	2013
MS 714:2005	Occupational Safety and Health Management Systems - Specification	2005
MS 719:2005	Hazardous Waste – Management, Classification and	2005

	Disposal – Code of Practice	
MS 59:2002	Solid waste – handling, transportation and disposal – code of practice	2002
MS 730:2005	Solid waste disposal sites, guidelines for design	2005
MS 539:2013	Industrial effluents- Tolerance limits for discharge into inland surface waters	2013

4.6. Environmental and social management standards for EIB

The EIB is a public institution driven by the policy objectives of the European Union and their principles of sustainable development, public participation, and accountability. It seeks to promote sustainable and inclusive growth while protecting the natural and social environment in a holistic manner, thereby ensuring that requirements relating to the protection of the environment and human well-being are integrated in the definition, preparation and implementation of all operations financed by the EIB. The EIB also recognises the need for a proactive approach to ensure that environmental and social considerations are taken into account during the early stages of strategic decision-making by promoters so as to have a real influence on the choice of alternative developments. Five relevant standards to the project have been reviewed in the report, and they include;

4.6.1. Assessment and management of environmental and social impacts and risks

The overall objective of this Standard is to outline the promoter’s responsibilities in the process of assessing, managing and monitoring environmental and social impacts and risks associated with the operations. EIB promotes the application of strategic environmental assessment as a tool for identifying and evaluating potential impacts of plans and programmes as well as the development of adequate management plans and programmes. Hence, the development of this ESIA by NRW.

The standard also stipulates that “in this respect, all EIB-financed operations shall comply with national legislation and international conventions and agreements ratified by the host Country. The NRW will comply with all legislative requirements for the Republic of Malawi as outlined above and the EIB standards in all the phases of the project.

4.6.2. Pollution prevention and abatement standard

One of the objectives of the pollution prevention and abatement standard is “avoiding of any deterioration in the quality of human health or the environment, and any loss of biodiversity, by avoiding, reducing and, if possible, compensating/remediating significant adverse effects of projects supported by the EIBs. Clearing of vegetation is anticipated in this project especially during the construction phase as the area to store the building materials will be located near the River Intakes and within the forest reserve. Hence, NRW will ensure that biodiversity loss and deterioration of quality of human health or the environment and loss of biodiversity is avoided by adhering to the recommendations; and implementing the mitigation measures in this report.

4.6.3. Labour standards

The responsibilities of the promoter/employer are defined to ensure that the project embraces the principles of International Labour Standards. The workforce is a valuable asset

for any company. Sound management of human resources and of worker relations is key for sustainable business practices. The development of fair, safe and healthy working conditions based on respect for workers' rights fosters efficiency and productivity. In contrast, the failure to create and maintain sound worker-management relationships can undermine workforce commitment and effective project implementation. The standard also stipulates that good labour practices and the use of appropriate codes of conduct are important to extend and protect the reputation of firms, governments and lenders; whilst labour rights violations can on the contrary damage the promoter's and the EIB's reputation. NRW will produce a code of conduct for all employees and make sure that all employees are working under a safe and health working conditions throughout its implementation of the project.

4.6.4. occupational and public health, safety and security

Projects often bring employment, economic growth and social improvement opportunities to both workers and communities. Benefits can also result from access to health, education or social protection. Project activities, however, can also increase exposure to hazards, risks and negative impacts in terms of public health and safety. These may arise through or be amplified by project-related occurrences such as increased environmental pollution, elevated noise levels the spread of communicable diseases or disproportionate use of violence by private or public security forces. The NRW will make sure that its employees are not exposed to hazards, risks and negative impacts by following the measures proposed in this report from the construction to operation phases.

4.6.5. Stakeholder engagement

A meaningful engagement process allows for the efficient implementation of a financed operation and, in particular, the early and effective identification, assessment, and management of any environmental and social risks, impacts, and opportunities. The views, interests, and concerns of project affected communities and other interested stakeholders are heard, understood, and taken into account throughout the project lifecycle. During the preparation of this ESIA different stakeholders were identified and consulted and their views are appended in this report. NRW will follow the recommendations provided in this report from different stakeholders and allow for efficient implementation of the project.

CHAPTER 5 : DESCRIPTION OF THE PROJECT ENVIRONMENT

5.1. PHYSICAL CHARACTERISTICS OF THE PROJECT AREA

5.1.1. Spatial location

Ekwendeni is one of the fast growing trading centres in the northern region of Malawi. Ekwendeni is in Mzimba district and it lies in the northern corner of the district. The trading centre is about 24km northwest of Mzuzu city on M1 road to Karonga and about 47km southeast of Rumphi district. The centre is near S52 road junction to Mzimba Boma via Kafukule. Ekwendeni being located in between Mzuzu city and Rumphi district is treated as a satellite town for these areas. The designated radius for Ekwendeni is 1.5km but its boundary has extended about three times due to the centre's growth. Geographically, the centre is positioned along latitude 11⁰21' 55.0" Sand longitude 33⁰52' 52.6" E (Ekwendeni Urban Structure report).

On the other hand, Mzuzu City is located to the Northern Region of Malawi. The City is the largest urban centre of Malawi's Northern Region and is located in Mzimba District at about 117 km north-eastwards of the Mzimba Boma (the District's administrative headquarters). The Mzuzu borders to the East with Khanabad District and it is surrounded to the North, West, and South by the Mzimba District. The Centre of Mzuzu City is located on the road junction of M1 road which comes from the south and M5 road which comes from the east (Mzuzu Urban Profile). Geographically the city is positioned along latitude 11⁰27'55.02S and longitude 34⁰01'14.56" E

5.1.2. Climate (rainfall and temperature)

5.1.2.1. Temperatures

Ekwendeni is located in the rain shadow and as such due to these physiographic factors the center experiences much warmer temperatures. The mean minimum temperature is experienced in June and July with about 12°C and mean maximum temperature is experienced in October and November with reading of about 28°C (Ekwendeni Urban Structure report).

Mzuzu City experiences cold and warm temperatures with a mean annual temperature of 17°C. Mean minimum temperatures range from 3°C to 17°C and occur between June and July. Mean maximum temperatures range from 17°C to 30°C and are registered between October and November. July is the coldest month. (Mzuzu Urban Profile, 2011).

5.1.2.2. Rainfall

The area starts receiving rains in the middle of the months of October and November and continues to until April. The project area's mean annual rainfall ranges between 800 – 1200mm. From May to October the area experiences dry season. The area receives both convectional rainfall and relief rainfall. The main rain bearing system in the area is the Inter Tropical Convergence Zone (ITCZ).

5.1.3. Topography and soils

Generally, the area is flat with gentle slopes. The elevation of the project area ranges from 1000m to the northern part and 1300m to the southern part of the area.

Due to the many different types of sediments and rocks a wide variety of soils have developed in Mzuzu city that varies from area to area. The soils in the area are classified by the Geological Map of Malawi, 1979. The south western part of the area is comprised of tony clay soils with loam soils especially in flat areas. While the northwest; clay loam dark alluvial soils and eastern part and central part of the area is comprised of sandy soils and loam sandy soils to the northern part.

5.1.4. Land use patterns

The Land Tenure System is comprised of two categories: “Public” which is comprises of customary and government land) and private land. Ekwendeni’s was identified way back in 1889 by CCAP missionaries and government prepared the first land use plan for area in 1979 and had proposed zones for commercial, residential, institutional and light industry. However, the area’s current situation land is used by commercial, institutional and residential and some for farming especially in the peripherals of the area. Much land in the area is administered by traditional leaders.

5.1.5. Settlement patterns

Settlement in the area is dominantly rural and not planned. The area was predominantly settled by the Ngoni tribe with some traces of Tumbukas. The settlements are linear along the M1 road to Karonga forming some ribbon developments. Other settlements are nucleated in the central part of the area, isolated and scattered towards the peripherals. However, the area is getting urbanized with all utility services like water and electricity supply especially at the central part as it is getting commercialised.

5.1.6. Geology

Ekwendeni Town lies within the East African Great Rift Valley System which is characterized by intense faulting. Malawi basement complex and is dominated by the rocks of the amphibolite facies, gneisses of the Pre-Mafingi group. There is also a stretch of sedimentary and volcanic rocks particularly to the north of the city along the Mzuzu – Nkhatabay road. The other types found include nepheline syenite, garnet – mica schist phyllonites and Ekwendeni is along the same stretch as Mzuzu city hence share similar mineral deposits.

5.1.7. Hydrology

Ekwendeni has two main rivers called Lunyangwa and Thukutu. Lunyangwa runs from the north western part through the area towards the southern part of the project area. While Thukutu runs from the eastern part into the area. Both Lunyangwa and Thukutu rivers have a network of tributaries that form a dendritic drainage pattern. The area has the natural drainage system that enables water flow from highland into the streams and to the main rivers hence the area free from water flooding.

5.2. BIOLOGICAL CHARACTERISTICS OF THE AREA

5.2.1. Flora for Mzuzu City

The vegetation of Mzuzu is basically closed canopy woodlands dominated by *Brachystegia* species. These woodlands developed into thick forest popularly known as Miombo woodlands. 'Miombo' Woodlands comprise forestlands in the plateau, hills and escarpments that have medium to high rainfall. The proposed location for the River intakes the Kaning'ina Forest Reserve. Said Reserve hosts a lot of rare species of monocots, dicots and pteridophytes. The main indigenous tree species are *Brachystegia* wood land, montane grass lands and *Pterocarpus angolensis*. Major tree species found include: *Jubenardia floribunda*, *Azadirachta indica*, *Brachystegia boehmii* (Mombo/Miombo), *Brachystegiaspiciformis* (Tsamba/Muputu), *Brachystegia utilis* (Long-Pod) *Burkeaafricana* (Mufulu) *Erythrina abyssinica* (Chitimbe), *Parinari curatelliafolia* (Mbula/Muula) *Syzygium gerrardii* (Forest Waterberry), *Syzygium guineense* (Katope/Waterberry), *Syzygium cordatum* (Jambula Tree), *Uapaca kirkiana* (Masuku) *Bauhinia thonningii* (Kachele).



Figure 5.1: Flora Captured at the Project Site

5.2.2 Flora of the project area

The water intake has the following horticultural fruit trees and agro-forestry species: *Acacia polyacantha* (Mthethe), *Psidium guajava*, and *Faidherbia albida* (Msangu) *Musa paradisiaca* (Nthochi), and *M. livingstoniana* (Nthochi). There are pockets of plantation forests of *Eucalyptus* species and regenerating shrubs found around the Ekwendeni water weir is within the vicinity of downstream water weir. The major grass species are *Cynodon plectostachyus* (star grass) and *Phragmites australis* (reeds).

5.2.3 Threatened and endemic flora species of the project area

In all, none of the vegetation groups listed are endemic or threatened from a conservation perspective; implementation of said weirs will therefore have minimal impacts on flora in the project areas. It must however be stressed that due to the prevalence and water retention characteristics of *Syzygium spp.*, measures should be taken not to disturb these species.

5.2.4 Invasive Alien Species (IAS) of the project area

An IAS was recorded from the project areas during the field survey at Ekwendeni. This is *Eucalyptus camaldulensis* (blue gum). This species has potential to suppress the growth and displace indigenous species of flora and fauna. *Eucalyptus camaldulensis* tends to lower the ground water table through excessive evapo-transpiration. Therefore, this species should not be planted in water catchment areas and instead it should be replaced with the species with water retention characteristics such as *Syzigium spp.* Another invasive species is *Phragmites australis* which must be eradicated from the project area as it can easily colonise large areas of the water catchment and negatively displace the indigenous flora species with water retention potential.

5.2.5 Tree density estimates

An estimate of tree density in this vegetation community of Lunyangwa and Ekwendeni water intakes show that on average, there are about 1600 individual stems and 210 stems per hectare respectively. The majority of flora species belonged to genera *Syzigium*. The tree stand density was calculated using estimated number of trees and basal areas of trees per hectare. Along with extrapolating the total number of trees enumerated in the respective plots in a hectare using the following formula:

$$N = \frac{h}{a} \times C$$

Where:

N = estimated number of trees per hectare

h = one hectare

a = area of a plot in a hectare

C = number of trees counted in a plot

5.3. Fauna

The fauna comprises small mammals, birds, fish, and insects. Common and unique bird species include *Ceryle rudis* (Pied kingfisher), *Erythrocercus livingtonei* (Livingstone flycatcher), *Francolinus levaillantii* (red-winged francolin) and *Pyconotus barbatus* (Black-eyed Bulbul). The vegetation is dominated by different types of dragon flies and butterfly species that thrive in the area.

5.3.1 Fauna Species at the Project Sites

The fauna species of the project area were comprehensively surveyed using transect walks in each vegetation type and these were recorded. Fauna species that occur in the project areas were also identified by listening to their sound. Fauna species that occur frequently in the project areas are grasshoppers and dragon flies of different species. The data was supplemented by reviewing available literature, and conducting public consultations with relevant stakeholders.

5.3.2 Fauna species at Ekwendeni Intake

Ekwendeni has some species of birds and mammals which were recorded species during the survey. They are primarily woodland or grassland varieties including *Erythrocercus livingtonei* (Livingstone flycatcher), *Francolinus levaillantii* (red-winged francolin) and *Pyconotus barbatus*

(Black-eyed Bulbul). No mammal species were recorded during the field survey. It was reported during the public consultations that there are some mammal species in the area such as *Lepus microtis* (African common hare), *Mus* spp. (mice), *Silvicapra grimmia* (Common Duiker).

5.3.3 Fauna species at Lunyangwa Intake

The majority of the fauna species recorded were dragon flies, butterflies and fish species (e.g. *Tilapia rendalli* (Matemba)) were easily seen in the waters of Lunyangwa river.

5.3.4 Mammals

No mammal species were recorded during the field survey. However, it was reported during the public consultations that there are some mammal species in the project area. A total of three (2) mammal species were reported to be found in the project area. These included: *Lepus microtis* (African common hare), *Mus* spp. (mice), *Silvicapra grimmia* (Common Duiker).

5.3.5 Threatened, endemic and Invasive Alien Species (IAS) in the project area

There are no mammal species or animal groups reported to be rare, endemic, or vulnerable or classified as threatened by the IUCN Red List in the project area. No IAS of mammal was recorded from the project area during the field survey and/or reported by stakeholders during the consultations.

5.3.6 Birds

A total of three (3) species of birds were recorded from the project area during the field survey. The recorded species included *Erythrocerus livingstonei* (Livingstone flycatcher), *Francolinus levaillantii* (red-winged francolin) and *Pyconotus barbatus* (Black-eyed Bulbul).

5.3.7 Threatened, endemic or Invasive Alien Bird Species (IAS) in the project area

None of the species recorded from the project area are threatened, endemic or Invasive Alien Species (IAS). No migratory birds were recorded from the project areas during the field survey.

5.4. Fish

Small fish could clearly be seen in the water and the information was supplemented by the public consultation with relevant stakeholders, the following fish species *Tilapia rendalli* (Matemba), *Clarias gariepinus* (Kampango) and *Ictalurus punctatus* (Catfish) were reported to occur in Lunyangwa River of the project areas.

5.4. Socio-Economic Characteristics

5.4.1. Population characteristic

According to the National Statistic Survey report 2018, Mzuzu City has a population of 221,272 people and Ekwendeni Town has a population of 16,304 people (NSO Report 2018). According to the feasibility study report, the population for the areas that will benefit from the water supply in Mzuzu City and Ekwendeni Town (project area) was at 101, 231 and was projected at 160,663 in 2018 (Mzuzu WS Project-Design Report for priority works 2016). These are areas in and surrounding different water reservoirs which are Lusangazi, Choma, Doroba, Nkhongolo, signal hill and Marymount in Mzuzu City and Chinunga in Ekwendeni Town. Specifically, the extended water supply will cover the areas of Gunda Jere, Ekwaiweni, Langa Lungu, Emvuyeni and Zombwe EPA in Ekwendeni Town.

During the household survey, the average household size for the proposed water project areas was 5 people, with most of the households being male headed.

5.4.2. Tribe and Ethnicity

The project areas have variety of ethnic groups. The common ethnic groups in the project area are Tumbuka, Tonga, Chewa, Nkhonde, Lambya, Yao and Nyakyusa. Tumbuka, Tonga, Chichewa, Nkhonde, Lambya, Yao and Nyakyusa are the common languages in the area. Additionally, some people speak foreign languages i.e. Swahili, Bemba, Chinese, different Indian languages i.e. Tamail and Shona within the project area especially in Mzuzu City as it's the base for tourist for in the northern region.

During the household baseline survey, it was also observed that the project areas are composed of people different tribes or ethnic groups. It was noted that over half of the respondents were of Tumbuka tribe which constituted 59.7 percent, seconded by Ngoni tribe which constituted 13.6% of the sampled population. The data also shows that there are a number of other ethnicities in the area, as indicated in figure 5.1.

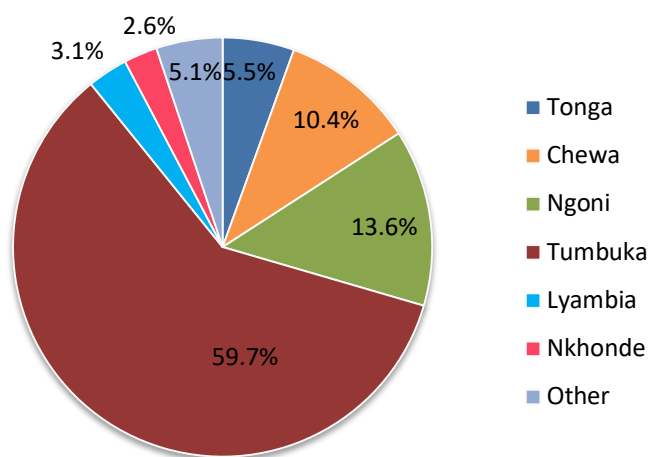


Figure 5.2: Ethnic tribes in the project area(ESIA HH survey, March 2019)

5.4.3. Religion

According to the NSO 2018 report, 87.7 percent of the population in Mzimba district belong to Christianity religion, 1.2 percent belong to Islam religion, 3 percent belong to traditional religions, 7.9 percent belong to other religions and 0.2% do not belong to any religious group (NSO Report 2018). From the baseline household survey only 2 religious groups were identified; Christianity comprised of 98.7% and 1.3% were Islam. Figure 5.2 shows the composition of the religions in the proposed project areas.

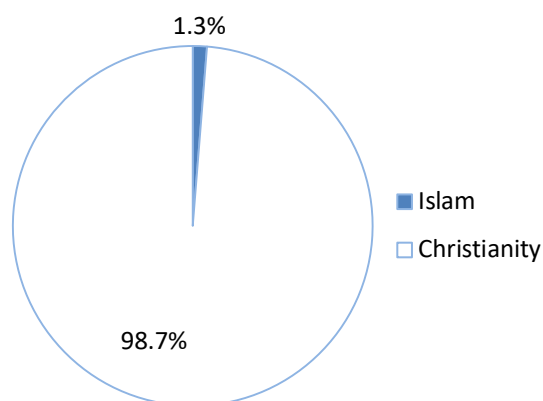


Figure 5.3: Composition of the religions

5.4.4. Livelihood and income

Agriculture, Enterprise, formal and informal employment are the major sources of income in the areas (Mzuzu Urban profile 2008 and Mzimba Socio-economic Profile). According to the household survey that was conducted in the project area, formal employment was identified as a principle source of income with 35.8 percent. This includes employees from the private sector for different organisations and public employees. In addition, the people are also involved in informal employment, commercial agriculture and trading (business) for income source and livelihood. It was observed that not many people are involved in agriculture as a source of income as the area is mostly urban such that many organisations exist which leads to many people involved in the formal employment. Figure 5.4 shows common sources of income in the project areas.

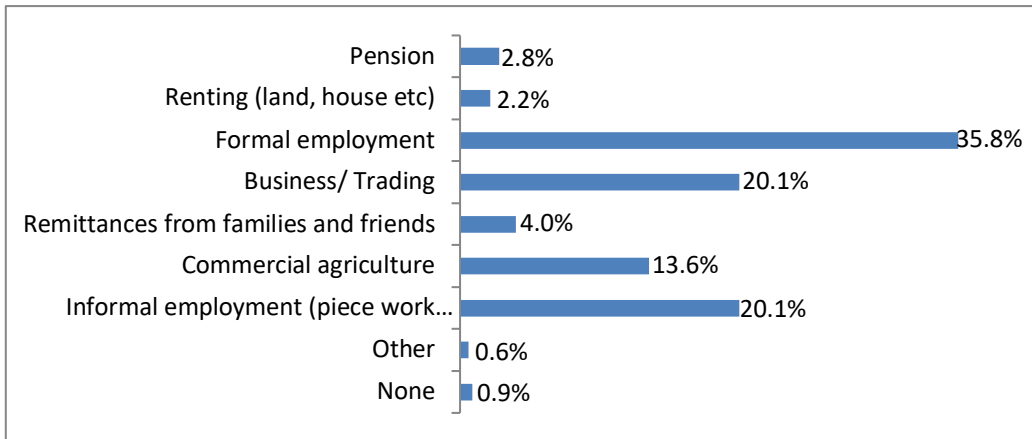


Figure 5.4: Income sources in the project area

It was noted that on average, income per month for both primary and secondary sources was between MK 20,000 to 50,000 with 25.8%; seconded by MK 50,001 to 100,000 with 25.2%. These sources of income also include pensions, remittances and other sources of income that people are involved in. Figure 5.5 shows monthly income levels for the project area.

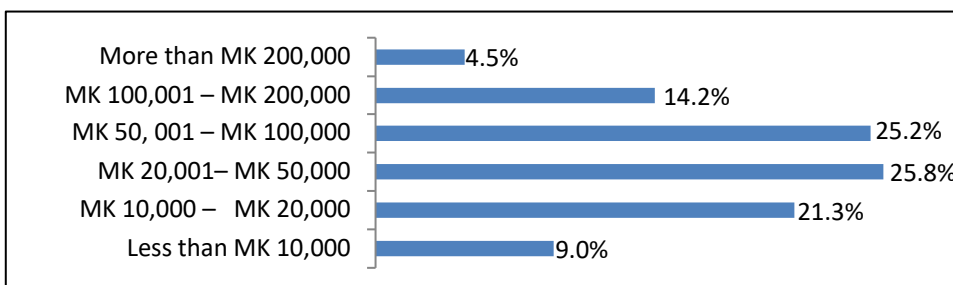


Figure 5.5: Income per month

5.4.5. Education

There are both public and private schools in the project area. These offer both primary and secondary education. There are also tertiary institutions which includes the Mzuzu University and Mzuzu Technical College. The household survey and stakeholder consultations investigated literacy rates and challenges in education that lead to in school drop-outs. It was noted that dropout rates for both primary and secondary schools are generally low and pass rate is high in the project area. Hence there are few organisations that focus on improving education and this is mainly in the Ekwendeni Town areas. However, the district faces some challenges in providing quality education in the area. some of these challenges are;

- Lack of enough secondary schools
- High cost for accessing education
- Lack of good learning environment and materials as some schools do not have laboratory facilities;

From the household survey that was conducted during field assessment, 56.4 percent of the surveyed households indicated that cost of accessing education is the main challenge in education. This includes tuition fees for both secondary and tertiary education and cost for buying school materials. In addition, distance to school, illness and early marriages are other

challenging factors in completing education. Figure 5.6, shows some of the challenges that the communities face in accessing education.

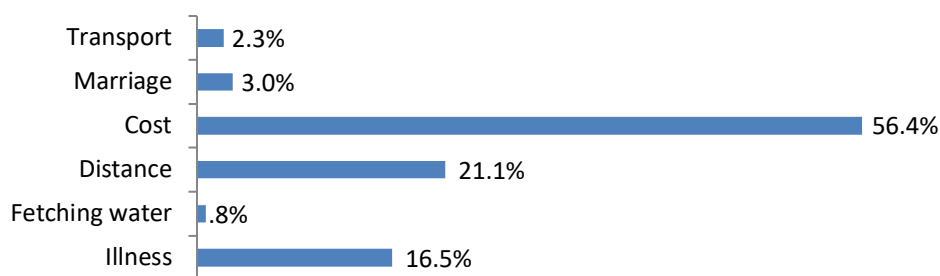


Figure 5.6: Challenges communities face accessing education(ESIA HH survey, March 2019)

5.4.6. Health situation for the project area

The leading causes of morbidity in the project areas are Malaria, upper respiratory infections, skin conditions and diarrhoea. Malaria contributes to 30 percent of the causes of illness and sickness in Mzimba District and Mzuzu city (GoM, Mzuzu Urban Profile and Mzimba SEP 2013-2018).

Malaria, chronic respiratory infections and water related diseases are the major diseases that affect people in the project area. (ESIA HH survey, March 2019). Malaria was rated at 55.7 percent by respondents followed by respiratory infections (33.7%) and water related diseases. It was noted from the consultation’s that negligence, poverty and lack of safe water are the main causes of the diseases. Hence, recommended that the project implementers (NRWB) should include sensitization of communities on water management and sanitation and hygiene as part of the project so that the positive impacts are enhanced. Figure 5.7 shows common diseases that affect people in the project areas.

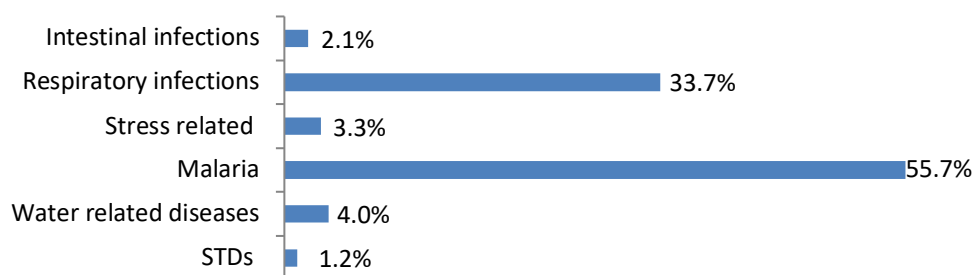


Figure 5.7: Common diseases

During the household survey it was also noted that distance and poor health services are the major health problems in the areas. HIV and AIDS is a major public health problem in Mzuzu and Mzimba with prevalence rate of 7 and 6 % respectively in 2015. The most affected group of people was the productive age group (15 – 49 years). This resulted to reduced productivity, absenteeism, early terminal benefits, loss of highly qualified and skilled labour, overstretched health service system, increased medical costs, increase in the number of orphans and growing social economic insecurity. There have been interventions from government and non-governmental organisations to help in working to reduce the growth rate of the disease.

Various Public and Private Clinics offer health services in different parts of the City. From the household survey it was observed that 36.7 percent of the people live near and access private health facilities which includes mission health centres and hospitals (for example Ekwendeni Mission Hospital). However, a larger population of people access government health facilities that are within the project areas and this represented 63.3 percent. Figure 5.8 shows the type of health facilities that people access in the project area. From the household survey it was also noted that more than 50 percent of the population do not travel very far to access health facilities. It was noted that only 4.6 percent of the population travel more than 2 hours to access health services. Figure 5.9 shows the time that people take to reach to the nearest health facility either government or private.

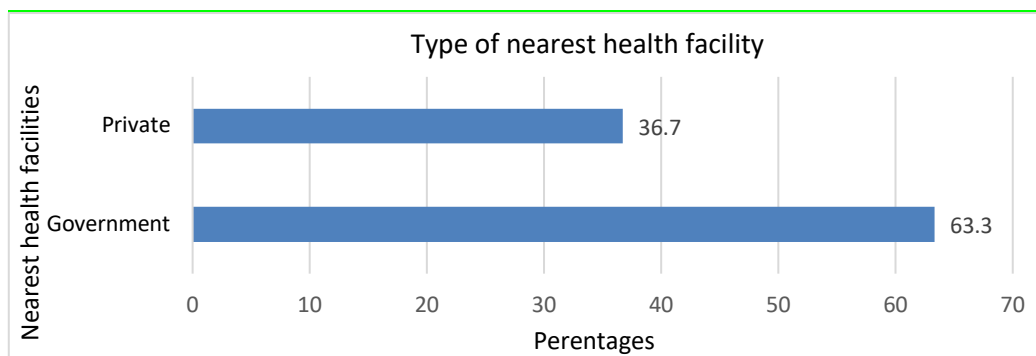


Figure 5.8: Type of health facilities access in the project area

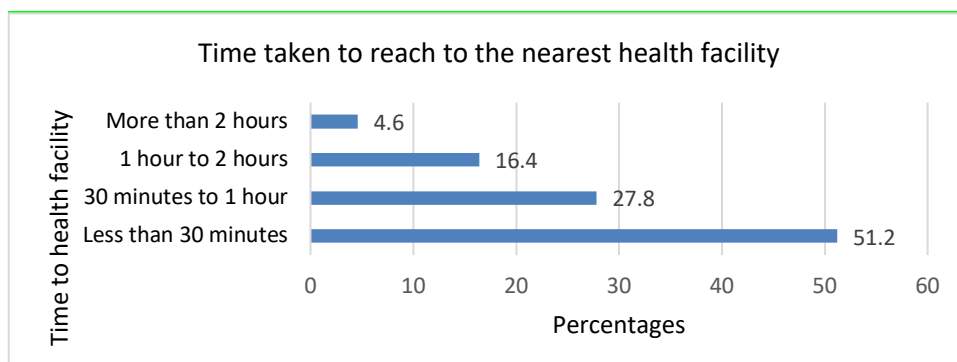


Figure 5.9: Time taken to reach the nearest health facility

5.4.7. Agricultural production

Agriculture in form of small and medium scale is one of the main sources of income in the areas as stated earlier. The main crops that are grown in the project areas include maize, groundnuts, pigeon peas, tobacco, beans and rice. Rice, Pigeon peas and tobacco are mainly grown as cash crops, while the rest are mainly for food. There is also livestock farming in the project area. Cattle, goats, pig and poultry are the common livestock that are reared either for consumption or for sale.

Growing demand for housing and other land uses pressures the scope and outcome of urban agriculture, especially in the western and northern part of Mzuzu where informal settlements

continue to spread out. In addition, the urban agricultural households receive very limited agricultural extension services, subsequently negatively affecting urban agricultural productivity.

5.4.8. Trade and commerce

Mzimba District specifically the Mzuzu City is the main business hub in the northern region of Malawi provides many trade opportunities, which induces demand for goods and services at the city and the project area. Mzuzu City has manufacturing companies which produce medication, coffee, cosmetics and timber. Mzuzu is an important trading center especially for imported products because of its positioning. Wholesalers use Mzuzu as the first major domestic distribution point when arriving from the Tanzanian port of Dar es Salaam.

Development of various forms of trade is visible in the project area, as evidenced by the presence of the following:

- a) Banks i.e. Reserve bank of Malawi branch, National Bank, Standard Bank, First Merchant Bank (FMB), New Building Society (NBS) Bank, Malawi Savings Bank and National Bank of Malawi (NBM)
- b) Shops for various items including the Toyota Malawi workshop
- c) Curios (handcraft materials).

On the other hand, Ekwendeni Town is also one of the major trading centres in Mzimba district and it offers a wide variety of trading services. There are retail and wholesalers in the town. There are no banks at the town. However, there are TNM Mpamba and Airtel Money services that people access for sending and receiving money. Currently, the Mzimba district and Mzuzu City Councils receive a growing number of applications for warehouses, petrol stations, commercial shops, office space and lodges/guesthouses. This is in response to the growing demand for such facilities throughout the Mzuzu City and Ekwendeni Town.

5.4.9. Transport, telecommunication and other services

Mzimba district has a series of roads and footpaths which link various areas such as residential areas, trading centers, institutions and other districts. Different forms of transport are used in the areas which includes, minibuses, buses and taxis, wheelbarrows and bicycles. The bicycles are the most popular transport mode in the project area of Mzuzu city and Ekwendeni town. Road traffic has been increasing within the last years because of the increasing growing of population in the areas.

Road networks in the project areas include; Main, Tertiary, District, Secondary, Estate, Feeder and Distributor roads. The Lilongwe - Mzuzu - Karonga (M1) road is the main road that passes through Mzuzu City to Karonga district and there is also the Nkhatabay - Mzuzu (M5) road which connects Lilongwe - Mzuzu - Karonga (M1) road with Mzuzu Mall connects to Ekwendeni Town. It is from these two main roads that roads of various categories emanate into the central business area, institutions and residential areas.

Telecommunication networks in the Mzuzu City and Ekwendeni Town comprise a landline network and two cellular networks (Airtel and TNM). There are no post offices specifically located in the project areas as such people access them in Mzuzu city (Mzuzu Post Office) and

Ekwindeni Town (Ekwindeni Post Office). Services rendered by these post offices and postal agencies include: sales of postal stamps, stationery, postal money orders, payments and issues of postal and money orders and acceptance and delivery of postal ordinary letters, parcels, registers, express mail services, bills, and telegrams.

There are also radios and television networks in the city and project area. Additionally, the National Publications Limited (NPL) and the Daily Times provide daily and weekly newspapers from street sellers as well as at some supermarkets.

5.4.10. Energy

a). Fuel for cooking

Firewood is the main source of energy for cooking and boiling water in the project areas as it was noted during the household survey. However, some households still use electricity and charcoal. Firewood is accessed through buying and collection. However, cost for buying firewood, long distances to access firewood and availability have posed a challenge in accessing firewood. Cost has also been a challenge for people that buy firewood. These challenges are because of increase in population which has resulted in high demand for energy resources like firewood.

b). Fuel for lighting

There is electricity supplied by ESCOM in the project areas and many houses are connected. It was observed during the household survey that almost 49.1% of the sampled households use electricity for lighting. However, ESCOM electricity is mainly used for lighting and not cooking as people have perceptions that its costly such that they can afford paying the bills. Torches with batteries, portable solar lamps, candles and solar panels are also used for lighting. It was noted that though there has been an increase in use of solar for lighting in the country not many households in the project area use solar panels with 2.2% only. Figure 5.10 presents energy use in the project area.

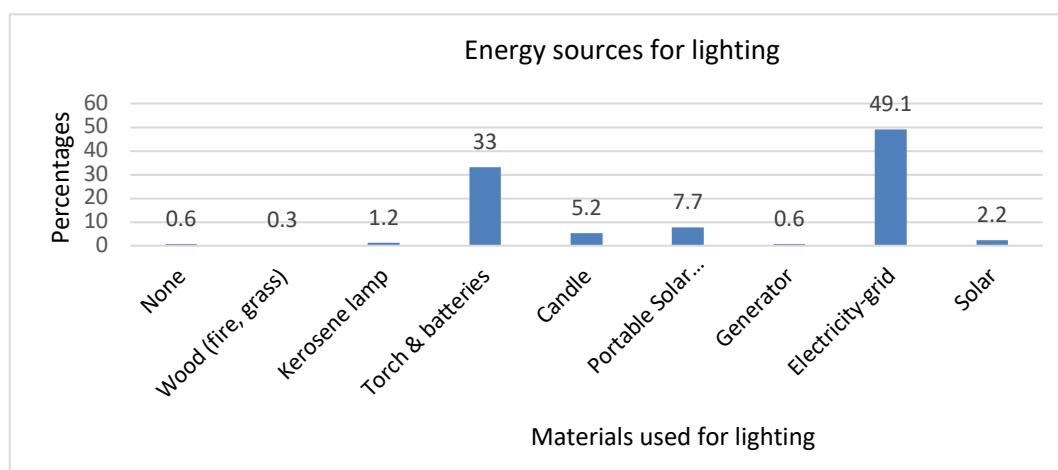


Figure 5.10:Energy use in the project area (ESIA Household Survey, March 2019)

5.4.11. Waste management

Indiscriminate disposal of solid waste is a challenge which is more prominent in market places, streets, open space, industrial, high density and traditional residential areas of Mzuzu City.

According to the Mzuzu Urban Profile, amounts of solid waste generated in the city are estimated at about 171 kg per person per year. Services for solid waste collection and disposal in Mzuzu are provided by the Mzuzu City Council (MCC) and some private operators (who include Mr clean Malawi). The city council has a skip carrier which is used for collection of solid waste. It also has only one waste compactor. The council mainly collects solid waste from commercial, health institutions, and some industrial areas. Residential areas (particularly homes in high density and traditional housing areas) in the City are mostly not covered by solid waste collection services. The MCC has plans to extend its services for collecting waste to these areas and it is also encouraging more private operators to come in and assist with provision of the service to a growing population in the City.

Collected solid waste from the City is disposed at the Msilo waste management facility which is located in Dunduzu Township (approximately) 15km northwest from the Mzuzu City Centre. The waste management facility commissioned in 2017, covers a large area of 12ha is designed to serve the city for about 50 years. The facility being the only one of its kind in this country was planned to accommodate various waste management activities including waste sorting, composting (processing organic waste into manure), plastic recycling and biogas generation. The waste management activities at the Msilo facility are however not happening to a satisfactory extent, a thing which is resulting into piling up of garbage and increased breeding of flies at the facility.



Figure 5.11: Piled up garbage at the Msilo Waste Management Facility

The Mzuzu City Council as well as some health institutions such as Mzuzu Central Hospital and St John’s Hospital have incinerators which are currently used for burning waste that cannot be disposed of at the waste management facility.

Mzuzu City has no Municipal conventional sewerage system. Only three institutions have localized sewerage systems with oxidation ponds. These are Moyale, SOBO (Castel Malawi Ltd) and Mzuzu Central Hospital. Septic tanks as well as pit latrines in the city are emptied when full using sewage vacuum emptying trucks. Some pit latrines are buried or abandoned when they are full. Services for emptying of septic tanks and pit latrines are currently provided by Moyale Barracks and some private companies (Mr Clean Malawi being majorly the sole private service provider). Mzuzu City Council stopped providing the emptying services after their only vacuum tanker broke down in 2007. Waste that is emptied from pit latrines and septic tanks is disposed of at the only site for public sewage sludge ponds at Nkhorongo.

5.4.12. Sanitation and hygiene

As Mzuzu City as well as Ekwendeni Town have no Municipal conventional sewerage system, most homes and offices which have water closet toilets rely on use of septic tanks. Use of pit latrines is still largely common in the City particularly among low and some middle income homes. The Mzuzu Urban Profile puts usage of flush toilets in the City as a whole at some 9.9% of the total households. There is a problem of lack of adequate number of pit latrines among High-Density Traditional Housing Areas of the City. Other major sanitary concerns within the Mzuzu City are those of indiscriminate waste disposal and overflowing of waste from latrines and septic tanks, particularly in high density areas.

In the project area, as indicated in Figure 5.12, 58% of the respondents indicated that they use traditional pit latrines; with 20% using improved traditional pit latrines. About 15% of the respondents are using flush toilets connected to septic tanks and some 6.6% are using ventilated improved pit latrines.

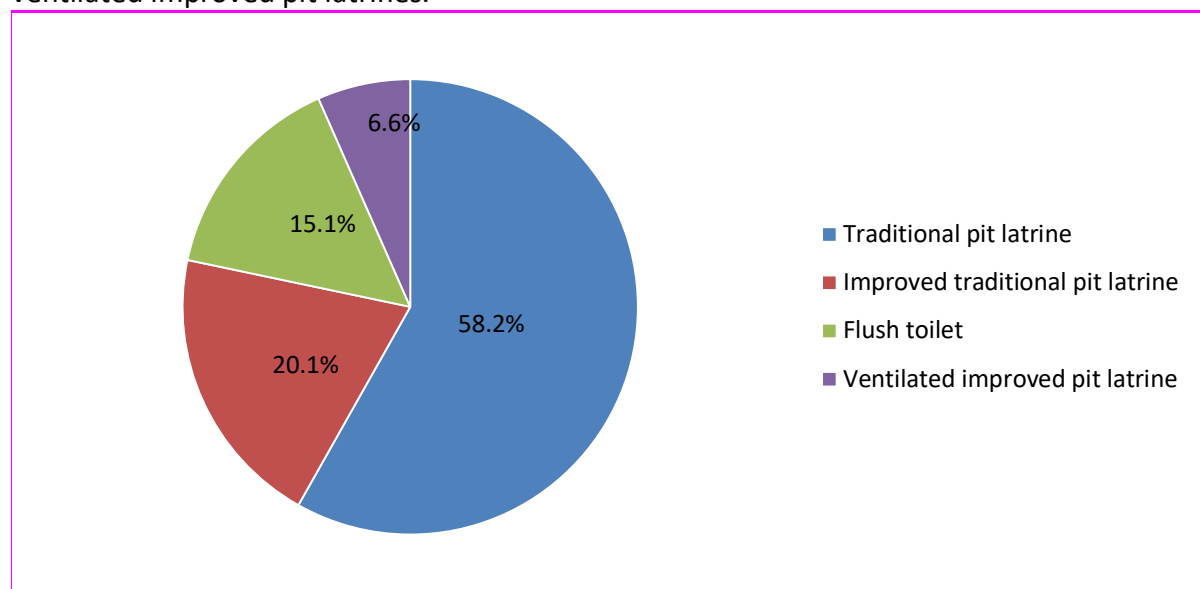


Figure 5.12: Common types of latrines

5.4.13. Access to water

In Ekwendeni Town and Mzuzu City, potable water is mainly supplied by the Northern Region Water Board which provides the water through piped connections to approximately 82% of households in the City (Mzuzu Urban Profile, 2013-2018). A study of WASH status for the low income areas of the City under the Peri-Urban Hygiene and Sanitation project in 2014 revealed that 79% of homes in the high density areas of the City are using piped water from NRWB with 14% of the homes in the high density areas using NRWB water kiosks as their primary source of potable water. Nevertheless, a remaining larger proportion of about 18% of the total population in the City consumes water from wells, rivers, boreholes, and rainwater harvesting. This remaining proportion not dependent on treated water from NRWB still remains at a high risk of waterborne ailments. In the project area, the majority of households primarily use water supplied by the NRWB through private piped connections.

As indicated in figure 5.13, frequent water shortages, high water charges and poor water quality are the major challenges that people in the project area are facing in relation to water supply. Shortages of water in the project area could most likely be attributed to the fact that the current water demand for the Mzuzu water supply system has exceeded the available water supply capacity. The high water demand is contributing water interruptions due to limited availability of water supply particularly during dry periods when less water is available for abstraction.

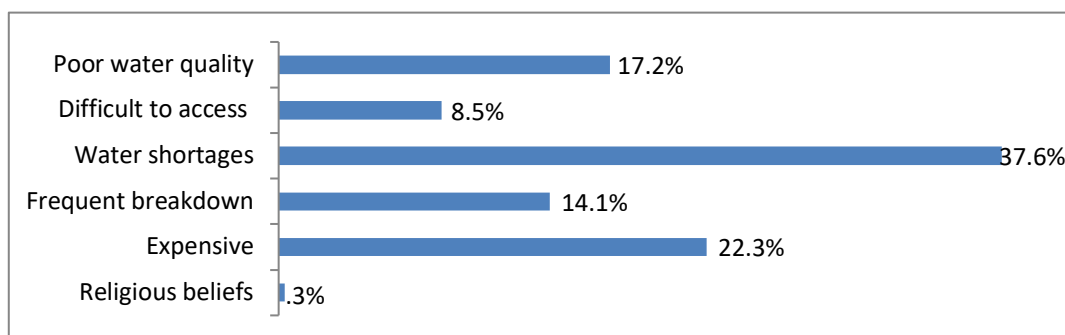


Figure 5.13: Water supply challenges

The government of Malawi recommends a maximum walking distance of 500m and 300m for rural and urban areas respectively and a round-up time of less than 30 minutes to fetch water. Due to the fact that more households in the project area have private piped water connections, the majority of the homes (about 80%) spend round-up walking times of less than 15 minutes to get to the nearest water source. Figure 5.14 presents the times people spend to walk to a water source

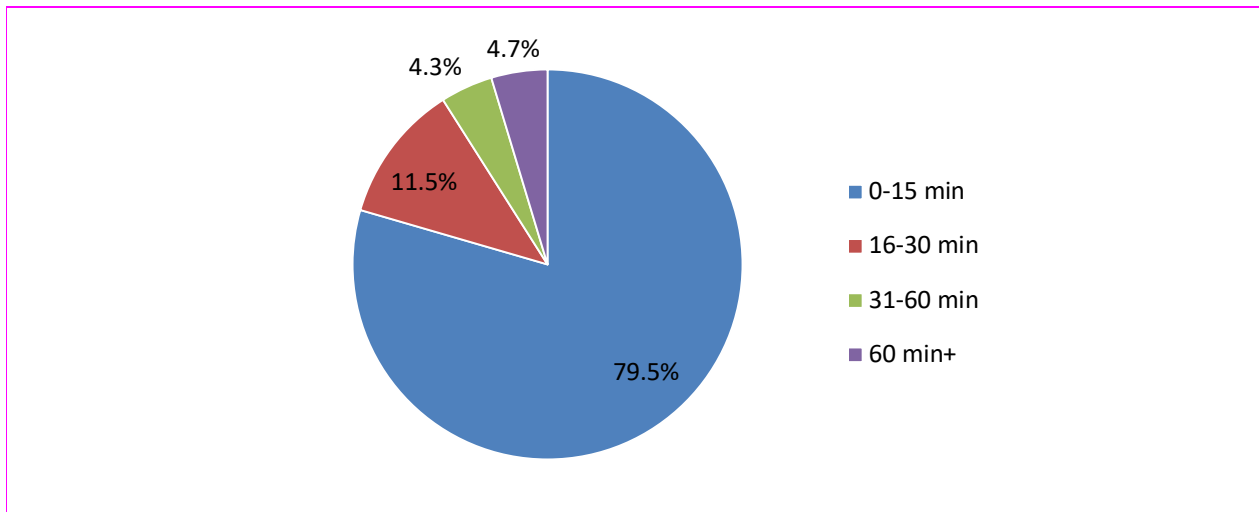


Figure 5.14: Maximum walking time to nearest water point

Again due to the fact that most households in the project areas have private piped water connections, it was established from the household survey that most of the homes (about 69%) spend times of less than 5 minutes to draw water from their water points. Figure 5.15 gives details of average waiting times at water points for the communities to draw water in the project areas.

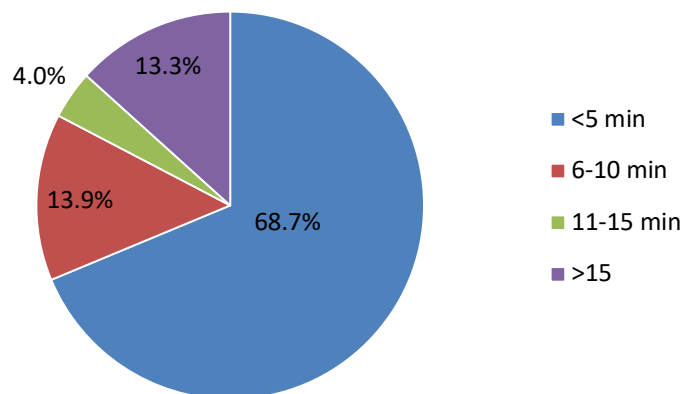


Figure 5.15: Waiting time at the water point

5.4.14. Gender and sustainable development

Communities in project areas are deeply patrilineal which directly impacts on gender roles and equality in the area. The household survey assessed women participation in development activities. It was noted that men and women of the project area work together in development activities in areas of education, water, sanitation and hygiene, nutrition and roads maintenance. Women also participate in decision making in the communities and some were seen to be village leaders during the household assessments. Women in the project area are responsible for fetching water and carrying out sanitation and hygiene activities by ensuring that the households and surroundings are clean and that their households are free from sanitation and hygiene related diseases. These women also travel long distances to fetch water, especially in the dry season when water is scarce.

Implementation of the Mzuzu Water Supply Project will significantly reduce the burden of walking long distances to the rivers and wells to fetch water in the project area. Hence, the women will have more productivity time and will be able to contribute more to social and economic development through increased participation.

5.4.15. Degree of gender mainstreaming

Gender mainstreaming refers to promoting gender equality within projects and/or organisations thereby enabling men and women to fully participate within the organisation and enjoy equal opportunities.

The Northern Region Water Board has a specific gender policy in place that was approved in 2016. The gender policy key principles include equal opportunities for both males and females. In addition, the Board considers itself to be an equal opportunity employer and may also resort to affirmative action measures in line with the Malawian constitution in order to balance the female-male ratio in the Board.

CHAPTER 6 : ASSESSMENT OF ENVIRONMENTAL AND SOCIAL IMPACT

Environmental and social impacts are defined as the alteration to environmental and socio-economic baseline conditions, or creation of a new set of negative or positive environmental and social consequences, caused by the implementation of project activities. These impacts are classified as negative or positive, direct or indirect, short-term or long-term, reversible or irreversible; and cumulative (e.g. in combination with other projects). This Chapter has identified and assessed the potential environmental and social impacts from implementing the two river intakes construction works along Lunyangwa River.

6.1. METHODS FOR IMPACT IDENTIFICATION

The identification of the impacts of the project will be established by an “environmental matrix” (Table 6.1) opposing, on one hand, the **potential sources of impacts** tied to the water supply system’s pre-construction, construction and operation, and, on the other hand, all of the biophysical and socioeconomic components of the project. This will be based on the following information:

- **Environmental and Social Impact Screening** conducted during feasibility studies.
- **Technical aspects of the project:** This enabled the identification of potential sources of impacts, based on the analysis of the technical characteristics of the infrastructures to be built, as well as the construction activities, methods and schedule. The project activities are described in detail in chapter 3.
- **Environmental and socio-economic baseline data (environmental and social components):** This information facilitated understanding of the biophysical, social and economic contexts in which the project will be implemented and identification of issues that should be considered. The environmental and social components are described in chapter 4.
- **Issues and concerns raised by stakeholders and project affected persons:** These issues, from stakeholder consultations, assisted in identification of the main concerns related to the project. Public issues and concerns are discussed in chapter 9.

The **potential sources of impacts** can be defined as all the activities linked to the project likely to have an impact on the biophysical or socioeconomic environment. The sources of impact are grouped by project phase: planning and design, construction, demobilisation, operation and maintenance and decommissioning phases.

It should be noted that impacts resulting from the project’s decommissioning phase were neither identified nor assessed in the present report. Indeed, it is anticipated that the water supply system will be continuously maintained and operated for several decades. This very long useable life makes it very difficult and potentially counter-productive to predict, at this stage, the circumstances under which the project’s structures might ultimately be decommissioned. However, it is recommended to conduct the full assessment of the decommissioning phase’s impacts when enough information becomes available.

Table 6.1: Environmental matrix used in the study

Environmental Components	Air		Water		Soil	Biological Components					Socio components							
	Ambient air/quality	Noise and vibration	Surface water resources	Surface water quality and sediments	Soils	Flora	Terrestrial Fauna	Aquatic fauna	Biodiversity	Habitats	Land planning	Cultural heritage and sites	Local communities	Livelihoods	Health and safety	Gender	Local economy	Aesthetic and amenity values
Potential sources of impacts																		
Planning and designing phase																		
Presence of workers													X	X				
Construction phase																		
Presence of workers		X				X							X	X	X	X	X	
Site preparation	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	
Purchase of materials, goods and services			X										X	X	X	X	X	
Transportation and circulation	X	X	X	X	X		X							X	X		X	X
Construction of facility and associated structures	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	
Waste management			X	X											X			
Demobilisation phase																		
Removal of temporary structures	X	X	X		X								X	X	X	X		X
Worksites restoration	X	X		X	X	X		X			X		X		X		X	X
Operation phase																		
Presence of water supply system infrastructure																		X

Environmental Components	Air		Water		Soil	Biological Components					Socio components							
	Ambient air/quality	Noise and vibration	Surface water resources	Surface water quality and sediments	Soils	Flora	Terrestrial Fauna	Aquatic fauna	Biodiversity	Habitats	Land planning	Cultural heritage and sites	Local communities	Livelihoods	Health and safety	Gender	Local economy	Aesthetic and amenity values
Potential sources of impacts																		
Water abstraction, pumping, treatment, reservoir and transmission and distribution			x					x					x	x				
Maintenance and repair	x	x											x	x	x	x	x	
Presence of workers						x	x	x	x	x			x	x	x	x	x	x
Transportation and circulation																		
Purchase of materials, goods and services													x	x	x	x	x	

6.2. ANALYSIS OF POTENTIAL POSITIVE IMPACTS

6.2.1. Positive Impacts During Planning and Design

a. Employment Opportunity for Skilled and unskilled Workers

During the planning phase of the project engineers will be required to visit the proposed site in order to come up with the appropriate design of the dam. Surveyors will also be required to visit the proposed site to gather requisite data for the project, provide data relevant to the shape and contour of the earth's surface for engineering and map making.

Local laborers will be involved during bush clearing to create access road to the proposed site.

Recommended Enhancement Measures

- i. The client (NRWB) to provide the necessary support for the team involved in the planning and design by;
 - Allowing their official to accompany and show them around
 - Provide primary data
 - Introduce the planning team to stakeholders of the project i.e. Community Leaders
 - Help the team to source other important data from the key stakeholders.
- ii. The team to be composed of members with the appropriate qualifications and expertise to provide required information for the production of accurate designs.

6.2.2. Positive Impacts During Construction Phase

a. Source of Employment and Business

One of the most direct positive impacts of the river intake is the creation of job opportunities that commensurate with the level of skill for the people living in areas surrounding the Lunyangwa Dam and the river intakes. Indirectly, the people involved in small scale business enterprises will also benefit by selling food stuffs to the people working in the construction sites. The projects will present a great opportunity for women and people living with disability to be employed; this will in turn enhance the situation of women and the disabled living in the surrounding areas of the intakes.

Recommended Enhancement Measures

- i. Inform local communities of employment opportunities and prioritise employment of local persons that qualify;
- ii. The contractor should comply to both the gender policy and the Labour Act
- iii. Encourage the contractor to buy the construction materials within the city in order to empower the local business enterprises;
- iv. Employ workers who present legitimate proof of identification that they are above 18 years of age;
- v. Treat and pay employs fairly and keep records for proof of payment at the site;
- vi. Match responsibilities of the employed women, members of the vulnerable group and youth to their abilities Wages must at the minimum meet the minimum wage standard and overtime must be paid on time;
- vii. Workers must be sensitized to save and invest during project implementation;
- viii. Encourage the workers to participate in Community Services Investment programmes (COMSIP) and Village Saving and Loans groups.

b. Increase in Trade Opportunities

The project will provide opportunities for trade due to demand for construction materials and for goods and services by contractors and workers. For example, the project will provide business opportunities for the legitimate site within the city. These quarries will provide stone aggregates and quarry dust for the concrete works. This will benefit the government as well in that it will increase revenue generated in the form of taxes from wages, goods and taxes.

Recommended Enhancement Measures

- i. Source building materials from the local licensed dealers within the city e.g. quarry dust
- ii. Encourage works to source materials such as food and groceries within the local communities;
- iii. Pay the building material suppliers within the agreed time.
- iv. Support and promote of entrepreneurship skills amongst communities and business people in the project area by engaging them where appropriate.
Promote village savings and loan (VSL) schemes during project implementation.

c. Training Opportunities in Vocational Skills for youth

The construction works will require unskilled labourers to undertake some tasks and provide support to technicians such as bricklayers. These labourers have the opportunity to learn new skills in construction through exposure and on the job attachment with capable personnel. Such opportunity will provide vocational training for many unskilled labourers. New skills and work experience will help the Un-skilled worker to find formal employment in the later years.

Recommended Enhancement Measures

- i. Contractors to consider high potential women for skills training program.
- ii. Contractors to consider focused training program to optimize skills transfer to unskilled workers.

6.2.3. Positive Impacts During Operation and Maintenance Phase

a. Improved water supply and access to potable water source

The project is expected to result in improved steady supply of potable water in the City of Mzuzu, Ekwendeni Town and the surrounding areas. The availability of portable water will also improve the productivity of women as they will not be spending their time fetching for water when supply is interrupted. Improved water supply will enable more households within Mzuzu City to be connected to the piped water. This is expected to result in easy access to potable water; the improved access to clean water will reduce the hustles involved when certain households do not have the easy access to portable water. It is deeply imbedded in our culture that women and children should bear the responsibility of fetching for water, this easy access to clean water will help children concentrate more on their academic work and this will positively impact school attendance.

Recommended enhancement measures:

- i. Ensure water reservoir tanks have adequate water all the time to cover periods of no water pumping

- ii. Sustain the desired performance of the water supply system through timely preventive maintenance.
- iii. Quickly carryout maintenance works and restore water supply when there are problems.
- iv. Adequately treat water at the treatment plant.
- v. Regularly conduct water quality tests at the water treatment plant, in the distribution lines and in the supply points and implement control measures where results are below safe water standards.
- vi. Employ adequate staff and ensure that they provide appropriate work inputs through proper work schedules
- vii. Sensitize the water users on proper water management practices, water pricing and importance of payments of water bills in time.
- viii. Mzuzu City Council (MCC) should provide planned expansion programme
- ix. Process water connection applications and provide water to the communities as quickly as possible;
- x. Ensure that the recommended maximum distances of 500 metres from houses to a water point is observed when constructing communal water points;
- xi. Ensure water is available all the time at the water points;
- xii. Encourage communities to form water kiosks committees in order to establish ownerships of the water draw off points.

b) Improved sanitation, hygiene and health

The community that has access to clean water is a healthier community. The Increased availability of treated water will help prevent the community from getting exposed to untreated water that has the potential to spread communicable water borne diseases. Treated water will be available to households, public places and institutions including health centres, markets, trading canters and schools, for use in toilets and washrooms; thereby enhancing sanitation and hygiene. Improved water quality for consumption will also reduce health risks to the people including expecting mothers and infants; and this will translate into financial saving through reduced cost for medical treatment.

Recommended enhancement measures:

- i. Sensitize communities on hygienic practices for handling water to avoid secondary contamination.
- ii. Sensitize the community members to be vigilant in reporting water leakages and broken pipes.
- iii. Promote general sanitation practices amongst communities in the project area.
- iv. Monitor the quality of water and to promote health and hygiene at water points.
- v. Support initiatives implemented by community-based organizations to promote health, sanitation and hygiene
- vi. Ensure there is adequate drainage within the community water points to avoid accumulation of stagnant waters which lead to rapid mosquito breeding as well as other waterborne parasites.

c) Improved socio-economic situation of the communities

The lost time realized due to employee sickness affects the productivity of an individual and in turn stifles the productivity of the whole company, so the improved health of the people will result in increased productivity and consequently poverty reduction. The time saved by women and children in fetching water could be utilized in doing other income earning activities, leading to economic empowerment of the women and their families.

Recommended enhancement measures

- iv. Provide quality water, with minimal loss of supply, through system monitoring and regular maintenance.
- v. Support women and other vulnerable groups to start and operate businesses through appropriate training and start-up capital.
- vi. Make water costs affordable.

d) Enhanced gender and women participation in development

Women form a high percentage of the project areas' population but are inadequately participating in development activities due the burden of fetching water. Increased availability of water (including short distances to fetch water) will relieve them of these burdens, thereby availing them the opportunity to engage in development activities.

Recommended enhancement measures:

- i. Sensitize recruiting authorities to maintain work place gender balance in line with the national gender policy
- ii. Ensure there are also women in important positions.
- iii. Promote gender mainstreaming in development activities through sensitization, advocacy and awareness.
- iv. Economically empower women within affected communities by linking them with the Community Services Investment Programmes (COMSIP)

e) Education benefits to the girl child

Availability of water will remove the burden of collecting water for the girl child, leading to improved academic pursuits. Improved academic pursuit of the girl child at early stage leads to further education and competitiveness in the job market, which is an exit route from poverty.

Recommended enhancement measures

- i. Conduct sensitizations aimed at encouraging girls to enrol in schools.
- ii. Provide the necessary support and adequate resources to schools to ensure that they have adequate resources for the provision of quality of education.
- iii. Provide scholarships and bursaries to deserving girls who cannot afford to pay the school fees.
- iv. Provide adequate water and appropriate sanitation facilities in schools to support female students.

f) Employment Opportunities

It is estimated that a good number of people will be employed by the project. A majority will be from surrounding communities of the Lunyangwa. The income generated by the people will certainly boost household income and food security in the area.

Recommended Enhancement Measures

- i. Prioritise employment of local persons that qualify;
- ii. Adequate occupational health and safety standards should be provided to ensure the work environment is conducive.
- iii. Consider employing both qualified female and male workers to enhance income distribution among both men and women.
- iv. The women and people living with disability should be given tasks that commensurate with their physical ability and level of skills.

g) Increased development

Availability of potable water improves the economic value of land and property and is one of the development pushers. A lot of investments and businesses are established in areas where there are sufficient and reliable water supply services. This is also expected to occur in the newly developed areas where water distribution will be extended. Water supply by NRW will also be less costly than when the customers provide own water supply.

To institutions, the project will relieve the burden of providing water to their respective communities when it is not their responsibility and allow them to concentrate on their core business and in the process serve financial resources for their activities.

Recommended enhancement measures

- i. New water connection applications must be treated within set time.
- ii. Provide adequate potable water supply to the new areas.
- iii. Sensitize the communities to report leakages and breakages of pipes.

The Mzuzu City and Mzimba District Councils must ensure that development activities are implemented within Council plans and laws

6.3. ANALYSIS OF POTENTIAL NEGATIVE IMPACTS

Negative impacts during planning and design phase

6.3.1. Negative impacts during construction phase

a) Degradation of water quality

Construction activities for then river intakes have potential to affect water quality due to waste mortar and debris from the construction activities resulting into water turbidity. These sediments could be pumped together with the water and may clog and damage downstream equipment. Water with high level of turbidity requires more chemicals for treatment. There is a direct correlation between level of water turbidity and the amount of resources used for treatment i.e. more resources are required to treat the water.

Fuel and lubricating oils have the potential to contaminate the water at the two river intakes if they leak during construction work. This may affect the flora and fauna along the river. Construction debris, dirt, silt and soil may run into natural waterways, causing pollution and siltation.

Recommended Mitigation Measures

- i. Provide a schedule for excavation works to the treatment plant team so that they plan to pump water in harmony with the works schedule.
- ii. Encourage use of mortar and debris traps during construction.
- iii. Strategic stakeholder consultations must be done comprehensively to make sure that those who could potentially be affected are aware of the works program. i.e. Tropha company (which is located down-stream).
- iv. Mix cement in areas, which are not directly connected to natural drainage systems.
- v. Shutters to be properly erected and monitored to check if there are any unallowable spaces in between the joints which may lead to concrete leakages.
- vi. Discourage any taking of food by the workers when the work is in progress.
- vii. Store cement, paints, lubricants and fuels in lined and covered areas.
- viii. Provide appropriate spill kits when working near water courses.
- ix. Provide appropriate facilities for the collection of wastes on site such that they will not come into contact with water.
- x. Site all material storage areas at least 10 m from watercourses.
- xi. Provide appropriate barriers to separate worksites from water resources in order to prevent accidental spillage into water courses.
- xii. Connect the drainage systems to oil interceptors.
- xiii. Line surfaces where cement, paints and oils will be stored and connecting the drainage systems to oil interceptors.
- xiv. Collect and dispose wastes in designated disposal sites as required by the Local Authority.
- xv. Construct pit latrines that are at least 1.5 meters deep, lined at the base and 30 metres from a water body.

b) Air Pollution

During the construction phase there will be an increase in road traffic associated with material and equipment haulage. These vehicles and machines will produce combustion gas emissions and nuisance dust. The principal sources of these gases are the exhaust fumes.

The vehicles, electricity generators and other machines, which will be used during construction are expected to result in emission of gas and particulate elements including carbon dioxide (CO₂), sulphur dioxide (SO₂), nitrogen oxides (NO_x) and various other hydrocarbons. The carbon containing gases and methane are greenhouse gases and hence responsible for causing global warming and consequently climate change.

Recommended mitigation measures

- i. Use new or fairly new machinery that is within the acceptable emission limits.
- ii. Erect safety signboards to warn other road users about the volume of traffic.
- iii. Timely and effectively maintain vehicles and equipment to prevent exhaust gas emissions above permissible emission limits.
- iv. Use the water bowsers to spray water along the access roads used by the haulage trucks.
- v. Provide protective gear (dust masks) to workers and ensure that they wear them.
- vi. Erect a barrier around the work sites where major construction activities are taking place to break or reduce wind and dust movement.
- vii. Store and handle quarry dust and cement properly to limit dust generation.

- viii. Optimize transportation management to avoid needless truck drives.
- ix. Construct gravel speed bumps to control vehicle speeds.
- x. Reduce engine idling time.
- xi. Provide or facilitate regular medical check-ups for construction workers to timely treat any occupational safety illnesses and disorders related to air pollution.

c) Soil contamination and land degradation

Soil contamination and land degradation may result from the following:

- Fuel and oil leaks from construction plant and vehicles, spills from vehicle maintenance operations, and spills from waste oil containers discarded from plant and vehicle maintenance during construction activities;
- Civil works construction wastes such as packaging materials, cement bags, oils and paints;
- Accidental or deliberate disposal of construction waste and chemicals;
- Improper disposal of soils from excavations and stockpiling;
- Unsustainable sand mining and quarrying – this is likely to result in land degradation outside the project site in sand mining and quarrying areas.

Recommended mitigation measures

- i. Provide garbage collecting bins at the construction site and monitor its usage so that all the litter at the project site are managed properly.
- ii. The contractor to develop the waste management plan in accordance with the Environmental Management Act 1996, and should keep records of the volume of waste generated and disposed.
- iii. Surface all vehicle servicing and fuel /oil storage areas with an appropriate impervious material to prevent contact of soil with the oils.
- iv. Use containers to collect used oil and then properly discard waste oil containers in approved disposal sites, as recommended by Mzuzu City Council and Mbelwa District Council.
- v. Segregate waste (e.g. cardboard and paint containers) to encourage reuse.
- vi. Provide all structures required for effective water drainage.
- vii. Construct waste disposal pits and bury the wastes after the construction period. The pits must not be near to surface water bodies.
- viii. Closely supervise the workforce to avoid or limit waste generation.
- ix. Store and contain construction materials on lined surfaces and in covered areas.
- x. Sensitize construction workers to avoid littering the site.
- xi. Use excavated soils for backfilling and site levelling.
- xii. Promote the usage of quarry dust and source quarry in approved sites that are run sustainably.
- xiii. Enforce the use of licensed construction material suppliers through the construction contract(s).

d) Loss of vegetation cover

An unavoidable part of any development project is the clearing of land and the consequential loss of vegetation cover. This is also anticipated in this project; the area to store the building

materials will be located near the River Intakes and within the forest reserve. This will also result in loss of vegetation cover also leads to loss of habitat for wildlife species and degradation of soil due to increased soil erosion. Plants absorb the carbon dioxide during photosynthesis which slightly offsets the amount of greenhouse gas being released in the atmosphere through the burning of fossil fuels and the Loss of vegetation cover also contributes to climate change.

Recommended mitigation measures

- i. Limit vegetation clearing and excavations to only those areas specified in the designs to avoid unwarranted clearance of vegetation.
- ii. Strict control of construction vehicles to ensure that they operate only within the areas to be affected by the construction works or engage only in activities that benefit the project.
- iii. Plant appropriate trees and grasses in all disturbed area.
- iv. Cost and appropriately compensate for all the trees to be cut down during construction.
- v. Ensure that for every single tree cut down, 10 tree seedlings of a similar species are planted in the adjacent areas.
- vi. Rehabilitate affected land by tilling the soils to facilitate natural regeneration of vegetation; and by planting trees, including indigenous trees, and grass immediately after construction works to minimize soil erosion.
- vii. Sensitize employees and the community to conserve vegetation.
- viii. Salvage vegetation (hollow logs, seedlings, seeds, etc.) affected by the project and reuse in areas to be planted with forest woodland.

e) Accidents and hazards from trenches and burrow pits

The project will require construction materials including earth, sand and quarry stone. Extraction of these materials may lead to creation of holes and burrow pits in the ground. These holes and burrow pits as well as trenches opened for the pipelines will be hazardous to people and animals.

Recommended mitigation measures

- i. Use construction material suppliers that are licensed by the Mzuzu city Council and Mbelwa District Council.
- ii. Avoid making deep pits when extracting construction materials.
- iii. Refill all burrow pits to be created during the upgrading, rehabilitation and expansion of the water supply systems.
- iv. Barricade all trenches and open pits and place clear signs to protect animals and people from falling into them.
- v. Inform and sensitize the public about all open pits and trenches.
- vi. Supervise adequately the construction activities and follow recommended procedures.

f) Disruption of water supply

Water supply services may be disrupted during construction to clear off working spaces for the River Intakes.

Recommended mitigation measures

- i. Give adequate notice of potential water disruption to the water users that could be affected
- ii. Provide alternative means of supplying water such as temporary by-pass piping or water bowsers where appropriate
- iii. The contractor to Provide a works schedule with strategically staggered activities to avoid total flow disruption during construction

g) Water pollution and siltation

Construction debris, dirt, silt and soil may run into natural waterways, causing pollution and siltation. Oil spillages, from construction machinery and solid waste from construction materials and camp sites will also contribute to water pollution during the rainy season, when the spills and solid waste are washed down to the water courses.

Recommended mitigation measures

- i. Mix cement in areas, which are not directly connected to natural drainage systems.
- ii. Store cement, paints, lubricants and fuels in lined and covered areas.
- iii. Provide appropriate spill kits when working near water courses.
- iv. Provide appropriate facilities for the collection of wastes on site such that they will not come into contact with water.
- v. Site all material storage areas at least 10 m from watercourses.
- vi. Provide appropriate barriers to separate worksites from water resources in order to prevent accidental spillage into water courses.
- vii. Line surfaces where cement, paints and oils will be stored.
- viii. Connect the drainage systems to oil interceptors.
- ix. Collect and dispose wastes in designated disposal sites as required by the Local Authority.
- x. Construct a pit latrine that is at least 1.5 meters deep, lined at the base and 30 metres from a water body.

h) Occupational incidents and accidents

Construction workers are likely to have injuries as the construction works unavoidably expose workers to occupational health and safety hazards. Improper use of various construction equipment, materials and tools may result in accidents, injury or death. According to the Occupational Safety, Health and Welfare Act 1996, employers are supposed to report any incidents and accidents, occurring at their workplace, to the Ministry of Labour. The employers are also supposed to cooperate in any investigations that may follow.

Recommended mitigation measures

- i. An emergency vehicle to be available all times when the works are in progress.
- ii. Workers to be trained on safe operating procedures.
- iii. Induct workers on OSH requirements and repeat reminders on the same.
- iv. Employ an OSH expert to monitor and ensure that appropriate equipment and acceptable codes of practice for various tasks are followed by workers at all times.
i.e.; Hazard Identification and risk assessments

- v. Provide appropriate personal protective equipment (PPEs) to construction workers and ensure that it is used at all times.
- vi. The contractor to provide a mechanism for reporting of accidents and near misses.
- vii. The first aid box to be made available for each team and a trained first aider to be available too.

i) Noise and vibrations

In this project, noise and vibrations are expected from the construction works, use of machinery and movement of materials, the movement of vehicles and rock blasting. Most of the construction machinery that will be used, for example trucks, compactors and concrete mixers, produce noise at levels ranging from 75 – 90 DB. This noise is a health risk only when one is exposed to it over a long time. Blasting activities, which are also likely to be carried out, can produce noise as high as 100 DB. Such noise can result in permanent ear damage.

In addition to being a health risk, noise is generally a nuisance, may disrupt communication and disturb people that want to sleep. As the construction will be closer to the communities, Noise will also affect livestock and wildlife species by masking sounds of predators and prey, causing stress or avoidance reactions. Animal reactions to noise vary from species to species.

Recommended mitigation measures

- i. Monitor the noise levels for any machine available on site regularly
- ii. Use appropriate and well-maintained noise mufflers on vehicles and machinery.
- iii. Regularly service and carry maintenance of equipment.
- iv. Provide ear muffs for the workers in noisy areas.
- v. Use electric motors instead of compressed air driven machinery.
- vi. Reduce noise by using plastic or rubber liners, noise control covers, and dampening plates and pads on large sheet metal surfaces.
- vii. Limit the number of days of operation; restrict hours of operation and schedule noisy tasks for periods of low occupancy on the project surroundings.
- viii. Notify the public of upcoming loud events.

j) The Spread of Communicable Diseases and other Infections

During the construction phase there is a risk of spread of communicable diseases such as tuberculosis and pulmonary infections. Aspects of the physical environment that promote transmission of diseases include; disposal of wastes and ventilation that are likely to occur during the construction phase of the project. With the influx of people during construction, there will be a likelihood of increase in diseases such as malaria, diarrheal diseases, respiratory diseases and dysentery.

Recommended Mitigation Measures

- i. Provide both male and female condoms to workers for appropriate use.
- ii. Treat the affected local and migrant workers so as to control the movement of disease vectors (through contaminated water and between people)
- iii. The contractor to provide sanitary facilities in good condition with adequate water supply.
- iv. Train workers on good personal hygiene practices e.g. washing of hands after visiting the toilet, drinking portable/treated water

- v. Alert the responsible health authority if there is an outbreak of any communicable diseases.

k) Increase in sexual relationships, unplanned pregnancies, breaking up of families

It is anticipated that the local women will have sexual relationships with the men at the construction site, to earn some money. This could lead to breaking up of families, where the women or the men are married. Unprotected sex could also lead to unplanned pregnancies and the transmission of STIs, HIV and AIDS where one of the partners is infected.

The other group of affected persons are teenage school going children. School girls and teenagers are likely to be exposed to sexual abuse in return for money. This may lead to pregnancies and increased school drop outs in the area.

Recommended mitigation measures

- i. Provide a reporting mechanism at the site where grievances can be channelled and this mechanism should also be available to the concerned public.
- ii. Sensitize communities on the disadvantages of indulging in extra-marital affairs.
- iii. Sensitize all contractors, workers and communities on the STD and HIV/AIDS program, including explanations on risks posed by STDs, sanctions, etc. as well as on grievance mechanisms in place.
- iv. Sensitize girls from the surrounding areas getting involved in pre-marital sex at a tender age.
- v. Enforce punitive and disciplinary measures, including dismissal from employment, on any project workers involved in any social malpractices with surrounding communities.
- vi. Engage stakeholders in encouraging and empowering women to be financially independent.
- vii. Provide both male and female condoms to workers for appropriate use.
- viii. Prepare and implement an STD and HIV/AIDS prevention program including a strict prohibition of sexual abuse and sexual intercourse with partners younger than 18 years of age (underage sex).
- ix. Support the District Social Welfare Office and the Community Development Office and Non-Governmental Organizations in the implementation of on-going projects aimed at assisting pupils to go back to school.

l) Incidence of sexual abuse and harassment

Incidence of sexual abuse and harassment are anticipated at the work sites and in the homes. At the worksite, women seeking jobs could voluntarily or involuntarily indulge in sex with the employers in order to get jobs. Men in higher positions will always want to exploit women who are desperate for employment. Some women may also offer sex as the way of gaining favours at the company. Sexual abuse and harassment could also occur during the course of employment, mostly affecting the women due to the perception that women are a weaker gender (inequality).

As construction workers will have extra disposable income that may be used for casual sex and some for excessive drinking; disagreements, due to the men's behavioural change, may lead to the harassment and sometimes molestation of the wives in the homes. Likewise, some

women working at the project sites may harass their unemployed husbands, due to increased disposable incomes.

Recommended mitigation measures

- i. Report any form of physical abuse/harassment to Police, that way workers will understand the seriousness of the offense.
- ii. Provide a reporting mechanism for both the public and the workers.
- iii. Sensitize workers and surrounding communities to avoid sexual abuse and harassment.
- iv. Conduct sensitization and awareness campaigns to encourage affected individuals to report cases of sexual harassment in the homes.
- v. Publicize places for reporting gender violence and sexual harassment.
- vi. Create a good work environment to allow female workers to report cases of harassment.
- vii. Enforce punitive and disciplinary measures, including dismissal from employment, on any project workers involved sexual abuse and harassment.
- viii. Prepare and implement an STD and HIV/AIDS prevention program including a strict prohibition of sexual abuse and sexual intercourse with partners younger than 18 years of age (underage sex).
- ix. Support the District Gender Welfare Office and Non-Governmental Organizations in the implementation of on-going projects aimed at promoting gender equality and ending sexual harassment.
- x. Implement and follow-up on grievance redress mechanisms.
- xi. Require the contractor to be responsible and to take necessary measures so his employees do not commit acts of sexual abuse and/or underage sex.

m) The increased pressure on community health services

The influx of immigrant workers and job seekers may result in increases of pressure on community and health services due to the associated significant health and safety impacts on local communities. First and foremost, interactions between workers and female community members increase the risk of sexually transmitted diseases such as HIV/AIDS and other STDs.

Recommended mitigation measures

- i. Conduct public awareness and sensitization on community health, HIV and AIDS.
- ii. Encourage employees to go for voluntary health screening and receive appropriate treatment where it is required.
- iii. Require the workers, sensitize the communities follow recommended environmental and water management practices.
- iv. Construct adequate sanitation facilities at the work sites and surrounding area.
- v. Locate worker camps at a minimum distance of 1 km from towns and villages in order to limit worker – community interactions.
- vi. Maintain construction camps in clean and healthy condition as prescribed by international worker health standards.
- vii. Require all contractors and sub-contractors to comply with relevant health and safety requirements and NRWB corporate policy.

- viii. Develop and implement an H&S management plan to protect every worker involved in construction activities, even temporary workers (e.g. vaccines, etc.).
- ix. Involving other stakeholders including NGO's in the promotion of social welfare.
- x. Support and supplement social services including the Health Surveillance Assistants.

n) Unequal employment opportunities

During informal consultations, it was observed that most of the project activities in the construction phase are considered manpower intensive and hence “men’s” jobs; for example, digging trenches. As such, the project will tend to employ more men than women. Additionally, according to the culture of the area, usually men take key positions while women take supportive roles. Similarly, at national level, there are more men in the construction industry than women. As such, women may take more supportive roles (for example cooking and ferrying water).

Recommended mitigation measures

- i. Contractor to strictly adhere to the gender policy
- ii. Conduct gender meetings to sensitize and encourage women and to instil confidence that they can also do the work that men do.
- iii. Ensure there are also women in important positions such as foremen and engineers.
- iv. Economically empower women within affected communities by linking them with community investment programs (COMSIP).
- v. Create a good work environment to allow female workers report any case of harassment.

6.3.3 Negative impacts during demobilisation phase

a) Increased Solid Waste

At the demobilising there will always be increased volume of solid waste generated from the demolished temporary structures and other left over materials left that have no real value for the project. These solid wastes will be of significant quantity and a strategic waste collection plan has to be put in place.

Recommended mitigation measures

- i. Sell or recycle metal waste to tinsmiths or vendors for reuse or re-sale
- ii. Provide solid waste storage bins and skips
- iii. Monitor skips so that they do not become overfilled.
- iv. Ensure that collected solid waste is disposed of in an approved disposal site
- v. Implement sensitization campaigns on consequences of indiscriminate waste disposal

b) Loss of jobs due to completion of construction works

Local labourers will be laid off during the demobilisation phase. This will result in loss of sources of income. Because of job losses, businesses that were thriving or had opened (mainly food and alcohol businesses) because of the project staff will also be affected negatively. This may in turn, also lead to loss of jobs where employees were running the businesses. Some houses that were rented by the contractor’s staff will also be vacated too.

Recommended mitigation measures

- i. Introduce Money saving programs like Savings and Capital Cooperative (SACCO) for the employees so that they are prepared well for retrenchment.
- ii. Provide alternative employment to employees where possible e.g. as maintenance staff.
- iii. Provide adequate notice to employees to prepare themselves and secure alternative employment.
- iv. Pay severance benefits to leaving workers in line with the labour regulations.
- v. Sensitize the workers and the general community to adopt the money saving culture.
- vi. Sensitize the business persons to diversify and find alternative markets.

c) Abandonment of used burrow pits and temporary pit latrines

There is potential for abandonment of burrow pits after the construction works, in particular sites where construction materials will be sourced. Burrow pits are an issue as they can be a death trap to wildlife and children. In addition, burrow pits create unsightly conditions and they can be breeding grounds for mosquitoes and other aquatic parasites; burrow pits can change the ecosystem. There is potential for abandonment of pit latrines that were designed to serve the workers during the construction phase. These latrines act as death traps too.

Recommended mitigation measures

- i. Fill up and close pits after the construction works.
- ii. The contractor should register all burrow pits to the Mzuzu City council and Mbelwa District Council.
- iii. Authorization Certificates (Signed by Land owners and chiefs) to be obtained before any soil extraction is done and also the Certificate of Rehabilitation to be issued at the end of the construction phase.
- iv. Construction materials e.g. sand and clay soils should be sourced from licensed supplier
- v. Rehabilitate all work site; The rehabilitation plan to include reforestation of the area.

6.3.4 Negative impacts during operational phase

a) Depletion of water resources in the rivers

During the operation phase

b) Increased solid waste generation

During the operation phase, mainly at the treatment plant, offices and staff houses, there will be an increased generation of solid waste (e.g. plastic, wrappings and containers), paper, office wastes including printing cartridges, kitchen (canteen) wastes etc. This waste can be a nuisance if not properly disposed.

Recommended mitigation measures

- i. Sell or recycle metal waste to tinsmiths or vendors for reuse or re-sale
- ii. Provide solid waste storage bins and skips.
- iii. Monitor skips so that they do not become overfilled.
- iv. Ensure that collected solid waste is disposed of in an approved disposal sites.
- v. Implement sensitization campaigns on consequences of indiscriminate waste disposal.

c) Increased pollution from wastewater and sludge

The water treatment activities will generate wastewater and sludge as by-products, which if not properly managed can pollute water and affect people's health, aquatic life and the natural habitat. Wastewater and sludge produce odours, can be breeding grounds for insects; and where they infiltrate into the ground, they can pollute groundwater.

The increase in water consumption (by all types of consumers) due to the expansion of the water supply scheme will result in increased wastewater generation by the consumers. This will lead to surface and groundwater pollution. Increase in wastewater will manifest itself as sullage at communal water points, bath shelters and septic tank soak-ways. This wastewater must be properly managed to avoid pollution.

Recommended mitigation measures

- i. Enforce proper excreta and wastewater management especially in the town.
- ii. Apply lime treatment to dewatered sludge to suppress pathogens and remove odour.
- iii. Enforce the use of licensed liquid waste handlers for liquid waste.
- iv. Dry sludge on drying beds before disposing off in a dedicated disposal site.
- v. Prepare and enforce operational guidelines for sludge treatment and management.
- vi. Conduct WASH activities to sensitize people on the benefits (including prevention of cholera) of good the hygiene.

d) Increase in Emergency incidents

The NRWB should be prepared to handle incidents affecting drinking water and water treatment systems. Some of the incidents that are likely to occur include:

- Excessive rains which may wash away the intake weir, channel or pipes;
- Contamination of water at the intake, the treatment plant or the reservoir site;
- Risk of fire from the booster pumps at the treatment plant; and
- Bursting of pipes due to high pressure.

The incidents have the potential to negatively affect the water users and the communities around the water supply infrastructure. For example, contaminated water is a threat to the health of consumers while high-pressure water from busted pipes can wash away people's property.

Recommended Mitigation Measures

- i. Design and implement an emergency response plan.
- ii. Install fire hydrants within the proposed development.
- iii. Use checklists to regularly monitor and maintain the water supply system.
- iv. Maintenance of natural drains around the weirs.
- v. Install and regularly service fire extinguishers at the plant and carryout periodic fire drills.
- vi. Maintain the critical spares lists

e) Potential risks of water leakage and flooding from theft and vandalism

The high unemployment rates because of a rapid population growth and a small economic base have resulted in increased criminal activities in Malawi. As such, cases of vandalism, theft of water supply infrastructure are reported in the project area. This is also anticipated in the operation and maintenance phase of the project, and may result in water leakages and flooding where a big pipe is vandalised. This is a negative impact as the leakages may result in inadequate supplies in the households, hence reduced sanitation, health and hygiene. Flooding on the other hand may damage property and result in accidents. Vandalism and theft also have an impact on the operation cost of water supply system.

Recommended Mitigation Measures

- i. NRWB must periodically conduct consultations and sensitizations with villages and group village heads and security personnel.
- ii. Provide security at the intake, treatment plant and water reservoir sites.
- iii. Support activities of the neighbourhood watch (community policing) e.g. through provision of torches, uniforms and shoes.
- iv. Support economic activities in the area as part of corporate social responsibilities.
- v. Reward for reports of vandalism and theft that may lead to capture.
- vi. Theft and vandalism cases must be reported to the police.
- vii. Regularly monitor the pipeline infrastructure.
- viii. Inclusion of the local people in the work force.

6.4. SIGNIFICANCE RATING OF THE IMPACTS

The significance of the identified potential environmental and social impacts has been determined by assessing the consequence and the probability of occurrence of the impact as follows:

$$\text{Significance of the impact} = \text{consequence} \times \text{probability}$$

where:

$$\text{Consequence} = \text{severity} + \text{reversibility} + \text{duration} + \text{spatial extent} + \text{environmental context}$$

The factors are defined as follows:

1. **Severity/ Magnitude:** measures the general degree, extensiveness, or scale of impact. It is defined in terms of the observable impact on a resource in the context of the project locality and wider ecosystem or social domain.
2. **Reversibility:** refers to the ability of the site or the impact receptor to recover after an impact has occurred.
3. **Duration:** this is the period of time over which an impact may occur; from a once-off occurrence to continuous, during the life of the Project. This aspect considers the time that is estimated for an affected population or resource to return to “baseline” conditions. Duration is calculated from the time an impact begins to when it ceases. Frequency: considers the number of times an impact is expected to occur over the duration of a proposed project.
4. **Environmental context:** considers the sensitivity of the receptor upon which the impact is occurring.
5. **Areal extent:** refers to the size of the impact area.
6. **The probability:** the likelihood of the impact occurring.

The above factors are ranked using the criteria indicated in Table 6.1 below.

Table 6.2: Criteria for Ranking Factors for Consequences and Probability

Severity/ Magnitude	Reversibility	Duration/ frequency	Areal extent	Environmental context	Probability
5 – Very high/ don't know	5 – Irreversible	5 – Permanent and/or continuous impact	5 - International	5 – highly sensitive or very rare environmental component	5 – Definite / don't know
++		4 – Long term (impact ceases after operational life) and/or very frequent impact	4 – National	4 – sensitive or rare environmental component	4 – High probability

3 – Moderate	3 - Recoverable (needs human input)	3 – Medium term (2 – 7 years) and/or frequent impact	3 – Regional	3 – moderately sensitive or uncommon environmental component	3 – Medium probability
2 – Low		2 – Short term (0 – 2 years) and/or infrequent impact	2 – Local	2 – non-sensitive or common environmental component	2 – Low probability
1 – Minor	1 – Reversible (regenerates naturally)	1 – Immediate and/or unique impact	1 – Site only	1 – non-sensitive and widely dispersed environmental component	1 – Improbable
0 – None					0 – None

Expert judgement is used when assigning the values for the factors. The maximum value that can be obtained for the significance of the impact is 125 points. The impacts are rated as of Very High, High, Moderate, Low or Very Low significance as shown in Table 6.3 following.

Table 6.3: Significance Rating of the Impacts

SIGNIFICANCE RATING FOR POSITIVE IMPACTS		
More than 100	Impact is of the highest order possible.	Very High
Between 76 and 100	Impact is substantial.	High
Between 51 and 75	Impact is real but not substantial in relation to other impacts.	Moderate
Between 26 and 50	Impact is of low order.	Low
25 or less	Impact is negligible.	Very Low
SIGNIFICANCE RATING FOR NEGATIVE IMPACTS		
Value	Description	Significance
More than 100	Impact is of the highest order possible. Mitigation is required to lower impacts to acceptable levels. Potential fatal flaw.	Very High
Between 76 and 100	Impact is substantial. Mitigation is required to lower impacts to acceptable levels.	High
Between 51 and 75	The impact is real but not substantial in relation to other impacts. Mitigation should be implemented to reduce impact.	Moderate
Between 26 and 50	Impact is substantial. Mitigation is required to lower impacts to acceptable level.	Low
25 or less	Impact is negligible. No mitigation is required.	Very Low

6.5. IMPACT SIGNIFICANCE RATING FOR THE IDENTIFIED IMPACTS

The potential environmental and social impacts were assessed and the significance ratings before the mitigation measures are applied are as presented in Table 6.4.

Table 6.4: Impact significance rating before the mitigation measures are applied

ID	Potential Environmental and Social impacts	Severity	Reversibility	Duration	Areal Extent	Environmental Context	Probability	Total	Significance without mitigation/Enhancement	Significance with mitigation/Enhancement
1.	POSITIVE IMPACTS									
1.1.	Planning and Design Phase									
1.1.1.	Employment Opportunity for Skilled and unskilled Workers	3	3	3	2	4	4	60	Moderate	High
1.2.	Construction Phase									
1.2.1.	Source of employment and business	3	3	3	2	4	4	60	Moderate	High
1.2.2.	Increase in trade opportunities	3	3	3	2	3	3	42	Low	High
1.2.3.	Training opportunities of vocational skills for youth	3	3	2	3	3	2	28	LOW	Moderate
1.3.	Operation and Maintenance Phase									
1.3.1.	Improved access to potable water source	4	3	5	2	4	4	72	Moderate	High
1.3.2.	Improved sanitation, hygiene and health	4	3	5	2	4	4	72	Moderate	High
1.3.3.	Improved socio-economic situation of the communities	3	3	5	2	4	4	68	Moderate	High
1.3.4.	Enhanced gender and women participation in development	2	3	3	2	5	3	45	Low	High
1.3.5.	Education benefits to girl child	2	3	3	2	5	4	60	Moderate	High
1.3.6.	Employment opportunities	4	3	3	2	4	4	64	Moderate	High
1.3.7.	Increased development	2	3	3	2	3	3	39	Low	High
2.	NEGATIVE IMPACTS									
2.1.	Planning and Design Phase									

ID	Potential Environmental and Social impacts	Severity	Reversibility	Duration	Areal Extent	Environmental Context	Probability	Total	Significance without mitigation/Enhancement	Significance with mitigation/Enhancement
2.1.1	Unrealistic public expectations	4	3	2	2	4	3	45	Low	Low
2.2	Construction Phase									
2.2.1.	Degradation of water quality	4	2	3	4	3	4	64	Moderate	Low
2.2.2.	Air pollution	3	3	2	1	3	3	36	Low	Very low
2.2.3.	Soil Contamination and land degradation	3	3	2	1	3	3	36		
2.2.4.	Loss of vegetation cover	2	3	2	1	3	3	33	Low	Very low
2.2.5.	Accidents and hazards from trenches and burrow pits	2	3	2	1	3	3	33	Low	Very low
2.2.6.	Disruption of water supply	3	3	1	2	3	3	36	Low	Very low
2.2.8.	Occupational incidents and accidents	3	3	2	1	4	3	39	Low	Very low
2.2.9.	Noise and vibrations	3	3	2	1	3	3	36	Low	Very low
2.2.10.	Spread of communicable diseases and infections	4	4	5	2	3	3	54	Moderate	Very low
2.2.11.	Increase in sexual relationships, unplanned pregnancies, breaking up of families	4	3	3	2	4	4	64	Moderate	Low
2.2.12.	Incidence of sexual abuse and harassment	4	3	3	2	4	3	48	Low	Very low
2.2.13.	Increased pressure on community health services	3	3	2	2	4	4	56	Moderate	Very low
2.2.14.	Unequal employment opportunities	3	2	3	2	3	4	52	Moderate	Very low
2.3	Demobilisation Phase									
2.3.1.	Increased load of solid waste	2	3	2	2	4	3	39	Low	Very low
2.3.2.	Loss of jobs and businesses	3	3	2	2	4	4	56	Moderate	Low
2.3.3.	Abandonment of used burrow pits and temporary pit latrines	2	3	3	1	3	4	48	Low	Very low
2.4	Operational Phase									

ID	Potential Environmental and Social impacts	Severity	Reversibility	Duration	Areal Extent	Environmental Context	Probability	Total	Significance without mitigation/Enhancement	Significance with mitigation/Enhancement
2.4.1.	Depletion of water resources in the rivers									
2.4.2.	Solid waste generation	2	3	3	2	4	3	42	Low	Very low
2.4.3.	Increased pollution from wastewater and sludge	2	3	3	2	3	3	39	Low	Very low
2.4.4.	Increase in Emergency incidents	2	3	3	1	3	3	36	Low	Very low
2.4.5.	Potential risks of water leakage and flooding from theft and vandalism	2	3	4	1	3	3	39	Low	Very low

From the assessment in Table 6.4 overall the anticipated negative impacts are assessed as low and can be mitigated to very low. The most significant impacts are mainly on the socioeconomic environment and these include the following:

- Spread of communicable diseases and infections
- Increase in sexual relationships, unplanned pregnancies, breaking up of families
- The increased pressure on community health services
- Unequal employment opportunities
- Loss of jobs and businesses
- Poor water quality

These impacts are assessed as moderate and can be mitigated to low or very low. Overall the positive impacts are assessed as moderate and can be enhanced to high.

CHAPTER 7 : ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN TABLE

This Environmental and Social Management Plan (ESMP) has been prepared to facilitate the integration of environmental and social management measures, recommended in Chapter 6, in the implementation of the proposed River Intake works for Mzuzu City and Ekwendeni Water Supply Project. The ESMP for this ESIA provides indication of the measures to be taken, to ensure that the identified impacts of the Project activities are mitigated through the following hierarchical order:

- a) **Avoiding** activities that could result in negative impacts and avoiding resources or areas considered as sensitive;
- b) **Preventing** the occurrence of negative environmental impacts and/or preventing such an occurrence from causing negative environmental impacts;
- c) **Preserving** resources by extending the legal protection to selected resources beyond the immediate needs of the project;
- d) **Minimizing** the impact by limiting or reducing the degree, extent, magnitude or duration of negative impacts through scaling down, relocating and/or redesigning elements of the project;
- e) **Rehabilitating**, repairing or enhancing affected resources, such as natural habitats or water sources, particularly where previous developments have resulted in significant resource degradation;
- f) **Restoring** affected resources to an earlier and more stable productive state (background / pristine condition); and/or
- g) **Compensation** by provision of the same type or better resource/ property at another suitable and acceptable location, compensating for the lost resources/ property.

The ESMP, presented in Table 7.1 contains the following:

- Potential positive and negative environmental and social impacts of the project
- Enhancement measures for the positive impacts and the mitigation measures for the negative impacts.
- Responsible institutions to implement the mitigation measures.
- Estimated cost for implementing the measures.
- Time frames for implementation of the mitigation measures.

Northern Region Water Board and the Contractor have the responsibility of ensuring that the ESMP is implemented effectively and fully.

Table 7.1: Environmental and Social Management Plan for the Project

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
1.	ENHANCEMENT MEASURES FOR POSITIVE IMPACTS				
1.1.	Planning and Design Phase				
1.1.1.	Employment opportunities	<ul style="list-style-type: none"> • Client to provide the necessary support for the team involved in the planning and design • The team to be composed of members with the appropriate qualifications and expertise to provide requisite information for the production of accurate designs. 	On as needed basis for planning and design phase	Client, Contractor, Consultants, District Labour Officer, District Community Development Officer	Included in contractor/ Consultant's BoQs
1.2	The Construction Phase				
1.2.1.	Source of employment and business	<ul style="list-style-type: none"> • Inform local communities of employment opportunities and prioritise employment of local persons that qualify • Prescribe to the gender policy and labour Act which stipulates that 5 -10% of the workforce should be women. • encourage the contractor to buy construction materials within the city in order to empower the local business enterprises • Employ workers possessing legitimate proof of identification that they are above 18 years of age. • Treat and pay employees fairly and keep records of proof for payment at the site. • Match responsibilities of the employed women, members of the vulnerable group and youth to their abilities Wages must at the minimum meet the minimum wage standard and overtime must be paid on time. • Sensitize workers to save and invest during project implementation; 	Continuously throughout construction	Contractor, District Labour Officer, District Community Development Officer	3.5

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<ul style="list-style-type: none"> Encourage the workers to participate in Community Services Investment programmes (COMSIP) and Village Saving and Loans groups. 			
1.2.2.	Increase in trade opportunities	<ul style="list-style-type: none"> Source building materials from the local licensed dealers within the city e.g. quarry dust Encourage works to source materials such as food and groceries within the local communities; Pay the building material suppliers within the agreed time. Support and promote of entrepreneurship skills amongst communities and business people in the project area by engaging them where appropriate. Promote village savings and loan (VSL) schemes during project implementation. 	Continuously throughout construction	Contractor, District Community Development Officer	Cost included in 1.1.1
1.2.3.	Training opportunities in vocational skills for youth	<ul style="list-style-type: none"> Contractors to consider suitably motivated women on skills training program. Contractors to consider focused training program to optimize skills transfer to unskilled workers. 	Continuously throughout construction		N/A
1.3.	OPERATION PHASE				
1.3.2.	Improved access to potable water source	<ul style="list-style-type: none"> Process water connection applications and provide water to the communities as quickly as possible. Ensure that the recommended maximum distances of 500 metres from houses to a water point is observed when constructing communal water points. Ensure water is available all the time at the water points. Encourage communities to establish water kiosks committees in order to establish ownerships of the water draw off points. 	Continuously throughout the operation period	NRWB	Cost included in 1.3.1
1.3.3.	Improved sanitation, hygiene and health	<ul style="list-style-type: none"> Sensitise communities on hygienic practices for handling water to avoid secondary contamination. 	Monthly for water quality analysis and	NRWB District water officer	7.0

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<ul style="list-style-type: none"> • Sensitize the community members to be vigilant in reporting water leakages and broken pipes. • Promote general sanitation practices amongst communities in the project area. • Conduct trainings aimed at building the capacity of water kiosks committee. • Monitor the quality of water and to promote health and hygiene at water points. • Support initiatives implemented by community-based organisations to promote health, sanitation and hygiene. • Ensure there is adequate drainage within the community water points to avoid accumulation of stagnant waters which lead to rapid mosquito breeding as well as other waterborne parasites. 	quarterly for sensitization and capacity building initiatives	NGOs	
1.3.4.	Improved socio-economic situation of the communities	<ul style="list-style-type: none"> • Provide quality water, with minimal loss of supply, through system monitoring and regular maintenance • Support women and other vulnerable groups to start and operate business through appropriate training and start-up capital • Make water costs affordable 	Throughout the operation period	Client, District Community and Development Office	Cost included in 1.2.1
1.3.5.	Enhanced gender and women participation in development	<ul style="list-style-type: none"> • Sensitize recruiting authorities to maintain work place gender balance in line with the national gender policy • Ensure there are also women in important positions • Promote gender mainstreaming in development activities through sensitization, advocacy and awareness. • Economically empower women within affected communities by linking them with the Community Services Investment Programmes (COMSIP) • 	Throughout the operation period	District social welfare officer, District gender officer	7.3

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
1.3.6.	Education benefits to girl child	<ul style="list-style-type: none"> • Conduct sensitizations aimed at encouraging girls to enrol in schools. • Provide the necessary support and adequate resources to schools to ensure that they have adequate resources for the provision of quality of education. • Provide scholarships and bursaries to deserving girls who cannot afford to pay the school fees. • Provide adequate water and appropriate sanitation facilities in schools to support female students. 	Throughout the operation period	Client, District Education Office, District Gender Office	Included in 1.3.5
1.3.8	Employment opportunities	<ul style="list-style-type: none"> • Prioritise employment of local persons that qualify; • Adequate occupational health and safety standards should be provided to ensure the work environment is conducive. • Consider employing both qualified female and male workers to enhance income distribution among both men and women. • The women and people living with disability should be given tasks that commensurate with their physical ability and level of skills. 	Throughout operational phase	Client	Included in 1.2.1 and 1.3.5
1.3.7.	Increased development	<ul style="list-style-type: none"> • New water connection applications must be processed within set time • Provide adequate potable water supply to the new areas • Sensitize the communities to report leakages and breakages of pipes. • The Mzuzu City and Mzimba District Councils must ensure that development activities are implemented within Council plans and laws • 	Throughout operation phase	NRWB	Cost included in 1.2.1
2. MITIGATION MEASURES FOR NEGATIVE IMPACTS					

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
2.1.	Planning and design phase				
2.1.1.	Unrealistic public expectations with regard to land/compensations/resettlement negotiations	<ul style="list-style-type: none"> • Conduct sensitization and awareness on the need constructing the two weirs. • Conduct sensitization and awareness on the need for land for the project and compensation process. • Sensitize the affected people to use the existing Grievance Redress Mechanism • Compensate and resolve any grievances before handing over the land before commencement of construction activities • Conduct a disclosure and verification exercise before payment of compensations to ensure that there are no conflicts. • Observe transparency and accountability when evaluating the land and property and paying the compensations. 	During the planning and design phase	NRWB, District Land Office	3.5
2.2.	Construction Phase				
2.2.1.	Degradation of water quality	<ul style="list-style-type: none"> • Provide a schedule for excavation works to the treatment plant team so that they plan to pump water in harmony with the works schedule. • Encourage use of mortar and debris traps during construction. • Strategic stakeholder consultations must be done comprehensively to make sure that those who could potentially be affected are aware of the works program. i.e. Tropha company (which is located down-stream). • Mix cement in areas, which are not directly connected to natural drainage systems. 	Throughout construction phase	Client, Contractor,	1.0

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<ul style="list-style-type: none"> • Shutters to be properly erected and monitored to check if there are any unallowable spaces in between the joints which may lead to concrete leakages. • Discourage any taking of food by the workers when the work is in progress. • Store cement, paints, lubricants and fuels in lined and covered areas. • Provide appropriate spill kits when working near water courses. • Provide appropriate facilities for the collection of wastes on site such that they will not come into contact with water. • Site all material storage areas at least 10 m from watercourses. • Provide appropriate barriers to separate worksites from water resources in order to prevent accidental spillage into water courses. • Connect the drainage systems to oil interceptors. • Line surfaces where cement, paints and oils will be stored and connecting the drainage systems to oil interceptors. • Collect and dispose wastes in designated disposal sites as required by the Local Authority. • Construct pit latrines that are at least 1.5 meters deep, lined at the base and 30 metres from a water body. • . 			
2.2.2.	Air Pollution	<ul style="list-style-type: none"> • Use new or fairly new vehicular equipment with exhaust gas emissions above permissible emission limits. • Erect safety signboards to warn other road users about the volume of construction traffic. 	Throughout construction	Contractor	5.0

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<ul style="list-style-type: none"> • Timely and effectively maintain vehicles and equipment to prevent exhaust gas emissions above permissible emission limits. • Use the water bowsers to spray water along the access roads used by the haulage trucks. • Provide protective gear (dust masks) to workers and ensure that they wear them. • Erect a barrier around the work sites where major construction activities are taking place to break or reduce wind and dust movement. • Store and handle quarry dust and cement properly to limit dust generation. • Optimize transportation management to avoid needless truck drives. • Construct gravel speed bumps to Control vehicle speeds. • Reduce engine idling time. • Provide or facilitate regular medical check-ups for construction workers to timely treat any occupational safety illnesses and disorders related to air pollution. 			
2.2.3.	Soil contamination and land degradation	<ul style="list-style-type: none"> • Provide garbage collecting bins at the construction site and monitor its usage • Contractor to develop the waste management plan in accordance with the Environmental Management Act 1996, and should keep records of the volume of waste generated and disposed. • Surface all vehicle servicing and fuel /oil storage areas with an appropriate impervious material to prevent contact of soil with the oils. • Use containers to collect used oil and then properly discard waste oil containers in approved disposal sites, as 	Throughout construction	Contractor	7.0

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<p>recommended by Mzuzu City Council and Mbelwa District Council.</p> <ul style="list-style-type: none"> • Segregate waste (e.g. cartons and paint containers) to encourage reuse. • Provide all structures required for effective water drainage. • Construct waste disposal pits and bury the wastes after the construction period. • Closely supervise the workforce to avoid or limit waste generation. • Store and contain construction materials on lined surfaces and in covered areas. • Sensitize construction workers to avoid littering the site. • Use excavated soils for backfilling and site levelling. • Promote the usage of quarry dust and source quarry in approved sites that are run sustainably. • Enforce the use of licensed construction material suppliers through the construction contract(s). 			
2.2.4.	Loss of vegetation cover	<ul style="list-style-type: none"> • Limit vegetation clearing and excavations to only those areas specified in the designs to avoid unwarranted clearance of vegetation. • Strict control of construction vehicles to ensure that they operate only within the areas to be affected by the construction works or engage only in activities that benefit the project. • Plant appropriate trees and grasses and grasses in all disturbed area. • Cost and appropriately compensate for all the trees to be cut down during construction. 	Throughout construction (but mainly during land preparation)	Contractor, Client	3.0

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<ul style="list-style-type: none"> • Ensure that for every single tree cut down, 10 tree seedlings of a similar species are planted in the adjacent areas. • Rehabilitate affected land by tilling the soils to facilitate natural regeneration of vegetation; and by planting trees, including indigenous trees, and grass immediately after construction works to minimise soil erosion. • Sensitize employees and the community to conserve vegetation. • Salvage vegetation (hollow logs, seedlings, seeds, etc.) affected by the project and reuse in areas to be planted with forest woodland. 			
2.2.5.	Accidents and hazards from trenches and burrow pits	<ul style="list-style-type: none"> • Use construction material suppliers that are licensed by the Mzuzu City Council and Mbelwa District Council. • Avoid making deep pits when extracting construction materials. • Refill all burrow pits to be created during the upgrading, rehabilitation and expansion of the water supply systems. • Barricade all trenches and open pits and place clear signs to protect animals and people from falling into them. • Inform and sensitize the public about all open pits and trenches. • Supervise adequately the construction activities and follow recommended procedures 	Throughout construction	Contractor	1.5
2.2.6.	Disruption of water supply	<ul style="list-style-type: none"> • Give adequate notice of potential water disruption to the water users that could be affected. • Provide alternative means of supplying water such as temporary by-pass piping or water bowsers where appropriate 	Throughout construction	Contractor, Client	Cost included in 1.2.1

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<ul style="list-style-type: none"> The contractor to Provide a works schedule with strategically staggered activities to avoid total flow disruption during construction 			
2.2.7.	Water pollution and siltation	<ul style="list-style-type: none"> Mix cement in areas, which are not directly connected to natural drainage systems. Store cement, paints, lubricants and fuels in lined and covered areas. Provide appropriate spill kits when working near water courses. Provide appropriate facilities for the collection of wastes on site such that they will not come into contact with water. Site all material storage areas at least 10 m from watercourses. Provide appropriate barriers to separate worksites from water resources in order to prevent accidental spillage into water courses. Line surfaces where cement, paints and oils will be stored. Connect the drainage systems to oil interceptors. Collect and dispose wastes in designated disposal sites as required by the Local Authority. Construct a pit latrine that is at least 1.5 meters deep, lined at the base and 30 metres from a water body. 	Throughout construction	Contractor	Included in 2.2.2
2.2.8.	Occupational incidents and accidents	<ul style="list-style-type: none"> An emergency vehicle to be available all times when the works are in progress. Workers to be trained on safe operating procedures. Induct workers on OSH requirements and repeat reminders on the same. Employ an OSH expert to monitor and ensure that appropriate equipment and acceptable codes of practice 	Throughout construction	Contractor	3.7

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<p>for various tasks are followed by workers at all times. i.e. Hazard Identification and risk assessments</p> <ul style="list-style-type: none"> • Provide appropriate personal protective equipment (PPEs) to construction workers and ensure that it is used at all times. The contractor to provide a mechanism for reporting of accidents and near misses. viii. The first aid box to be made available for each team and a trained first aider to be available too. 			
2.2.9.	Noise and vibrations	<ul style="list-style-type: none"> • Monitor the noise levels for any machine on site regularly. • Use appropriate and well-maintained noise mufflers on vehicles and machinery. • Regularly service and carry maintenance of equipment. • Provide ear muffs for the workers in noisy areas. • Use electric motors instead of compressed air driven machinery. • Reduce noise by using plastic or rubber liners, noise control covers, and dampening plates and pads on large sheet metal surfaces. • Limit the number of days of operation; restrict hours of operation and schedule noisy tasks for periods of low occupancy on the project surroundings. • Notify the public of upcoming loud events. 	Throughout the construction period	Contractor	Cost of ear muff included in 2.2.7
2.2.10.	Spread of communicable diseases and infections	<ul style="list-style-type: none"> • Provide both male and female condoms to workers for appropriate use. • Treat the affected local and migrant workers so as to control the movement of disease vectors • The contractor to provide sanitary facilities in good condition with adequate water supply. 	Throughout construction	Contractor, District Health Officer	Included in 2.2.10

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<ul style="list-style-type: none"> • Train workers on good personal hygiene practices e.g. washing of hands after visiting the toilet, drinking portable/treated water • Alert the responsible health authority if there is an outbreak of any communicable diseases. 			
2.2.11.	Increase in sexual relationships, unplanned pregnancies, breaking up of families	<ul style="list-style-type: none"> • Provide a reporting mechanism at the site where grievances can be channelled and this mechanism should also be available to the concerned public. • Sensitise communities on the disadvantages of indulging in extra-marital affairs. • Sensitize all contractors, workers and communities on the STD and HIV/AIDS program, including explanations on risks posed by STDs, sanctions, etc. as well as on grievance mechanisms in place. • Sensitise girls on the dangers of getting involved in pre-marital sex at a tender age. • Enforce punitive and disciplinary measures, including dismissal from employment, on any project workers involved in any social malpractices with surrounding communities. • Engage stakeholders in encouraging and empowering women to be financially independent. • Provide both male and female condoms to workers for appropriate use. • Prepare and implement an STD and HIV/AIDS prevention program including a strict prohibition of sexual abuse and sexual intercourse with partners younger than 18 years of age (underage sex). • Support the District Social Welfare Office and the Community Development Office and Non-Governmental 	Quarterly	Contractor, District HIV/AIDS Coordinator	3.7

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		Organisations in the implementation of on-going projects aimed at assisting pupils to go back to school.			
2.2.12.	Incidence of sexual abuse and harassment	<ul style="list-style-type: none"> • Report any form of physical abuse/harassment to Police, that way workers will understand the seriousness of the offense. • Provide a reporting mechanism for both the public and the workers. • Sensitise workers and surrounding communities to avoid sexual abuse and harassment • Conduct sensitization and awareness campaigns to encourage affected individuals to report cases of sexual harassment in the homes. • Publicise places for reporting gender violence and sexual harassment. • Create a good work environment to allow female workers to report cases of harassment. • Enforce punitive and disciplinary measures, including dismissal from employment, on any project workers involved sexual abuse and harassment. • Prepare and implement an STD and HIV/AIDS prevention program including a strict prohibition of sexual abuse and sexual intercourse with partners younger than 18 years of age (underage sex). • Support the District Gender Welfare Office and Non-Governmental Organisations in the implementation of on-going projects aimed at promoting gender equality and ending sexual harassment. • Implement and follow-up on grievance redress mechanisms. 	Quarterly	NRWB, Contractor, District HIV/AIDS Coordinator, District Gender Office	Included in 2.2.10

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<ul style="list-style-type: none"> Require the contractor to be responsible and to take necessary measures so his employees do not commit acts of sexual abuse and/or underage sex. 			
2.2.13.	The increased pressure on community health services	<ul style="list-style-type: none"> Conduct public awareness and sensitization on community health, HIV and AIDS. Encourage employees to go for voluntary health screening and receive appropriate treatment where it is required. Require the workers, sensitize the communities follow recommended environmental and water management practices. Construct adequate sanitation facilities at the work sites and surrounding area. Locate worker camps at a minimum distance of 1 km from towns and villages in order to limit worker – community interactions. Maintain construction camps in clean and healthy condition as prescribed by international worker health standards. Require all contractors and sub-contractors to comply with relevant health and safety requirements and NRWB corporate policy. Develop and implement an H&S management plan to protect every worker involved in construction activities, even temporary workers (e.g. vaccines, etc.). Involving other stakeholders including NGO's in the promotion of social welfare. Support and supplement social services including the Health Surveillance Assistants. 	Quarterly	Contractor, Client, DHO	Cost included in 2.2.10
2.2.14.	Unequal employment opportunities	<ul style="list-style-type: none"> Encourage the contractor to employ women as well. A clause should be included in the contract specifying that at least 5 - 10% of the employees should be women. 	Quarterly	Contractor District social welfare officer	Included in 1.1.1

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<ul style="list-style-type: none"> • Conduct gender meetings to sensitize and encourage women and to instil confidence that they can also do the work that men do. • Ensure there are also women in important positions such as foremen and engineers. • Economically empower women within affected communities by linking them with the District Council's Community Service Investment Programme (COMSIP). • Create a good work environment to allow female workers report any case of harassment. 			
2.3.	DEMobilisation PHASE				
2.3.1.	Increased solid waste	<ul style="list-style-type: none"> • Sell or recycle metal waste to tinsmiths or vendors for reuse or re-sale • Provide solid waste storage bins and skips • Monitor skips so that they do not become overfilled. • Ensure that collected solid waste is disposed of in an approved disposal site • Implement sensitization campaigns on consequences of indiscriminate waste disposal. 		Contractor, MCC	
2.3.2.	Loss of jobs due to completion of construction works	<ul style="list-style-type: none"> • Introduce Money saving programs like Savings and Capital Cooperative (SACCO) for the employees so that they are prepared well for retrenchment. • Provide adequate notice to employees to prepare themselves and secure alternative employment. Pay severance benefits to leaving workers in line with the labour regulations. • Sensitize the workers and the general community to be saving. • Sensitize the business persons to diversify and find alternative markets. 	Twice during the construction phase	Contractor, District Labour Office, District Community Development Office	Included in 1.1.1

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<ul style="list-style-type: none"> • Pay severance benefits to leaving workers in line with the labour regulations. • Provide alternative employment to employees where possible e.g. as maintenance staff. 	Once during lay offs	Contractor, NRWB	Severance pay to be included in the contractor's bills of quantities
2.3.3.	Abandonment of used burrow pits and temporary pit latrines	<ul style="list-style-type: none"> • Fill up and close pits after the construction works; • The contractor should register all burrow pits to the Mzuzu City council and Mbelwa District Council. • Authorization Certificates (Signed by Land owners and chiefs) to be obtained before any soil extraction is done and also the Certificate of Rehabilitation to be issued at the end of the construction phase; Rehabilitate all work site; The rehabilitation plan to include reforestation of the area. • Construction materials e.g. sand and clay soils should be sourced from licensed suppliers. • 	Throughout construction	Contractor	1.0
2.4.	OPERATION PHASE				
2.4.1.	Increased solid waste generation	<ul style="list-style-type: none"> • Sell or recycle metal waste to tinsmiths or vendors for reuse or re-sale • Provide solid waste storage bins and skips. • Monitor skips so that they do not become overfilled. • Ensure that collected solid waste is disposed of in an approved disposal sites. • Implement sensitization campaigns on consequences of indiscriminate waste disposal. 	Throughout the operation period	NRWB	Cost included in 1.2.1
2.4.2.	Increased pollution from wastewater and sludge	<ul style="list-style-type: none"> • Enforce proper excreta and wastewater management especially in the town. • Apply lime treatment to dewatered sludge to suppress pathogens and remove odour. 	Bi Annually	Client, Environmental Health Officer	Cost included in 1.2.1

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<ul style="list-style-type: none"> • Enforce the use of licensed liquid waste handlers for liquid waste. • Dry sludge on drying beds before disposing off in a dedicated disposal site. • Prepare and enforce operational guidelines for sludge treatment and management. • Conduct WASH activities to sensitize people on the benefits (including prevention of cholera) of good the hygiene. 			
2.4.3.	Increase in Emergency incidents	<ul style="list-style-type: none"> • Design and implement an emergency response plan. • Install fire hydrants within the proposed development. • Use checklists to regularly monitor and maintain the water supply system. • Maintenance of natural drains around the weirs; • Install fire extinguishers at the plant and train workers on how to use. • Maintain the critical spares lists. 	Monthly	Client	Cost included in 1.2.1
2.4.4.	Potential risks of water leakage and flooding from theft and vandalism	<ul style="list-style-type: none"> • NRW must periodically conduct consultations and sensitizations with villages and group village heads and security personnel. • Provide security at the intake, treatment plant and water reservoir sites. • Support activities of the neighbourhood watch (community policing) e.g. through provision of torches, uniforms and shoes. • Support economic activities in the area as part of corporate social responsibilities. • Reward for reports of vandalism and theft that may lead to capture. • Theft and vandalism cases must be reported to the police. 	Throughout the operation period	Client	Cost included in 1.2.1

ID	Potential Impact	Recommended enhancement/mitigation measure	Schedule for implementation	Responsible institution	Implementation cost/year (000,000 MKW)
		<ul style="list-style-type: none"> • Regularly monitor the pipeline infrastructure. • Include the people from the local area in the work force. 			

7.2. COST FOR ENVIRONMENTAL AND SOCIAL IMPACTS MANAGEMENT

Table 7.2 presents a summary of costs for implementing the Environmental and Social Management Plan.

The majority of the costs associated with the implementation of mitigation measures and enhancements cannot be specified at this stage of the study. Many of these measures are to be under the responsibility of the contractor(s) who will carry out the project implementation activities. The costs will therefore be integrated with other construction costs. It should be mentioned that the present ESMP imperatively needs to be appended to the construction tender documents to be published in order to ensure that those costs are placed under the responsibility of the project contractor(s).

Table 7.2: Summary of Environmental and Social Management Costs

S/ N	Potential Impacts	Implementation cost in MWK/Year
1	Creation of employment opportunities	3,500,000
2	Improved water supply to Mzuzu City and the surrounding areas	20,000,000
3	Improved sanitation, hygiene and health	7,000,000
4	Unrealistic public expectations	3,500,000
5	Enhanced gender and women participation in development	7,300,000
6	Poor water quality	1,000,000
7	Air Pollution	5,000,000
8	Soil contamination and land degradation	7,000,000
9	Loss of vegetation cover	3,800
10	Loss of vegetation cover	3,000,000
11	Accidents and hazards from trenches and burrow pits	1,000,000
12	Occupational incidents and accidents	3,700,000
13	Increase in sexual relationships	3,700,000
	Total	65,703,800

CHAPTER 8 : ENVIRONMENTAL AND SOCIAL MONITORING PLAN

8.1. ENVIRONMENT AND SOCIAL MONITORING PLAN ACTIVITIES

The Environmental and Social Monitoring Plan, presented in Table 8.1 provides for monitoring to check the implementation of the enhancement and mitigation measures proposed in the Environmental and Social Management Plan (table 7.1).

The monitoring plan identifies the roles and responsibilities of stakeholders to conduct the monitoring and the estimated cost of these monitoring activities. It provides monitoring indicators, means of their verification and the frequency of monitoring.

Implementation of the monitoring programme helps to verify the magnitude, duration and scope of the predicted impacts during and after implementing the enhancement and mitigation measures. It also helps to detect any unforeseen impacts at an early stage so that corrective measures can be taken, before significant damage takes place on the social, economic and biophysical components of the environment.

Table 8.1: Environmental and Social Monitoring Plan

ID	Potential Impact	Recommended enhancement/mitigation measure	Monitoring Indicator	Means of monitoring	Monitoring frequency	Responsibility for monitoring	Monitoring cost (MWK/Year)
1.	ENHANCEMENT MEASURES FOR POSITIVE IMPACTS						
1.1.	PLANNING AND DESIGN						
1.1.1.	Employment opportunities	Client to provide support to planning and design team	Duration taken for data to be provided from the time requested	Quality of information provided to planning and designing team	Quarterly	Client, Consultant, Contractor	800,000
		The team to be composed of members with the appropriate qualifications and expertise to provide requisite information for the production of accurate designs.	Availability of Client staff when required				
1.2.	Construction phase						
1.2.1.	Source of employment and business	Inform local communities of employment opportunities and prioritise employment of local persons that qualify	Number of locals informed and employed through the council	Review of job applications forms and staff interview	Quarterly	District Labour Officer (DLO), District Social Welfare Officer, District Gender Officer, NRW's Project Supervisor	300,000
			Percentage of locals employed	Review of employee files			
		Prescribe to the gender policy and labour Act which stipulates that 5 -10% of the workforce should be women.	Number of women employed against men	Head count, Review of employee files			
		Encourage the contractor to buy construction materials within the city in order to empower the local business enterprises	Number and availability of local materials	Interviews			

		Employ workers possessing legitimate proof of identification that they are above 18 years of age.	Age of employees	Inspection, Review of employee files, check IDs			
		Treat and pay employees fairly and keep records of proof for payment at the site.	Number of cases of unfair treatment	Interviews			
		Match responsibilities of the employed women, members of the vulnerable group and youth to their abilities	Roles of the vulnerable groups compared against their abilities	Review of job descriptions			
		Wages must be above the minimum wage and overtime must be paid on time	Amount paid as wages including for over time	Interviews, Review of payment records			
		Sensitize workers to save and invest during project implementation.	Number of Workers sensitized, number of workers saving	Interviews			
		Encourage the workers to participate in Community Services Investment programmes (COMSIP) and Village Saving and Loans groups.	Number of workers participating in COMSIP	Interviews, Review of COMSIP reports			
1.2.2.	Increase in trade opportunities	Source materials from approved licenced suppliers	Percentage of licenced suppliers used	Review of procurement records, Interviews	Quarterly during construction	Director of Planning and Development, District Community Development	Included in 1.1.1
		Encourage workers to source materials such as	Number and availability of local materials bought				

		food and groceries within the local communities;				Office, NRW's Project Supervisor	
		Pay building material suppliers within the agreed times	Time for paying suppliers				
		Support and promote of entrepreneurship skills amongst communities and business people in the project area by engaging them where appropriate.	Number of people engaged				
		Promote village savings and loan (VSL) schemes during project implementation.	Number of workers participating in VSL				
1.2.3.	Training opportunities in vocational skills for youth	Contractors to consider suitably motivated women on skills training program.	Number of women and youth on training	Employment records, visual inspection	Bi-annually	DLO, NRW, DCDO	N/A
		Contractors to consider focused training program to optimize skills transfer to unskilled workers.	Strategic attachments and rotations of selected workers to specific sections/ area of specialization	Number of identified mentors/ mentees			
1.3.	Operation Phase						
1.3.1.	Improved access to potable water source	Process water connection applications and provide water to the communities as quickly as possible	Number of water applications attended to Duration taken for water applications to be processed	Review of new water connection reports, Interviews	Quarterly	NRWB, District Water Development Officer	Included in 1.3.2

		Ensure that the recommended maximum distances of 500 metres from houses to a water point is observed when constructing communal water points.	Distance between houses to a kiosk	Site visits, Interviews, Review of kiosks management reports			
		Ensure water is available all the time at the water points.	Percentage time water is available at the water points				
		Encourage communities to establish water kiosks committees in order to establish ownerships of the water draw off points.	Number of kiosks established				
1.3.2.	Improved sanitation, hygiene and health	Sensitise communities on hygienic practices for handling water to avoid secondary contamination.	Number of times sensitizations are conducted; Number of reported secondary contamination	Review of health records from health care services Visual inspections, Review of water quality tests results	Quarterly	NRWB, District Health Officer, Environmental Health Office	300,000
		Sensitize the community members to be vigilant in reporting water leakages and broken pipes.	Number of sensitizations conducted; Number of leakage and breakage reports received	Review of sensitization reports, Review of maintenance records			
		Promote general sanitation practices amongst communities in the project area.	Number of sanitation promotion				

			activities conducted				
		Conduct trainings aimed at building the capacity of water kiosks committee.	Number of trainings conducted	Review of training reports, interviews			
		Monitor the quality of water and to promote health and hygiene at water points.	Quality of water	Review of water quality tests results			
		Support initiatives implemented by community-based organisations to promote health, sanitation and hygiene.	Number of initiatives supported	Record review, interviews			
		Ensure there is adequate drainage within the community water points to avoid accumulation of stagnant waters which lead to rapid mosquito breeding as well as other waterborne parasites.	Presence of adequate drainage structures	Inspection			
1.3.3.	Improved socio-economic situation of the communities	Provide quality water, with minimal loss of supply, through system monitoring and regular maintenance	Water quality results, Average duration for loss of supply	Review of water supply reports, Review of water quality tests results	Quarterly	NRWB, District Social Welfare Office, District Water Office, District Community Development Office	300,000
		Support women and other vulnerable groups to start and operate business through appropriate training and start-up capital	Number of women and vulnerable groups supported to start businesses	Review of reports for supports with start-up capital			

		Make water costs affordable	Cost of water compared to income levels	Review of water tariffs and social-economic profile			
1.3.4.	Enhanced gender and women participation in development	Sensitize recruiting authorities to maintain work place gender balance in line with the national gender policy	Number of sensitizations, awareness meetings conducted	Review of sensitization reports	Quarterly	District Gender Office, District Community Development Office, NRW	Included in 1.3.4
		Ensure there are also women in important positions	Number of women in important positions	Review of employee records			
		Promote gender mainstreaming in development activities through sensitization, advocacy and awareness.	Number of women involved in development activities	Review of sensitization records, Review of development activities records			
		Economically empower women within affected communities by linking them with the Community Services Investment Programmes (COMSIP)	Number of women linked to economic empowerment programmes	Review of economic empowerment programme reports			
1.3.5.	Education benefits to girl child	Conduct sensitizations aimed at encouraging girls to enrol in schools.	Number of sensitization meetings conducted	Review of sensitization reports	Quarterly	District Monitoring Information and Evaluation Office, District Education Office, District Social Welfare Office	Included in 1.3.4
		Provide the necessary support and adequate resources to schools to ensure that they have adequate resources for the provision of quality of education.	Availability of adequate resources in the schools	Review of education statistics			

		Provide scholarships and bursaries to deserving girls who cannot afford to pay the school fees.	Number of deserving girls provided with bursaries and support				
		Provide adequate water and appropriate sanitation facilities in schools to support female students.	Availability of adequate water supply and sanitation in schools				
1.3.6.	Employment opportunities	Prioritise employment of local persons that qualify	Percentage of locals employed	Review of employee files	Quarterly	District Labour Officer (DLO), District Social Welfare Officer, District Gender Officer, NRWB's Project Supervisor	300,000
		Adequate occupational health and safety standards should be provided to ensure the work environment is conducive.	Availability of health and safety standards at the site	Observations, records review, interviews			
		Consider employing both qualified female and male workers to enhance income distribution among both men and women.	Number of female employees against the number of males	Review of employees files			
		The women and people living with disability should be given tasks that commensurate with their physical ability and level of skills.	Roles of the vulnerable groups compared against their abilities	Review of job descriptions			
1.3.7.	Increased development	New water connection applications must be processed within set time	Duration for processing applications	Review of water connection records	Quarterly	NRWB, District Water Development	300,000

		Provide adequate potable water supply to the new areas	Volume of water supplied compared to the demand	Interview, Review of water supply records		Office, Director of Planning and Development	
		Sensitize the communities to report leakages and breakages of pipes	Number of sensitizations conducted; Number of leakage and breakage reports received	Review of sensitization reports, Review of maintenance records			
		The Mzuzu City and Mzimba District Councils must ensure that development activities are implemented within Council plans and laws	Percentage of time water is available and adequacy of sanitation	Review of water supply reports, Interviews, Visual inspection on sanitation			
2.	MITIGATION MEASURES FOR ADVERSE IMPACTS						
2.1.	PLANNING AND DESIGN PHASE						
2.1.1.	Unrealistic expectations with regard to lands/compensation/resettlement negotiations	Conduct sensitization meetings in regard to land laws, land acquisition and compensations.	Number of awareness and sensitization meetings conducted	Review of sensitization reports/records	Monthly before commencement of construction	NRWB, District Lands Office, Director of Planning and Development	300,000
Conduct sensitization and awareness on the need for land for the project and compensation process.							
Sensitize the affected people to use the existing Grievance Redress Mechanism		Number of PAPs sensitised					
Compensate and resolve any grievances before handing over the land		Percentage of people to have not received	Interview, review of grievance redress				

		before commencement of construction activities.	compensations and/or with grievances before commencement of construction				
		Conduct a disclosure and verification exercise before payment of compensations to ensure that there are no conflicts.	Number of people to have attended to the disclosure exercise and to have signed the compensations due	Review of the disclosure exercise report and compensation schedule, audit of the land acquisition process			
		Observe transparency and accountability when evaluating the land and property and paying the compensations.	Degree of transparency and accountability when evaluating land				
2.2.	Construction phase						
2.2.1.	Degradation of Water Quality	Provide a schedule for excavation works to the treatment plant team so that they plan to pump water in harmony with the works schedule.	Presence of a schedule	Visual inspection, interviews, record review			Included in 2.2.1
		Encourage use of mortar and debris traps during construction.	Presence of mortar and debris traps				
		Strategic stakeholder consultations must be done comprehensively to make sure that those who could potentially be affected are aware of the works program. i.e. Tropha	Number of consultations done				

		company (which is located down-stream).					
		Mix cement in areas, which are not directly connected to natural drainage systems.	Distance to natural drainage of areas for cement and paint mixing				
		Shutters to be properly erected and monitored to check if there are any unallowable spaces in between the joints which may lead to concrete leakages.	Perimeter with a barrier as compared to the total area that requires a barrier				
		Store cement, paints, lubricants and fuels in lined and covered areas.	Percentage of construction materials stored and contained on lined surface				
		Provide appropriate spill kits when working near water courses.	Availability of spills kits at the site				
		Provide appropriate facilities for the collection of wastes on site such that they will not come into contact with water.	Availability of appropriate waste collection materials				
		Site all material storage areas at least 10 m from watercourses	Distance from water source to the				
		Provide appropriate barriers to separate worksites from water resources in order to	Availability of barriers at the worksite				

		prevent accidental spillage into water courses.					
		Connect the drainage systems to oil interceptors.	Presence of drainage structures				
		Line surfaces where cement, paints and oils will be stored and connecting the drainage systems to oil interceptors.	Percentage of construction material on lined surface				
		Collect and dispose wastes in designated disposal sites as required by the Local Authority	Volume of waste disposed in approved sites				
		Construct pit latrines that are at least 1.5 meters deep, lined at the base and 30 metres from a water body.	Distance from to pit latrines and depth of pit latrines				
		.					
2.2.2.	Air Pollution	Use new or fairly new vehicular equipment with exhaust gas emissions above permissible emission limits.	Number of years equipment has been in use, Level of emissions from equipment	Review of procurement records, Inspection, Interviews	Monthly	Contractor, NRWB, Environmental District Office	900,000
		Erect safety signboards to warn other road users about the volume of construction traffic.	Availability of safety signboards	Site inspection			
		Timely and effectively maintain vehicles and equipment to prevent exhaust gas emissions	Dates for servicing vehicles and equipment in	Review of maintenance records			

		above permissible emission limits.	respect to set dates for service				
		Use the water bowsers to spray water along the access roads used by the haulage trucks.	Number of times the site is sprayed with water to control dust, Dust complaints	Interviews, Visual inspection			
		Provide protective gear (dust masks) to workers and ensure that they wear them.	Reports of use of protective gear during dust generating activities				
		Erect a barrier around the work sites where major construction activities are taking place to break or reduce wind and dust movement.	Perimeter with a barrier as compared to the total area that requires a barrier				
		Store and handle quarry dust and cement properly to limit dust generation.	Reports of proper handling and storage of sand and cement, Presence of dust				
		Optimize transportation management to avoid needless truck drives.	Number or errands for vehicles per day				
		Construct gravel speed bumps to Control vehicle speeds.	Number of reports of over speeding, Presence of vehicle speed signs	Review of vehicle logs			
		Reduce engine idling time.	Time period vehicles remain on idling	Interviews, Visual inspections			
				Random checks, interviews			

		Provide or facilitate regular medical check-ups for construction workers to timely treat any occupational safety illnesses and disorders related to air pollution.	Number of times workers go for check-up	Review of human resources records/employee records			
2.2.3.	Soil contamination and land degradation	Provide garbage collecting bins at the construction site and monitor its usage	Presence and number of garbage collection bins available at the site	Site Inspection	Monthly	Contractor, NRWB, Environmental District Office	Included in 2.2.1
		Contractor to develop the waste management plan in accordance with the Environmental Management Act 1996, and should keep records of the volume of waste generated and disposed.	Presence of a waste management plan at the site				
		Surface all vehicle servicing and fuel /oil storage areas with an appropriate impervious material to prevent contact of soil with the oils.	Size of surfaced areas	Visual inspection, Measurements,			
		Use containers to collect used oil and then properly discard waste oil containers in approved disposal sites, as recommended by Mzuzu City Council and Mbelwa District Council.	Volume of waste disposed in approved sites	Review of waste management records			

		Segregate waste (e.g. cartons and paint containers) to encourage reuse.					
		Provide all structures required for effective water drainage.	Presence of adequate drainage structures				
		Construct waste disposal pits and bury the wastes after the construction period.	Presence of waste disposal pits and distance to water bodies				
		Closely supervise the workforce to avoid or limit waste generation.	Volume of generated waste				
		Store and contain construction materials on lined surfaces and in covered areas.	Percentage of construction materials stored and contained on lined surface				
		Sensitize construction workers to avoid littering the site.	Number of sensitizations; Presence of littered sites	Review of records			
		Use excavated soils for backfilling and site levelling.	Volume of excavated used for backfilling and levelling	Inspection			
		Promote the usage of quarry dust and source quarry in approved sites that are run sustainably.	Presence of quarry dust, sites and methods for quarrying	Inspection, Interviews			

		Enforce the use of licensed construction material suppliers through the construction contract(s).	Clause in contracts, and the types of suppliers that are used	Review of contracts and suppliers used			
2.2.4.	Loss of vegetation	Limit vegetation clearing and excavations to only those areas specified in the designs	Size of cleared areas in relation to required space	Inspection, measurement	Monthly	Contractor, NRWB, Environmental District Office	Included in 2.2.1
		Strict control of construction vehicles to ensure that they operate only within the areas to be affected by the construction works or engage only in activities that benefit the project.	Number of trips outside the area affected by construction	Record review			
		Plant appropriate trees and grasses in all disturbed areas.	Size of affected area planted with trees and grass	Inspection, measurement			
		Cost and appropriately compensate for all the trees to be cut down during construction	Percentage of trees compensated for	Review of compensation records			
		Ensure that for every single tree to be cut down, 10 tree seedlings of a similar species should be planted in the adjacent areas.	Number of seedlings planted in adjacent areas	Inspection, Counting, Measurement			
		Rehabilitate affected land by tilling the soils to facilitate natural regeneration of vegetation; and by planting trees,	Size of rehabilitated sites				

		including indigenous trees, and grass immediately after construction works to minimise soil erosion.					
		Sensitize employees and the community to conserve vegetation.	Number of employee and community sensitized	Review of sensitization records			
		Salvage vegetation (hollow logs, seedlings, seeds, etc.) affected by the project and reuse in areas to be planted with forest woodland.	Volume/number of reused plants materials	Interviews, Inspections			
2.2.5.	Accidents and hazards from trenches and burrow pits	Use construction material suppliers that are licensed by the Mzuzu City Council and Mbelwa District Council.	Size of rehabilitated sites	Visual inspection, Review of procurement records, Interviews	Once during the demobilisation phase	Contractor, NRWB, Environmental District Officer	Included in 2.2.8
		Avoid making deep pits when extracting construction materials.	Depths of pits				
		Refill all burrow pits to be created during the upgrading, rehabilitation and expansion of the water supply systems.	Number of barrow pits rehabilitated				
		Barricade all trenches and open pits and place clear signs to protect animals and people from falling into them.	Presence of barricades, and appropriate signs, around trenches				

		Inform and sensitize the public about all open pits and trenches.	Number of people sensitized					
		Supervise adequately the construction activities and follow recommended procedures	Number of hours a supervisor is on site					
2.2.6.	Disruption of water supply	Give adequate notice of potential water disruption to the water users that could be affected	Number of times water supply is disrupted without notice	Review of construction reports, Interviews	Monthly	Contractor, NRWB, District Water Office	900,000	
		Provide alternative means of supplying water such as temporary by-pass piping or water bowsers where appropriate	Availability of alternative means of supplying water					
		The contractor to Provide a works schedule with strategically staggered activities to avoid total flow disruption during construction	Presence of written working schedule					
2.2.7.	Water pollution and siltation	Mix cement in areas, which are not connected to natural drainage systems.	Distance to natural drainage of areas for cement and paint mixing	Visual inspection, Interview, Measurement of distance	Daily	Contractor	Included in 2.2.5	
		Store cement, paints, lubricants, and fuels in lined and covered areas.	Presence and size of cover and surface lining		Monthly			NRWB, Environmental District Office
		Provide appropriate spill kits when working near water courses.	Availability (and number) of spill kit					

		Provide appropriate facilities for the collection of wastes on site such that they will not come into contact with water.	Availability of facilities used for disposing and collecting of wastes				
		Site all material storage areas at least 10 m from watercourses.	Distance between storage area and watercourse				
		Provide appropriate barriers to separate worksites from water resources in order to prevent accidental spillage into water courses	Presence of and size of barrier separating work site and water resources				
		Line surfaces where cement, paints and oils will be stored	Percentage of construction material on lined surface				
		Connect the drainage systems to oil interceptors.	Presence of oil interceptors				
		Collect and dispose wastes in designated disposal sites as required by the Local Authority.	Percentage of wastes collected and disposed in approved sites				
		Construct a pit latrine that is at least 1.5 meters deep, lined at the base and 30 metres from a water body.	Specification of pit latrines				
2.2.8.	Occupational incidents and accidents	An emergency vehicle to be available all times when the works are in progress.	presence of an emergency vehicle	Inspection, interviews	Daily	Contractor	300,000

		Workers to be trained on safe operating procedures.	Number of trainings conducted	Record review	Quarterly	District Labour Office, NRW	
		Induct workers on OSH requirements and repeat reminders on the same	Number of workers inducted and reports of reminders	Review of OSH induction records			
		Employ an OSH expert to monitor and ensure that appropriate equipment and acceptable codes of practice for various tasks are followed by workers at all times.	Presence of an OSH expert	Review of human resources records, Inspection			
		Provide appropriate personal protective equipment (PPEs) to construction workers; and to ensure that it is used at all times.	Availability and evidence of use of appropriate PPEs	Inspection, Interview			
		The contractor to provide a mechanism for reporting of accidents and near misses	Number of accidents reported	Record review, interviews			
2.2.9.	Noise and vibrations	Monitor the noise levels for any machine on site regularly.			Daily	Contractor NRWB, Environmental District Office	Included under 2.2.8
		Use appropriate and well-maintained noise mufflers on vehicles and machinery	Types and number of times noise mufflers are used and maintained	Inspections and Interviews	Monthly		
		Regularly service and carry maintenance of equipment	Number of times the equipment is maintained;	Inspection, Review of maintenance reports			

			Condition of equipment				
		Provide ear muffs for the workers in noisy areas	Number of workers are provided with ear muffs	Inspection, Interviews			
		Use electric motors instead of compressed air driven machinery	Use of electric motors against the use air driven machinery	Inspection			
		Reduce noise by using plastic or rubber liners, noise control covers, and dampening plates and pads on large sheet metal surfaces.	Number of complaints during construction	Interviews			
		Limit the number of days of operation; restrict hours of operation and schedule noisy tasks for periods of low occupancy on the project surroundings	Number of days and hours of noise activities	Random interviews, Construction reports			
		Notify the public of upcoming loud events	Number of notices sent, and the time when notices are sent	Inspection of records			
2.2.10.	Spread of communicable diseases and infections	Provide both male and female condoms to workers for appropriate use.	Number of condoms provided	Interviews, Inspections	Quarterly	Contractor NRWB, Environmental District Office, District Health Officer	Included under 2.2.11
		Treat the affected local and migrant workers so as to control the movement of disease vectors	Number of treated affected people	Record review from the contactor and nearby health facilities			

		The contractor to provide sanitary facilities in good condition with adequate water supply.	Presence and number of sanitary facilities	Inspection			
		Train workers on good personal hygiene practices e.g. washing of hands after visiting the toilet, drinking portable/treated water	Number of trainings on personal hygiene	Training record review			
		Alert the responsible health authority if there is an outbreak of any communicable diseases.	Number of alerts	Record review			
2.2.11.	Increase in sexual relationships, unplanned pregnancies, breaking up of families	Provide a reporting mechanism at the site where grievances can be channelled and this mechanism should also be available to the concerned public.	Number of grievances lodged	Record review	Quarterly	Contractor, NRWB, District Social Welfare Office, District Gender Office	300,000
		Sensitise communities on the disadvantages of indulging in extra-marital affairs.	Number of sensitization meetings conducted	Review of sensitization records/minutes			
		Sensitize all contractors, workers and communities on the STD and HIV/AIDS program, including explanations on risks posed by STDs, sanctions, etc. as well as on grievance mechanisms in place.	Number of people sensitized				

		Sensitise girls on the dangers of getting involved in pre-marital sex at a tender age.					
		Enforce punitive and disciplinary measures, including dismissal from employment, on any project workers involved in any social malpractices with surrounding communities.	Number of workers disciplined for engaging in illicit sex with school going girls	Review of human resources/disciplinary records			
		Engage stakeholders in encouraging and empowering women to be financially independent.	Number of stakeholders engaged in empowering women	Review of stakeholders (e.g. NGO and CBO) activities records			
		Provide both male and female condoms to workers for appropriate use.	Availability and number of male and female condoms	Inspections, Interviews			
		Prepare and implement an STD and HIV/AIDS prevention program including a strict prohibition of sexual abuse and sexual intercourse with partners younger than 18 years of age (underage sex).	Presence and implementation of an STD and HIV/AIDS prevention programme	Interviews, Review of reports of implementation of STDs and HIV/AIDS program			
		Support the District Social Welfare Office and the Community Development Office and Non-Governmental	Level of support	Interviews, review of reports indicating activities for supporting various District			

		Organisations in the implementation of on-going projects aimed at assisting pupils to go back to school.		Council Offices and NGO			
2.2.12.	Incidence of sexual abuse and harassment	Report any form of physical abuse/harassment to Police, that way workers will understand the seriousness of the offense.	Number of physical abuse/ harassment reported	Review of human resources/ disciplinary records Interviews, Review of reports of implementation of STDs and HIV/AIDS program Interviews, Review of support records	Quarterly	NRWB, Environmental District Office, District Health Offices, District Gender Office, District Labour Office	300,000
		Provide a reporting mechanism for both the public and the workers					
		Sensitise workers and surrounding communities to avoid sexual abuse and harassment	Number of sensitizations conducted	Review of sensitization records			
		Conduct sensitization and awareness campaigns to encourage affected individuals to report cases of sexual harassment in the homes.	Number of sensitizations conducted; Number of reports received on sexual harassment				
		Publicise places for reporting gender violence and sexual harassment.	Availability of places for reporting gender related and sexual harassment	Inspections, Interviews			
		Create a good work environment to allow female workers to report cases of harassment.	Availability of a good work environment, Number of	Interviews, Review of human resources records			

			harassment reports received				
		Enforce punitive and disciplinary measures, including dismissal from employment, on any project workers involved sexual abuse and harassment.	Number of workers disciplined for being involved in sexual harassment	Review of human resources/ disciplinary records			
		Prepare and implement an STD and HIV/AIDS prevention program including a strict prohibition of sexual abuse and sexual intercourse with partners younger than 18 years of age (underage sex).	Presence and implementation of an STD and HIV/AIDS prevention programme	Interviews, Review of reports of implementation of STDs and HIV/AIDS program			
		Support the District Gender Welfare Office and Non-Governmental Organisations in the implementation of on-going projects aimed at promoting gender equality and ending sexual harassment.	Level of support provided	Interviews, Review of support records			
		Implement and follow-up on grievance redress mechanisms.	Number of times the grievance redress mechanism and follow ups	Audit of the grievance redress mechanism, Review of grievance redress records			

		Require the contractor to be responsible and to take necessary measures so his employees do not commit acts of sexual abuse and/or underage sex.	Availability of a clause in the contract requiring the contractor to take measures for avoiding sexual abuse and underage sex	Review of the contract prevention programme			
2.2.13.	Increased pressure on community health services	Conduct public awareness and sensitization on community health, HIV and AIDS.	Number of awareness and sensitizations conducted	Review of sensitization records	Bi-annually	NRWB, District Health Offices	
		Encourage employees to go for voluntary health screening and receive appropriate treatment where it is required.	Percentage of potential employees screened	Review of recruitment reports			
		Require the workers, sensitize the communities follow recommended environmental and water management practices.	Percentage of workers and communities following recommended water resources and environment management practices	Inspections, Interviews			
		Construct adequate sanitation facilities at the work sites and surrounding area.	Number of sanitation facilities constructed, compared to the population to use them	Visual inspections, Counting			

		Locate worker camps at a minimum distance of 1 km from towns and villages in order to limit worker – community interactions.	Distance between workers camp and community	Inspection, Measurement			
		Maintain construction camps in clean and healthy condition as prescribed by international worker health standards.	Adherence to the international worker health standards	Inspections, Comparisons of the conditions in the camps to the international standards			
		Require all contractors and sub-contractors to comply with relevant health and safety requirements and NRW corporate policy.	Presence of relevant health and safety requirements and policy	Review of records			
		Develop and implement an H&S management plan to protect every worker involved in construction activities, even temporary workers (e.g. vaccines, etc.).	Presence and implementation of an H & S management plan	Inspections, Interviews, review of an H & S management plan			
		Involving other stakeholders including NGO's in the promotion of social welfare.	Number of stakeholders involved	Review of records, Interviews			
		Support and supplement social services including the Health Surveillance Assistants.	Level of support and supplement to health surveillance system	Interview, Review of support records			
2.2.14.	Unequal employment opportunities	Encourage the contractor to employ women as well. A clause should be included in	Number of women employed versus the number of men	Head count, Review of	Quarterly	Contractor, District Labour Office, District	Included in 2.2.7

		the contract specifying that at least 30% of the employees should be women.		employee files, Head count, Review of sensitization records		Social Welfare Office	
		Conduct gender meetings to encourage women and to instil confidence that they can also do the work that men do	Number of women sensitized, Number of women doing the work said to be for men				
		Ensure there are also women in important positions such as foreman and engineers	Number of women in important positions				
		Economically empower women within affected communities by linking them with the District Council's Community Service Investment Programme (COMSIP)	Number of women linked to COMSIP	Review of COMSIP records			
		Create a good work environment to allow female workers report any case of harassment.	Number of females being able to report harassment	Interview, Review of harassment records			
2.3.	Demobilisation Phase						
2.3.1.	Increased load of solid waste	Sell or recycle metal waste to tinsmiths or vendors for reuse or re-sale	Volume of wastes sold or reused	Inspections, Interviews	Quarterly	NRWB, Environmental District Office, District Health Office	900,000
		Provide solid waste storage bins and skips	Number of storage bins and skips at the sites				

		Monitor skips so that they do not become overfilled.	Number of times skips are over filled				
		Ensure that collected solid waste is disposed of in an approved disposal site	Volume of waste disposed in approved sites				
		Implement sensitization campaigns on consequences of indiscriminate waste disposal.	Number of times sensitizations are conducted				
2.3.2.	Loss of jobs due to completion of construction works	Introduce Money saving programs like Savings and Capital Cooperative (SACCO) for the employees so that they are prepared well for retrenchment.	Number of money savings program	Interviews, record review	Once during the demobilisation phase	Contractor, NRWB, District Labour Officer	100,000
		Provide alternative employment to employees e.g. as maintenance staff	Number of employees allowed to continue working	Review of the employee register			
		Provide adequate notice to employees to prepare themselves and secure alternative employment	The notice period before layoffs	Interviews, Review of employee files			
		Sensitize the workers and the general community to be saving	Number of workers saving from their pay; Number of people sensitized	Interviews, review of records of sensitizations			
		Sensitize the business persons to diversify and find alternative markets	Reports of business diversification and opening of new markets	Interviews			

2.3.3.	Abandonment of excavated areas for raw materials	Fill up and close pits after the construction works;	Presence and number of filled pits after construction works	Visual inspection, Review of procurement records, Interviews	Once during the demobilisation phase	Contractor, NRWB, District Labour Officer	100,000
		The contractor should register all burrow pits to the Mzuzu City council and Mbelwa District Council.	Number of burrow pits registered	Review of records, interviews			
		Authorization Certificates (Signed by Land owners and chiefs) to be obtained before any soil extraction is done and also the Certificate of Rehabilitation to be issued at the end of the construction phase;	Presence of signed certificates	Review of records, interviews			
		Rehabilitate all work site; The rehabilitation plan to include reforestation of the area.	Presence and number of filled pits after construction works	Visual inspection, Review of procurement records, Interviews			
		Construction materials e.g. sand and clay soils should be sourced from licensed suppliers	Size of area that is rehabilitated after construction	Interviews, Review of severance pay records			
2.4.	Operation Phase						
2.4.1.	Increased solid waste generation	Sell or recycle metal waste to tinsmiths or vendors for reuse or re-sale	Volume of wastes sold or reused	Inspections, Interviews	Quarterly	NRWB, Environmental District Office, District Health Office	300,000
		<ul style="list-style-type: none"> Provide solid waste storage bins and skips. 	Presence and number of storage bins and skips				

		Monitor skips so that they do not become overfilled.	Number of times skips are over filled				
		Ensure that collected solid waste is disposed of in an approved disposal sites.	Volume of waste disposed in approved sites				
		Implement sensitization campaigns on consequences of indiscriminate waste disposal.	Number of times sensitizations are conducted				
2.4.2.	Increased pollution from wastewater and sludge	Enforce proper excreta and wastewater management especially in the town.	Evidence of proper waste management	Inspections	Quarterly	NRWB, Environmental District Office, District Health Office	900,000
		Apply lime treatment to dewatered sludge to suppress pathogens and remove odour.	Number of times quicklime is used to treat sludge	Interviews			
		Enforce the use of licensed liquid waste handlers for liquid waste.	Number of times licensed liquid waste handlers are used	Review of waste collection records, Interview			
		Dry sludge on drying beds before disposing off in a dedicated disposal site.	Volume of waste dried before disposing				
		Prepare and enforce operational guidelines for sludge treatment and management.	Availability and reports of enforcement of operational guidelines for sludge treatment	Review of the operational guidelines, Interviews, Inspection			
		Conduct WASH activities to sensitize people on the benefits (including	Number of sensitizations; Number of	Review of diseases statistics			

		prevention of cholera) of good the hygiene.	reported cholera cases				
2.4.3.	Increase in Emergency incidents	Design and implement an emergency response plan.	presence of emergency response plan	record review, interviews	Quarterly	NRWB, Environmental District Office, District Health Office	300,000
		Install fire hydrants within the proposed development.	Presence of a written emergency preparedness plan	Inspections, Interviews, record review			
		Use checklists to regularly monitor and maintain the water supply system.	Presence of checklist				
		Maintenance of natural drains around the weirs;	Number and dates of maintenance				
		Install fire extinguishers at the plant and train workers on how to use.	Presence and number of fire extinguishers				
		Maintain the critical spares lists.	Number and dates of maintenance				
2.4.4.	Potential risks of water leakage and flooding from theft and vandalism	NRWB must periodically conduct consultations and sensitizations with villages and group village heads and security personnel.	Number of times consultations and sensitizations are conducted	Review of consultations records	Bi-annually	NRWB, District Water Development Office	Included in 2.4.1
		Provide security at the intake, treatment plant and water reservoir sites.	Presence and number of security personnel	Inspections			
		Support activities of the neighbourhood watch (community policing) e.g. through provision of	Support provided to the neighbourhood watch	Interviews, Review of Cooperate Social Responsibility records			

		torches, uniforms and shoes.					
		Support economic activities in the area as part of corporate social responsibilities.	Reports of implementation of cooperate social responsibility programmes				
		Reward for reports of vandalism and theft that may lead to capture.	Reports of rewards for information	Interviews, Review of reports of rewards			
		Theft and vandalism cases must be reported to the police	Number of reported theft cases	Review of theft cases			
		Regularly monitor the pipeline infrastructure	Number of times monitoring is done	Review of monitoring records			
		Include the people from the local area in the work force.	Number of locals in the workforce	Head count, review of employee files			

8.2. SUMMARY OF MONITORING COST

The costs in the Environmental and Social Monitoring Plan have been summarised and presented in Table 8.2. The total cost for monitoring the impacts from the planning and design to the construction phase is established as MWK 6,400,000 per year (Seven Million Kwacha). The Northern Region Water Board and stakeholders must ensure that the funds are available to ensure effective implementation of this monitoring plan.

The cost per year for monitoring activities during the operation and maintenance phase are presented in Table 8.2.

Table 8.2: Cost for monitoring activities

S/N	Potential Impact	Cost in MWK per Year
1	Employment opportunities	800,000
2	Improved sanitation, hygiene and health	300,000
3	Improved socio-economic situation of the communities	300,000
4	Increased development	300,000
5	Unrealistic expectations with regard to lands/compensation/resettlement negotiations	300,000
6	Air Pollution	900,000
7	Disruption of water supply, Water pollution and siltation	900,000
8	Occupational incidents and accidents	300,000
9	Increase in sexual relationships	300,000
10	Loss of jobs due to completion of construction works, Abandonment of excavated areas for construction materials	100,000
11	Solid waste generation	900,000
12	Abandonment of excavated areas for raw materials	100,000
13	Increased pollution from wastewater and sludge	900,000
	Total	6,400,000

CHAPTER 9 : PUBLIC CONSULTATIONS

Active consultations with relevant regulatory bodies, experts, affected communities and other interested and affected parties is a requirement in conducting environmental and social impact assessment. For this project, consultations have been on-going and will proceed until the finalization of the ESIA report, which will follow the baseline report. This chapter documents the approach to the consultations, objectives and a summary the consultation outcome for preparation of both the baseline report as well as the ESIA

9.1. OBJECTIVES OF THE PUBLIC CONSULTATIONS

During the ESIA studies, broad consultations involving officials from the Northern Region Water Board, the Regional and District members of staff from the Ministry of Irrigation and Water Development, the District Council Administration and the local leadership were undertaken to ensure that informed decisions are taken regarding the implementation of the water supply project. The meetings also aimed at soliciting information which was used during the environmental and social screening of the project.

During preparation of this ESIA Key objectives of the public consultations were to:

1. Communicate and clarify the objectives and activities for the proposed upgrading and expansion works for Mzuzu water supply systems;
2. Increase public awareness about the proposed project to enhance their understanding;
3. Facilitate and provide a forum for public dialogue and contribution on issues regarding the ESIA for the proposed project;
4. Gather and verify environmental and socio-economic baseline information and constructive ideas to complement the ESIA preparation process for project;
5. Ensure that the ESIA development process helps to consolidate efforts made by NRWB and the local authorities in order to establish lasting relationships with affected communities and other stakeholders; and
6. Ensure compliance with the national and international regulations.

9.2. APPROACH, TARGET GROUPS AND ENGAGEMENT METHODS

The approach to the public consultations process was based on what is outlined in Appendix G of the 1997 Guidelines for EIA for Malawi. Thus, the principal stakeholders (Project Affected Persons) were engaged and more than two methods were used in the engagement process. The consultations were designed to allow for obtaining and cross-checking information obtained at all levels. The consultations included the following:

- Formal meeting and presentations to the District Coordination Team for Mzuzu City Council and Mbelwa District Council.
- Direct interviews with stakeholders, and particularly representatives of regional and district level governmental institutions, service providers and NGOs/CSOs; and
- Formal and informal meetings with affected people through individual interviews through household survey.

9.3. CONSULTATION OUTCOMES

Details of consultation undertaken by WWEC, including the people consulted, dates of consultations and the issues discussed are presented in Appendix 4 and 5. Key issues established from the consultations are as follows:

- The locals anticipate that levels of water related diseases will be reduced. Additionally, they anticipate that the time they spend fetching water will be reduced and thereby increasing their time of productivity.
- The developer should consider having more awareness meetings with the locals to ensure that early marriages and sexually transmitted diseases are avoided to both locals and workers especially during the construction phase of the project.
- The developer should sustain the benefits of employment opportunities and business by encouraging the community to save and engaging them in COMSIP projects. These projects should also involve female headed households as their levels of income are usually low as compared to male headed households.
- The developer to prioritise the following mitigation measures to conserve the environment and avoid community disturbances:
 - a. Inform surrounding communities through sensitizations of any potential disturbances (such as noises) that may come as a result of the project works.
 - b. Waste management plans (both construction and domestic wastes) should be generated at construction camp sites and clearly presented in the developer's Environmental management plans.
- Minimise as much as possible, the hiring of migrant workers to avoid cases of influx of more people into the local communities that may cause disturbances into the social/cultural establishments of the locals and possibly lead to increased cases of crimes such as thefts.

CHAPTER 10 : CONCLUSION AND RECOMMENDATIONS

10.1. CONCLUSION

This Environmental and Social Impact Assessment report has identified and assessed significant environmental and social impacts of the proposed rehabilitation, upgrading and expansion works for Mzuzu Water Supply System. The Project is positive as it will help the Northern Region Water Board to address some of the challenges, which it has been facing in its operations because of inadequate water supply and old infrastructure, resulting in failure to meet the increased demand for social and economic development.

However, development of the structures is likely to generate some negative impacts on the biophysical and socio-economic environment. The negative impacts, on overall, are assessed to be medium; mitigation measures have been recommended and are compiled into the Environmental and Social Management Plan (ESMP). A monitoring plan has also been prepared and will assist Northern Region Water Board, the Contractor and other key stakeholders to effectively monitor the implementation of the Environmental and Social Management Plan and ensure that Key Performance Indicators are achieved. Hence, the project should be allowed to proceed.

10.2. RECOMMENDATIONS

To ensure satisfactory achievement of environmental and social sustainability in the implementation of the proposed project, the following recommendations are made:

- a) Water abstraction has to be in accordance to the Water Right, which NRWB will be required to obtain before the project can be implemented.
- b) The project should be fully supported by all the relevant institutions;
- c) Adequate financial support should be allocated to realise the full potential to improve the socio-economic wellbeing of the targeted communities;
- d) The negative environmental and social impacts should be avoided or minimised to the greatest extent possible by fully implementing the enhancement and mitigation measures advanced in this report;
- e) The communities have a negative perception of NRWB and how it calculates water tariffs, the NRWB must conduct adequate sensitization on water supply pricing and management.
- f) NRWB must allocate additional funds in cooperate social responsibilities to improve its image among the communities,
- g) During construction, the contractor should avoid clearing any protected or endangered plant species. Where they are removed, they must be replanted.
- h) Adequate and fair compensation must be given to all the affected people before construction activities start;
- i) NRWB and the respective key stakeholders should support and facilitate employment of women, the youth and vulnerable groups to eliminate potential gender and social imbalances; where possible and appropriate, employment of local people from the project area must be prioritised to encourage community ownership and sustainability of the project.

CHAPTER 11 REFERENCES

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APPENDICES

APPENDIX 1: TERMS OF REFERENCE



THE REPUBLIC OF MALAWI NORTHERN REGION WATER BOARD MALAWI NRW WATER EFFICIENCY PROJECT

PROCUREMENT OF CONSULTANCY SERVICES FOR ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) AND PREPARATION OF ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) FOR 2 RIVER INTAKES

1. Background

Contract No.: NRW/MZUZU/C02

TERMS OF REFERENCE

The Northern Region Water Board was established under the Waterworks Act No. 17 of 1995 as a parastatal organization responsible for the provision of water supply and waterborne sanitation services in the urban centers of the Northern Region of Malawi. The Mzuzu and Ekwendeni water supply systems are two of the ten water supply systems that are managed by the Northern Region Water Board (NRWB).

The sources of water for Mzuzu City, Ekwendeni Town and the surrounding areas have been surpassed by the current water demand. In the long term, the solution to this challenge is construction of an additional dam. However, being a major undertaking, construction of the additional dam and the associated water supply facilities will take several years. Accordingly, there is need for quick interventions which will sustain the water supply to Mzuzu City, Ekwendeni Town and the surrounding areas while funds for construction of the new dam and associated facilities are being sourced and, thereafter, during construction of the dam and these facilities. One of the interventions that has been identified is the construction of intake weirs across the Lunyangwa River at the Mzuzu Water Treatment Plant (WTP) and at the Ekwendeni WTP. The construction of these

1

weirs will be done as part of Malawi NRW Water Efficiency Project which is financed by the European Investment Bank (EIB).

These terms of reference cover the undertaking of Environmental and Social Impact Assessments (ESIAs) and the preparation of Environmental and Social Management and

Monitoring Plans (ESMPs) for the construction of the proposed intake weirs.

2. Details of proposed weirs

The principal source of water for Mzuzu is Lunyangwa Dam. Currently, the water supply from Lunyangwa Dam is supplemented by abstracting water from streamflow in the Lunyangwa River downstream of the dam using a makeshift intake weir constructed near the Mzuzu Water Treatment Plant (WTP). The proposed intake weir is a small reinforced concrete diversion weir incorporating a raw water pump station that will be constructed near the existing makeshift weir. The crest level of the proposed weir will be similar to that of the existing weir so as to avoid changes to the flood levels at the weir site.

Part of the water supply for Ekwendeni is obtained from the Ekwendeni WTP which is located next to the Lunyangwa River. Raw water for the Ekwendeni WTP is abstracted from the Lunyangwa River at an existing low concrete weir. The existing weir and the associated raw water pumping system are not capable of supplying the raw water requirements of an extension to the Ekwendeni WTP that will also be constructed under the Malawi NRW Water Efficiency Project. The proposed intake weir is a low reinforced concrete diversion weir incorporating a raw water pump station capable of delivering the extended WTP's raw water requirements. It will be constructed about 80 m downstream of the existing weir where sound rock is exposed in the river bed and on the left bank and where a hard formation has been found under the right bank at about river bed level.

3. Objective of the Consultancy Services

The objective of this consultancy is to conduct detailed environmental and social impact assessments (ESIAs) for the proposed intake weirs and to develop environmental and social impact mitigation measures commensurate with national and international standards and present them in the form of Environmental and Social Management and Monitoring Plans (ESMPs).

4. Scope of Work

4.1 General

The consultancy will provide useful information to the NRW on how the project should be planned, designed and constructed to avoid or mitigate negative impacts and to better capture potential environmental and social benefits. As such, the consultant will be required, inter alia, to:

- a) Conduct Environmental and Social Impact Assessment studies compliant with the relevant National Environmental and Social Legislation and EIB Safeguard Environmental and Social Policies;
- b) Generate baseline data for monitoring and evaluation of how well the mitigation measures will be implemented during the project cycle;
- c) Evaluate potential impacts of engineering and design activities during the site preparation, construction and operational phases of the project;
- d) Identify the positive and negative impacts of the sub-activities on the physical and socio-economic environments;
- e) Make recommendations of environmentally sound, socially acceptable and cost-effective measures to be implemented in the entire course of the proposed project;
- f) Prepare Environmental and Social Management and Monitoring Plans (ESMPs) for the project incorporating the findings of the activities described above and recommending appropriate mitigation measures for negative impacts and enhancement measures for positive impacts. The ESMPs must include an implementation schedule for the recommended

environmental and social management and monitoring measures, and a clear explanation of institutional responsibilities, including those pertaining to the NRW and to other organizations.

4.2 Baseline assessment The baseline assessment shall, inter alia, include:

- a) Reviews of the designs that have been prepared for the proposed facilities;
- b) Identification of the areas that will be affected by the proposed developments;
- c) Preparation of maps showing the locations of the proposed facilities, the areas that will be affected and the affected natural resources and settlements;
- d) Collection of information about the environment and communities within the areas that will be affected by the proposed developments. This should include:

Information about terrestrial plant and animal species known to or expected to occur within the project area, particularly any species of conservation concern (threatened, endemic to a small area, etc.);

- Information about fish and other aquatic life, including any migratory species which might be affected by construction of the weirs;
- Details of any sites of high environmental sensitivity or special legal protection;
- Information about vegetative cover, including the main vegetation types (natural and altered) present in the project area and the percentage ground cover of the different vegetation types, including any cultivated or degraded lands as well as natural woodlands; and
- Information about land tenure i.e. status of land to be affected by the project.

The Consultant will be free to add other relevant information when compiling the baseline data.

4.3 Compliance with legal and guideline requirements

The Consultant shall briefly describe the Malawi Government's policies, the Malawi legal framework and the EIB guidelines related to environmental and social issues that apply to the project and also describe how the issues raised in the policies, legal framework and guidelines will be addressed in the project.

4.4 Public consultations

The Consultant shall undertake public consultations to ensure that all interested and affected parties are involved in the Environmental and Social Impact Assessment. Evidence of consultations shall be provided and the viewpoints of the interested and affected parties shall be included in such evidence.

For purposes of the public consultations, the Consultant shall:

- . a) Develop and implement a public participation and consultation plan;
- . b) Identify institutional and community needs as a basis for supervising and monitoring implementation of mitigation measures;
- . c) Document organizations and interest groups that were invited to participate in public consultation events (names of individual persons are optional), record which ones participated in these events, when and where each public consultation event was held, and what main issues were raised by participants at the consultation events.

4.5 Environmental impact assessments

The environmental impacts to be considered include:

- . a) Impacts related to the expected water abstraction from the river (which should be

quantified, including as a percentage of low river flows) such as changes in water quality, river-edge vegetation or downstream water uses;

- . b) Impacts on aquatic life, including blockage of fish migration;
- . c) Impacts related to the increase in flooded land area (if any) above the weir;
- . d) Construction-related impacts, including the direct and induced impacts from any access road improvements.

Recommendations shall also be made on measures that might be taken to extend the useful life of the new water intakes by, for example, reducing sedimentation, including catchment management measures.

4.6 Social impact assessments The Consultant shall assess the positive and negative impacts of the proposed project on the communities within the influence of the project area. The study shall, inter alia:

- . a) Describe and quantify the effects (both positive and negative) of the proposed developments on the human environment;
- . b) Identify mitigation measures for minimizing, eliminating or off-setting Negative effects and enhancing any positive effects;
- . c) Recommend the most appropriate mitigation measures, including consideration of alternative designs to avoid significant negative impacts and/or enhance environmental/social benefits.

The Environmental and Social Impact Assessments shall, inter alia, be conducted in accordance with the EIB Guidelines as published in the EIB Environmental and Social Handbook and the Malawi Government Guidelines and Procedures on Environment Management and ESIA.

4.7 Cost estimates

The Consultant shall estimate the costs for implementing the recommended mitigation measures. The costs shall be based on those of similar works implemented recently in Malawi.

5. Time schedule

The indicative input from the Consultant is 9 person-weeks made up as shown in the table below. A week has been allowed for finalization of the ESMPs once comments have been received on the draft ESMPs. However, the Consultant shall make his own assessments of the periods required by him for undertaking the various tasks listed in the table below, or such other tasks as he may deem to be necessary, and of the period required for completing the assignment

Activity	Person-weeks
Baseline Assessments	2
Stakeholder consultations	1.5
Review of policies, legal instruments and guidelines	0.5
Environmental and social impact assessments including preparation of baseline reports	1.5
Preparation of cost estimates	0.5
Preparation of draft ESMPs	2
Preparation of final ESMPs	1
TOTAL	9

The assignment shall commence immediately after signing of the contract.

6. Expected outputs

The deliverables of the consultancy shall be:

- . a) The baseline environmental and social data for each of the two sub- projects;
- . b) Draft Environmental and Social Management and Monitoring Plans for each of the two sub-projects;
- . c) The Final Environmental and Social Management and Monitoring Plans for each of the two sub-projects.

The deliverables shall be in English and all quantities shall be expressed in metric units. The consultant shall prepare and submit to the NRW ten hard copies and one electronic copy on CD Rom or flash disk of each of the deliverables listed above. The indicative due dates for the listed deliverables are shown in the table below.

Deliverable N°	Description	Indicative due date (N° of weeks from commencement date)
1	Baseline environmental and social data	6
2	Draft Environmental and Social Management and Monitoring Plans	8
3	Final Environmental and Social Management and Monitoring Plans	1 week after receiving comments from EAD

The Consultant will be required to seek approval of the ESIA and ESMP from the Department of Environmental Affairs.

7. Valuation of Work

The Consultant's own assessment of the periods required by him for completing the assignment (see 5 above) shall be used, in conjunction with a rate negotiated between the NRW and the Consultant, for determining the Consultant's fixed fee for the assignment. Costs for all equipment required for the assignment e.g. computers, transport, venue hire, office accommodation, etc. will be deemed to be included in the negotiated rate and the Consultant will not be entitled to any payments over and above the fee determined as described above.

8. NRW's personnel and training

The NRW may, during the assignment, second staff to the Consultant. The Consultant shall provide training to the seconded personnel so that they can gain knowledge and contribute to the completion of the assignment.

Failure of the NRW to second such staff shall not relieve the Consultant of his responsibility for completing the assignment

9. Reporting

The Consultant will be responsible to the Chief Executive Officer of the NRW for the successful execution of the assignment. However, for carrying out day-to-day operational activities he shall interact with the Project Implementation Manager and the Director of Technical Services.

10. Obligations of the Consultant

The Consultant shall have at least a Bachelors' degree in natural resources management, in environmental sciences/engineering, in water resources management or in a similar field.

The Consultant shall have at least five years' experience in undertaking similar assignments and shall have a registration certificate issued by the Malawi Government, Environmental Affairs Department.

The Consultant shall be fully self-sufficient in all respects for undertaking the assignment including accommodation, office space, equipment and supplies, communications equipment, and transport. Procurement of equipment will not be allowed on the project. The Consultant will be responsible for sourcing documents and any information required from the relevant authorities.

11. Obligations of the NRWB

The NRWB will provide:

- . a) Access to data/information in its custody that is relevant to the assignment;
- . b) Letters of introduction, where necessary, for the Consultant to contact other institutions and agencies necessary for proper execution of the assignment.

12. Implementation arrangement

The Consultant will be engaged by the Northern Region Water Board and the assignment will be administered through a lump sum contract arrangement.

APPENDIX 2: KEY STAFF FOR THE ASSIGNMENT

Name	Proposed Position and Qualification	Task Assigned
Kent Kafatia, R. Eng	Team Leader and ESIA - Master of Science Degree (MSc.) in Water and Waste Engineering - Bachelor of Science Degree (BSc.) in Chemical Engineering - BSc. Degree in Engineering - Post Graduate Diploma - Advanced Certificate in Water and Environmental Management	<ul style="list-style-type: none"> • Coordinating the whole assignment • Conducting literature gathering and review • Identification and evaluation of project impacts • Conducting stakeholder consultations • Determination of, and evaluation project impacts, enhancement and mitigation measures • Analysis of proposed project alternatives basing on social impacts • Preparation of Environmental and Social Management and Monitoring Plan • Compilation of the ESIA report • Providing quality assurance
Itayi Nkhono	Sociologist - MSc. Environmental Engineering and Sustainable Infrastructure - BSc Honours Sociology	<ul style="list-style-type: none"> • Stakeholder mapping and analysis • Designing data collection tools • Conducting stakeholder consultations • Conducting literature gathering and review • Managing the household survey and leading and data analysis • Compiling socioeconomic and baseline information
Vincent Msadala, PhD	Water Resources Expert - Doctor of Philosophy (PhD) in Civil Engineering - MSc in Civil Engineering - BSc in Civil Engineering	<ul style="list-style-type: none"> • Conducting stakeholder consultations • Conducting a visual and physical surveys of flora, birds, reptiles and amphibians, animal/mammal • Visual observation and physical assessment of the present ecological importance, sensitivity and state of terrestrial and aquatic biodiversity within the proposed project footprint and surrounding environs

Name	Proposed Position and Qualification	Task Assigned
		<ul style="list-style-type: none"> Investigating of flora and fauna relationship to project affected persons
Jamestone Kamwendo	Ecologist - MSc. Degree in Conservation Biology - BSc. Degree - in Biology and minor Chemistry	<ul style="list-style-type: none"> Visual assessment and determination of impacts of the project on surface water sources and other water users downstream Recommend mitigation measures to the project impacts Recommend on project alternatives based on project impacts, water resource assessment. Assist in the preparation of ESIA

Support Staff

Kent Kafatia, Jr - 7 years ESIA Experience
 Precious Chaponda - 4 years ESIA experience
 Mazaza Mwafulirwa – 3 years ESIA experience
 Prisca Malenga – 1 year ESIA experience

APPENDIX 3: SELECTED CONSULTATION OUTCOMES

Date	2 April 2019
Place	Forestry Department head offices, Lilongwe City Centre
Participants	Interviewee: Mrs Nyuma Mughogho, Deputy Director for the Forestry Department Interviewer: Mr Mazaza Mwafulirwa for WWEC
Discussion	Views from the Department of Forestry (at national level) regarding the proposed projects to raise the height of the Lunyangwa Dam and to construct a new intake weir at Mzuzu Treatment Plant. The discussion focused on obtaining input from the headquarters of the Department of Forestry (DoF) regarding how the proposed projects (which will be implemented within and very near to a forest reserve area) should be done to adhere to guidelines for protecting forest reserve areas.
Issues	<p>Key points to note from the interview were as follows:</p> <ul style="list-style-type: none"> • The interviewee highlighted that for construction works that are to be done within a forest reserve area, the procedure is that a developer has to obtain an approving licence from the forestry department which stipulates the conditions under which the project works are to be done in order to ensure that the forest reserve area is protected. Among the major issues that are highlighted among the conditions in the licence (according to the interviewee) are the requirement to avoid unnecessary cut-down of trees as well as steps on how to mitigate any damage to forest areas that has come about due to construction works. • She indicated that, the normal procedure with their department is that when a developer would like to do some construction works within a forest reserve area, they have to first of all make an application to the forestry department (stating that they would like to do some construction works within a forest reserve area), then the department sends some of their staff to look at the proposed project site just to be certain of the possible impacts the proposed project may have on the forest reserve area. Upon looking at the site the forestry staff, write a recommendation letter to the headquarters to issue a licence of approval to the developer to go ahead with the construction works. • The general expectation of the department is that staff from the Regional Forestry Office (RFO) in Mzuzu will go to visit the sites (within the forest reserve) where the proposed construction is to take place. After the visit then the RFO will produce a letter of recommendation to the headquarters of the DoF who will issue the authorizing licence to NRWB for the project to go on. • It was also pointed out that as DoF, they do monitoring of compliance with the conditions laid down in the authorizing licence. In case of the proposed NRWB project, they indicated that the department will mostly be using the RFO in Mzuzu to do the monitoring work. • The department also has authority to stop the contractor doing the construction works if they see that the work is not being done in line with the conditions of the authorizing

licence. In such a case a project can remain halted until the identified violation of the conditions is remedied by the contractor.

- It was further highlighted that during their work of monitoring for compliance to the agreed conditions, they normally use the resources from the developer's budgets. However, during times of an emergency (i.e. when they receive an alert that some violation is going on), they do use their own resources as DoF to go and check.

Date	2 April 2019
Place	Environmental Affairs Department (EAD) head offices, Lilongwe City Centre
Participants	Interviewee: Ms Carthy Musa, Environmental Officer at the Environmental Affairs Department Interviewer: Mr Mazaza Mwafulirwa for WVEC
Discussion	Views from the Environmental Affairs Department (at national level) regarding the proposed projects to raise the Lunyangwa Dam and to construct new intake weirs at the Mzuzu and Ekwendeni Treatment Plants. The discussion focused on obtaining advices from the EAD on how the projects should be implemented to adhere to best practices of environmental management and what needs to be stressed out in the ESIA as critical mitigation measures against negative impacts of the proposed projects.
Issues	
Key points to note from the interview were that:	
<ul style="list-style-type: none"> • The interviewee advised the developer to prioritise the following mitigation measures to conserve the environment and avoid community disturbances: <ul style="list-style-type: none"> ○ Provide an alternative energy source at the campsites to keep workers from cutting down trees for firewood. ○ Cover all trenches that may be excavated for laying of any new pipes to avoid inconveniencing people that may be using the sites of the trenches as walking pathways. ○ Inform surrounding communities through sensitizations of any potential disturbances (such as noises) that may come as a result of the project works. ○ Waste management plans (both construction and domestic wastes) should be generated at construction camp sites and clearly presented in the developer's Environmental management plans. ○ Minimise as much as possible, the hiring of migrant workers to avoid cases of influx of more people into the local communities that may cause disturbances into the social/cultural establishments of the locals and possibly lead to increased cases of crimes such as thefts. • The interviewee recommended that stakeholder consultations done by the consultant at national level should also incorporate views from the department of forestry, since one of 	

the sites where the proposed construction projects are to be implemented is located within their area of jurisdiction (within the Kaning'ina Forest Reserve).

- The interviewee highlighted that as a department, they will also be involved (at both national and district level) to monitor the progress of the construction works to see that the necessary measures for managing the environmental impacts are being adhered to.
- She however pointed out that the main challenge encountered as a department in the work of monitoring the progress of projects (such as the ones being proposed by NRWB) is that of limited funds as mostly they utilise their own resources allocated to them from the government budgets and not necessarily the resources from the budgets of the project developer.

Date	24 March 2019
Place	Mphatso Motel, Mzuzu
Participants	Interviewee: Mrs Charity Kumwenda, Officer in charge for Mzuzu Nature Sanctuary under the Department of national parks and wildlife Interviewer: Mr Mazaza Mwafulirwa for WWEC
Discussion	Views of the Mzuzu Nature Sanctuary regarding the proposed projects to raise the Lunyangwa Dam and to construct a new intake weir at the Mzuzu Treatment Plant. The discussion went as far as talking of possible ways on how the project can be implemented to ensure conservation of the surrounding environment (which includes forests and some animals kept at the Sanctuary).

Issues

Key points to note from the interview were that:

- The Mzuzu Nature Sanctuary has been informed about the project by the NRWB, through a phone call some 3 days ago (from the day on interview).
- Their main worry as Mzuzu Nature Sanctuary is that the project may result into disturbances to the vegetation and animals at/around the sanctuary.
- The sanctuary has a wide variety of trees as well as some animals which mainly include baboons, monkeys, birds, bush pigs, and some common duikers. Of the available animal varieties, baboons and monkeys are the ones which are available in quite large numbers. The animals at the sanctuary are not put in cages; they are allowed to move in free range.
- The Sanctuary which has been in existence since 1985 is mostly used for educational trips, where students from different schools visit the place on their learning tours for free.
- To them the main threat with the proposed projects will be the possible disturbance of the forest area (through removal of vegetation) and the noises that may scare off their animals. The interviewee gave the following measures as recommendations to protect the sanctuary environment during the construction works for the proposed projects:
 - Noise levels should be controlled during the construction works. The contractor should ensure that they avoid very loud noises at the site particularly, they should

- control the noise levels to ensure a steady/gradual increase in the noise so that the animals can adapt to it and not be suddenly disturbed.
- They should avoid unnecessary removal of vegetation in the forest areas so that the surrounding natural beauty is conserved.
- If the contractor happens to find some special (rare/endangered) plant species in the project area that ought to be removed in order to clear the way for construction works, then they should ensure that the plants are safely transferred to some other place first before proceeding with the clearing.
- Nevertheless, as a sanctuary, they are confident that the sanctuary will survive the oncoming construction activities at the intake site as well as at the Lunyangwa Dam in a similar manner as it survived the construction works for the dam back in the early 90's (even though back then the sanctuary was at its infancy stage).
- As part of the department of national parks and wildlife, the Mzuzu Sanctuary is part of the catchment management committee for the Lunyangwa Dam together with the NRWB, Mzuzu City Council, the forest department, Wildlife and Environmental Society of Malawi among others.
- As part of their activities, the catchment management committee for the Lunyangwa Dam organises monthly patrols of the catchment area for the dam using staff from the forest as well as national parks and wildlife departments. They also organise quarterly (four times a year) joint patrols of the catchment area together with the Malawi Defence Force.
- As part of this catchment management committee, as the Mzuzu Sanctuary, they are certain that they will be involved on the proposed NRWB projects as part of the team to monitor the progress of the construction works to check that they are being done in a manner that is not detrimental to the surrounding natural environment.

Date	5 April 2019
Place	Gender and Social Welfare Departments head offices, Lilongwe Capitol Hill
Participants	Interviewee: Mr Misheck Mdambo, Social Welfare Officer for the Ministry of Gender, Children, Disability and Social Welfare Interviewer: Mr Mazaza Mwafulirwa for WWEC
Discussion	Views from the Departments of social welfare and gender (at national level) regarding the proposed NRWB projects to raise the height of the Lunyangwa Dam and to construct new intake weirs in Mzuzu and Ekwendeni. The discussion focused on obtaining input from the headquarters of the departments on how the projects should be implemented to minimise negative impacts on the well-being of societies in the project areas and to enhance positive social impacts.
Issues	Key points to note from the interview were that: <ul style="list-style-type: none"> ● The interviewee recommended that his department should be stated in the contract between NRWB and a contractor (doing the construction works) in case of any social

violations in the project area (For instance, young girls being impregnated, infected with STD's or being sexually harassed by the contractor's employees). In such cases, the contractor (instead of the individual worker who has committed the violation) will be held liable to compensate the victims.

- An example was given by the interviewee of a similar case that occurred last year in the same city of Mzuzu where under a project to construct electrical power lines for the Millennium Challenge Account (MCA) – Malawi; a contractor was made to compensate victims (young girls) who were defiled by his workers because the conditions for the contractor to be liable were already specified in the contracts.
- Apart from this issue of making the contractor responsible for the misconducts of his workers, the interviewee also stated that the department would also wish to see that adequate sensitizations should be done to the workers and communities on the matters of importance of abstaining from unsafe casual sex, sexual exploitation of children, harassments and all kinds of gender based violence.
- On the topic of employment opportunities for the proposed projects, it was said during the interview that the national gender policy encourages that there be a ratio of 40-60% employed female workers against 60-40% employed male workers. However, it was also pointed out that there is no regulation that ensures that this policy guideline concerning employment of male and female workers is adhered to. It was also said that, the main challenge concerning adhering to the requirement of providing balanced work opportunities to males and females on technical construction projects is that there are not as many qualified female workers that can fill up the technical positions.
- The interviewee highlighted that departments of social welfare and gender get involved both from the national level and at the district level in matters of monitoring of compliance to set out measures for managing social impacts emanating from projects. According to him, officers from the headquarters of the department go to initiate the monitoring process and inform the district staff on what issues they are supposed to look at in the monitoring work. The district officers (being those on the ground) then proceed with their work having received the guidance from the headquarters of the departments.
- The interviewee also called for adequate resources to be allocated on the project to support the work of monitoring for compliance to mitigation measures as well as the work of conducting sensitizations and awareness campaigns. According to him, their experience is that the issues of social welfare and gender are considered as trivial matters on many projects and hence they do not have the necessary resource allocation. He feels that if necessary attention is given to these matters then we would avoid the burdens of teenage unplanned pregnancies, spread of sexual infections and defilements of young girls that are normally associated with large scale construction projects.

Date	26 th March, 2019
Place	District Social Welfare Office
Participants	Edward Chisanga (District Social Welfare Officer)

	Prisca Malenga (WVEC)
Discussion	Views from the Departments of social welfare and gender (at national level) regarding the proposed NRW projects to raise the height of the Lunyangwa Dam and to construct new intake weirs in Mzuzu and Ekwendeni. The discussion focused on obtaining input from the headquarters of the departments on how the projects should be implemented to minimise negative impacts on the well-being of societies in the project areas and to enhance positive social impacts.
Issues	
<p>Key points to note from the interview were as follows:</p> <ul style="list-style-type: none"> • The project should anticipate cases of gender-based violence, child labour, child trafficking and break up of families as it has been seen from previous related projects. • There is need to have a strategy by which the project should be implemented to prevent the above-mentioned issues. The strategy should include; setting up some grievance committees which will help in conducting sensitizations before the start of the project and also act like a group which abused people can lodge their grievances in the project area. • The District Social Welfare Officer stressed that the work should be zero tolerance to child and women abuse. As its stipulated in the Gender Act (2013), women should be given equal job opportunities as men as long as they are capable of doing the work. He emphasized that 40 to 60 percent of the employees in each phase should be women • The social welfare office in Mzuzu area is working in the areas of women empowerment and child protection with a focus on human rights by conducting sensitization meetings on these issues. • The project should also have a component of reforestation as a corporate social responsibility. This will help in curbing the impacts of climate change in the area which mainly affects vulnerable people's welfare. • The NRW should also sensitize its works on gender-based violence and on how they can protect themselves from sexually transmitted diseases before the implementation of the project and should be done with the involvement of the social welfare office of the district. • In addition, women and children should be encouraged to report any criminal cases to the police or the office of social welfare in the district. 	
Date	25 th March, 2019
Place	District Education Office, Mzuzu
Participants	Interviewee: District Education Officer Interviewer: Prisca Malenga (WVEC)
Discussion	Views from the Education department (at district level) regarding the proposed projects to raise the height of the Lunyangwa Dam and to construct a new intake weir at Mzuzu Treatment Plant. The discussion focused on obtaining input from the education sector on how the project can be implemented to enhance its social benefits as regards to the education environment for the impact area.
Issues	

Key points to note from the interview were that:

- The District education office welcomed the project, since it is expected to bring water to the area which will help in improving attendance of girls in schools.
- Causes of drop outs in the area include; lack of school fees, distances to school, early marriages and pregnancies for girls. These are mostly associated with culture and traditions especially in the local areas.
- Dropout rates are low and the passing rate is generally high in the district. Hence, there are no projects on education in the district.
- The project developers should conduct sensitization meetings to ensure that children are protected from abuse and that early marriages and pregnancies because of the project are avoided.

Date	25 th March, 2019
Place	Mzuzu Labour offices
Participants	Interviewee: Mr Chidothi Interviewer: Thoko Mtewa for WWEC
Discussion	Views from the department of labour (at departmental level) regarding the proposed projects to raise the height of the Lunyangwa Dam and to construct a new intake weir at Mzuzu Treatment Plant. The discussion focused on obtaining input from the department of labour regarding how the project should be done to adhere to guidelines on employees' welfare.
Issues	
Key points to note from the interview were as follows: The interviewee advised that the project should follow labour office requirements as follows:	
<ul style="list-style-type: none"> • Have a Contract of employment, which explains on employment conditions including working hours, salaries and wages. <ul style="list-style-type: none"> ○ Recommended working hours are 8 hours per day, and treat excess hours as overtime. Treat 7th day of working as a day off but if the employees work on this day, pay them a double wage. ○ Minimum monthly salary for unskilled labour is K25,000.12 and wage is K962.00 per day. ○ There is ordinary over time and day off over time, where an employee works beyond the working hours and on the days meant for off duties, respectively. ○ Formula for calculating payment for ordinary over time: $\text{Ordinary overtime} = (\text{Hour rate} \times 1.5) \times \text{number of excess hours}$ Where; $\text{Hour rate} = \text{Basic salary} \div \text{working days} \div \text{working hours}$ ○ Formula for calculating payment for day off over time: $\text{Day off overtime} = (\text{Hour rate} \times 2) \times \text{number of excess hours}$ • Have a written statement or contract which contains the following, among others: <ul style="list-style-type: none"> ○ Names of employee and employer ○ Date of commencement of the contract 	

- Rate of enumeration
- Rate of pay
- Intervals at which the enumeration is paid
- Nature of work to be performed
- Normal hours of work
- Any provision of termination
- Pension scheme. It is a mandate that all employers place their employees on pension scheme.
- The interviewer recommended that the project should employ people from within the community as it is cost effective for both the project and the employees, but also, do consultations from other companies for example, construction companies on labour costs.

Date	26 th March 2019
Place	Mzuzu Regional water office
Participants	Interviewee: Human resources Officer Interviewer: Mrs Thoko Mtewa for WWEC
Discussion	Views from the Department of Forestry (at national level) regarding the proposed projects to raise the height of the Lunyangwa Dam and to construct a new intake weir at Mzuzu Treatment Plant. The discussion focused on obtaining input from the Department of Water (at Regional level) regarding ground water abstraction rights and abstraction volumes in Mzuzu city and Mzimba as a district.

Issues

Key points to note from the interview were that:

- Abstraction rights are centralized where one is referred to Lilongwe, now called National water resources authority which was called water resources board in the past.
- The interviewee explained that currently there is chaos on ground water abstraction because people just drill anyhow. He went on to say, in the past you applied for water rights if you wanted to drill a borehole but board took a long time to meet and approve of drilling services whilst on the other hand people needed water. This led to political influx as well as the chaos.
- In terms of the abstracted volumes he said it was difficult to quantify the volumes due to the chaos on the ground.
- He went on to explain that in towns, drilling of boreholes is not allowed unless water board declares to have encountered serious water challenges. Then they give provisional rights where when the challenges are rectified, the boreholes are supposed to be sealed but people do not seal them. One cannot seal a water source providing them with cheaper or free water and go for paid water.

Date	26 th March 2019
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Place	Mzuzu Meteorological department
Participants	Interviewee: Mr Theu Interviewer: Mrs Thoko Mtewa for WWEC
Discussion	Views from the Department of Forestry (at national level) regarding the proposed projects to raise the height of the Lunyangwa Dam and to construct a new intake weir at Mzuzu Treatment Plant. The discussion focused on obtaining input from the Meteorology Department (at District level) regarding climate change issues that can affect the project and the surrounding communities (after project implementation).
Issues Key points to note from the interview were that: <ul style="list-style-type: none"> • There have been reductions (or variability) in rainfall in the recent years. In the past, Mzuzu received a lot of rains in the month of March, above 250ml but not this year (2019). Temperatures are also rising with a minimum range of 14-16°C and maximum temperature reaching as high as 29-30°C, as compared to the past where minimum temperature used to be as low as 10°C. • In his view, the reason for such climatic changes is mainly rampant deforestation where people use the trees for charcoal. The interviewee gave an example of Choma hill which had big natural trees 10 years back, but now there is none. He said, people have reached a point of uprooting even the tree stumps for charcoal production. • The interviewer said the project and communities will be affected by these climatic changes because through time, the pattern of rainfall will change and therefore water levels will decrease and this will consequently affect the supply of water. • In his last remarks, he recommended that the project should at least plant trees in the surrounding areas especially the catchment areas of the rivers, as well as civic educating the surrounding communities on cultivation along river banks and deforestation. 	

Date	26 th March 2019
Place	Mzuzu department of Lands
Participants	Interviewee: Mr Kabambe Interviewer: Mrs Thoko Mtewa for WWEC
Discussion	Views from the Department of Lands (at District level) regarding the proposed projects to raise the height of the Lunyangwa Dam and to construct a new intake weir at Mzuzu Treatment Plant. The discussion focused on understanding the guidelines or procedures followed on land registration and certification in the district for proper implementation of the project.
Issues Key points to note from the interview were that: <ul style="list-style-type: none"> • Land certificate depends on location, where some places are just given a deed. • In town a lease certificate is granted and in rural areas a deed is given. A title deed is granted in towns because it is an adjudicated land which is administered through 	

Registered Land Act and a final document is a certificate of ownership. In the rural areas the land is not adjudicated and is governed by Land Act and a **deed document** is the final document.

- The Water board must have been granted a **title deed** (certificate) in the area close to Mzuzu government secondary school because it is located in town. And water board follows procedure; they do not start projects without papers.
- So far there are **no** land issues from the areas where water board facilities are located because the people were already given compensation before the land was acquired.

Date	29 th March 2019
Place	Action For Sustainable Development (ASUD)
Participants	Interviewee: Mrs Mzuza (Deputy Director) Interviewer: Mrs Thoko Mtewa for WWEC
Discussion	Views from Action for Sustainable Development (ASUD), a Non- Governmental Organization (NGO), regarding the proposed projects to raise the height of the Lunyangwa Dam and to construct a new intake weir at Mzuzu Treatment Plant. The discussion focused on understanding how the project will impact the implementation of ASUD programs from an NGO perspective.

Issues

Key points to note from the interview were that:

- ASUD operates in four districts nationwide namely; Mzimba, Nkhatabay, Rumphu and Thyolo. They have livestock farming (piggery), afforestation, apiculture and fish farming as some of the developmental programs.
- The discussion based on the positive and negative impacts (in the interviewee's point of view).
- The following were the reported positive impacts:
 - This project will enhance the implementation of the piggery Farming program. Clean water is an essential tool for pig production and the project once completed will enable most families involved to have a higher production rate.
 - The organisation will cut the costs on expenses that were allocated to bore hole drilling since most families will have an access to piped water.
 - They also believe that this program will benefit their nutrition program for people living with HIV AND AIDS. In nutrition, hygiene is an essential component and the access to clean water will help the people suffering from this pandemic to avoid some secondary infections that may arise if they use untreated water.
 - They also mentioned that the project will create many job opportunities for the community members.
 - The access to portable water will also improve the health standards of the community and the healthy people will support their programs.
- Negative impacts were reported as follows:

- The influx of the construction workers into the area will trigger the spread of Sexually Transmitted Infections like HIV/AIDS.
- Increase in greenhouse emissions by the construction machinery. Increase in greenhouse emissions have a direct negative effect on the ozone layer and subsequent enhancement of global warming and weather changes, this may have an environmental health impact for the area.
- Increase in demand of firewood and charcoal making by local people to supply the demand that will be created by people working for the project.

APPENDIX 4: LIST OF PEOPLE CONSULTED

S/N	Full Name	Position	Organization	Phone #	Signature
1	PINNUS W. WALITA	Plant Supervisor	NRWB	0999201708	<i>[Signature]</i>
2	Maxon Shaba	Plant operator	NRWB	0888578121	<i>[Signature]</i>
3	Emmanuel Chilango	Plant operator	NRWB	0994067037	<i>[Signature]</i>
4	Aram S. Mwenibanda	P/Operator	NRWB	0993270709	<i>[Signature]</i>
5	Jester Mlowika	Plumber	NRWB	0888217187	<i>[Signature]</i>
6	CHARLES PA-JERE	STA	CHIEF	0995416419	<i>[Signature]</i>
7	Kondwani Mbonde	Ag. RWB (A)	RWB (W)	08883-1110	<i>[Signature]</i>
8	Micawi Kumwenda	Project Coordinator	NRWB	0999755162	<i>[Signature]</i>
9	Agnes Nyivenda	DFO (Urban)	DFO	0994911200	<i>[Signature]</i>
10	Charity Kumwenda	PWD ^{Paras. & wild life officer.}	Wildlife	0999205685	<i>[Signature]</i>
11	Kw Mchilal	BWSO	WETA	0555662990	<i>[Signature]</i>
12	Jim Wotechi	BSWO	Social	0999624871	<i>[Signature]</i>
13	Russell Mshone	BLO	LABOUR	0999359455	<i>[Signature]</i>
14	Frank Mfene	MED	MDC	0999366496	<i>[Signature]</i>
15	Esther Chipokoro	TWE	NRWB	0881769130	<i>[Signature]</i>
16	Topsy Kachere	DCDO	Community Dev	0993591909	<i>[Signature]</i>
17	Emmanuel C. Mkomwa	PO-MASAF IV	MDC	0888474006	<i>[Signature]</i>
18	Mabvuto Lupwayi	ANISS	MCC	0994599998	<i>[Signature]</i>
19	Augustine Gama	SEHO	MCC	0881235218	<i>[Signature]</i>
20	Alexander K. Chiramba	APD	MCC	0999748691	<i>[Signature]</i>
21	FRANCIS E. KUNYADA	EHO	MOYALE	0991016650	<i>[Signature]</i>

APPENDIX 5: LOCAL NAMES FOR FLORA AND FAUNA IN THE PROJECT AREA**FLORA SPECIES****SCIENTIFIC NAME****LOCAL NAME**

<i>Hyphaene petersian</i>	Chiwale
<i>Pterocarpus angolensis</i>	Mlombwa
<i>Adansonia digitata</i>	Malambe
<i>Albizia spp</i>	Mtangatanga
<i>Azadirachta indica</i>	Neem
<i>Trichilia emetica</i>	Msikidzi
<i>Acacia tortilis</i>	Nchongwe
<i>Prosopis grandilosa</i>	mtcheza
<i>Prosopis cineraria</i>	mtcheza
<i>Albizia lebbeck</i>	Mtangatanga
<i>Azadirachta indica</i>	Nimu or Neem
<i>Acacia seyal</i>	Chisawani
<i>Tecomaria nyassae</i>	Masasa
<i>Colophospermum mopane</i>	Sanya
<i>Brasilettia mollis</i>	Mbumbi
<i>Hardiwickia binata</i>	Mswaswa
<i>Tamarix articulata</i>	Chiombo
<i>Cassia siamea</i>	Kadate
<i>Eucalyptus camandulensis</i>	Bluegum
<i>Eucalyptus hybrid</i>	Bluegum
<i>Leucaena leucocephala</i>	Mtengo wa feteleza
<i>Cenchrus ciliaris</i>	Udzu
<i>Cenchrus setigerus</i>	Udzu
<i>Zizyphus mauritiana</i>	Masawo
<i>Punica granatum</i>	Jamu
<i>Psidium guajava</i>	Gwava
<i>Phoenix dactylifera</i>	Kanjedza
<i>Feronia limonia</i>	Mlunguchulu
<i>Annona squamosa</i>	Mpoza wa chizungu
<i>Tamarindus indica</i>	Bwemba
<i>Salvadoro persica</i>	Mswache
<i>Cordia myxa</i>	Mpefu
<i>Syzygium quineense</i>	Mpeuma
<i>Embelia schimperii</i>	Nakonda
<i>Carissa edulis</i>	Mkangamwazi
<i>Faidherbia albida</i>	Msangu
<i>Ipomeo batatus</i>	Mbatata
<i>Mangifera indica</i>	Mango
<i>Zea mays</i>	Chimanga

<i>Musa paradisiaca</i>	Nthochi
<i>Musa livingstoniana</i>	Nthochi
<i>Carica papaya</i>	Papaya
<i>Manihot esculenta</i>	Chinangwa
<i>Eucalyptus ereticornis</i>	Bluegum
<i>Gmelia arborea</i>	Malayina
<i>Toona ciliata</i>	Sindilera
<i>Bauhinia petersiana</i>	Chitimbe
<i>Senna siamea</i>	Kesha
<i>Senna spectabilis</i>	Kesha
<i>Persea americana</i>	Mapeyala
<i>Citrus limon</i>	Lemon
<i>Citrus sinensis</i>	Orange
<i>Prunus persia</i>	Peach/Pichesi
<i>Pterocarpus angolensis</i>	Mlombwa

FAUNA SPECIES

<i>Haliaeetus vocifer</i>	Fish Eagle
<i>Corythornis cristatus</i>	Malachite kingfisher
<i>Ceryle rudis</i>	Pied kingfisher
<i>Cinnyris jugularis</i>	Sunbird
<i>Bycanistes bucinator</i>	Trumpeter hornbill
<i>Bycanistes brevis</i>	Slivery Cheeked hornbill
<i>Phacochoerus africanus</i>	Warthog
<i>Cercopithecus albogularisnyassae</i>	Blue Monkey
<i>Papio cynocephalus</i>	Baboon
<i>Crocuta crocuta</i>	Spotted Hyena
<i>Geochelone sulcata</i>	African spurred tortoise
<i>Lepus microtis</i>	African common hare
<i>Mus spp</i>	Mice

BIRD SPECIES

<i>Francolinus afer</i>	Red-necked Francolin
<i>Streptopelia semitorquata</i>	Red-eyed Dove
<i>Myioparus griseigularis</i>	Grey throated Tit-flycatcher
<i>Pyconotus barbatus</i>	Black-eyed Bulbul
<i>Tauraco corythaix</i>	Knysna Turaco

FISH SPECIES

<i>Oreochromis karonagae</i>	Chambo
<i>Oreochromis squampinis</i>	Chambo
<i>Opsaridium macrocephalum</i>	Mpasa
<i>Engraulicypris sardella</i>	Usipa
<i>Copadichromis spp</i>	Mbuna

Baseline Survey

Northern Region Water Board (NRWB)

Rhamphocromis spp

Labeo mesops

Tilapia rendalli

Clarias gariepinus

Bagrus meridionalis

Ctenopharynx nitidus

Aulonocara gertrudae

Synodontis njassae

Batala

Chisawasawa

Matemba

Bombe

Kampango

Gundakumwala

Chingongu

Nkholokolo

APPENDIX 6: HOUSEHOLD SOCIO-ECONOMIC SURVEY QUESTIONNAIRE
HOUSEHOLD SOCIO-ECONOMIC SURVEY QUESTIONNAIRE

For:

- (i) 2 RIVER INTAKES
(ii) RAISING OF LUNYANGWA DAM WORKS PROJECT

WATER SUPPLY PROJECT

INTRODUCTION:

Hi, my name is _____. I am hired by WWEC, a Malawian consultancy which has been mandated by the Northern Region Water Board to conduct an ESIA on:

- (i) 2 RIVER INTAKES
(ii) RAISING OF LUNYANGWA DAM WORKS PROJECT

for the proposed upgrading and expansion works for Mzuzu Water Supply Project. As part of the activities for the preparation of the ESIA, we are conducting a socio-economic survey (research).

The purpose of this research is to gather information on water supply issues in this area. The information provided will enable the project to be undertaken in a way that benefits the projects and affected communities. Your household has been selected randomly to participate in this research. The information that you will give us will be confidential and will not be used anywhere apart from for the purposes of this research. We sincerely appreciate the time that you are taking for this survey.

Do you have any questions on this survey or the project before I start?

SECTION 1: INTERVIEW DETAILS

A. INTERVIEWER	
Interview number	
Name of interviewer	
Date of Interview	
Name of Supervisor	

B. Location details	
District	
TA	
GVH	
Village	

C. IDENTIFICATION OF THE HEAD OF HOUSEHOLD/RESPONDENT	
Name (surname):	First name:

cellular phone number:	No pl <input type="checkbox"/>	(Tick box as appropriate)
Is the respondent the head of household?		
If not, what is the respondent's name:		
And what is his status: Spouse of <input type="checkbox"/> <input type="checkbox"/> of HH Other Specify:		

SECTION 2: DEMOGRAPHIC DETAILS

(Include all household members starting with the Household head (Please Write Name on Identity Card)

A. Member (Name and surname, start with HoH name)	B. Gender 1=F 2=M	C. Age	D. Marital Status 1=Single 2=Married Monogamous 3=Married Polygamous 4=Separated 5=Widowed 6=Cohabiting 7=Too young	E. Position within household 1. HoH 2. Spouse of HoH 3. Child of HoH 4. Grandchild of HoH 5. Parents 6. relatives 7. other, specify	G. Education 1. None 2. Primary 3. Secondary 4. Vocational 5. University 6. Too young	H. Ethnicity 1. Tonga 2. Chewa 3. Ngoni 4. Tumbuka 5. Lyambia 6. Nkhonde 7. Other (specify	I. Religion 1. Islam 2. Christianity 3. Other	J. Disability 1. Yes 2. No

SECTION 3. INCOME SOURCE	
A. What is the main source of income for this household	<ol style="list-style-type: none"> 1. Formal employment 2. Informal employment (piece work including agriculture day labor) 3. Commercial agriculture 4. Remittances from families and friends 5. Business/ Trading 6. Pension 7. Renting (land, house etc.) 8. Fishing 9. Other 10. None
B. What is the secondary source of income for this household	<ol style="list-style-type: none"> 1. Formal employment 2. Informal employment (piece work including agriculture day labor) 3. Commercial agriculture 4. Remittances from families and friends 5. Business/ Trading 6. Pension 7. Renting (land, house etc.) 8. Fishing 9. Other 10. None
C. Income per month (Combined)	<ol style="list-style-type: none"> 1. Less than MK 10,000 2. MK 10,000 – MK 20,000 3. MK 20,001 – MK 50,000 4. MK 50, 001 – MK 100,000 5. MK 100,001 – MK 200,000 6. More than MK 200,000

SECTION 4: HEALTH	
A. What is the nearest health facility in your village/area?	<ol style="list-style-type: none"> 1. Government 2. Private
B. How long does it take you to reach nearest health facility (the nearest)?	<ol style="list-style-type: none"> 1. Less than 30 minutes 2. 30 minutes to 1 hour 3. 1 hour to 2 hours 4. More than 2 hours
C. What are the most common diseases that affect the family? (Multiple response)	<ol style="list-style-type: none"> 1. Malaria 2. Water related diseases (cholera, dysentery, typhoid, diarrhea, eye and skin infections) 3. STDs (Syphilis, HIV, Gonorrhea, Hepatitis B) 4. Accidents (Traffic, Domestic)

	5. Stress related (Ulcers, Hypertension) 6. Respiratory infections (Cough, Asthma) 7. Intestinal infections 77 Others specify _____
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SECTION 5: EDUCATION	
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A. Education of the respondent	1. None 2. Primary 3. Secondary 4. Vocational 5. University 6. Too young
B. What is the name of the nearest school in this area?	Primary= Secondary=
C. How long does it take to get to school? (one way)	1. Less than 15 min 2. 16-30 min 3. 31-60 min 4. 61-90 min 5. 91+ min
	Primary= Secondary=
D. Are there any factors that limit household members from going to school? (if no, go to section 5 (health))	1. Yes 2. No (skip to section 6)
E. If yes, what factors limit household members going to school? (multiple response)	1. cost 2. Spend much fetching water 3. Distance 4. Illness 5. Work 6. Marriage 7. cultural/religious 8. lack of transport 77 other (specify)

SECTION 6: WATER	
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A. What is the main source of drinking water for this household?	1. Unprotected springs 2. Unprotected wells 3. Protected wells 4. Streams/river/lake
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SECTION 6: WATER	
	5. Boreholes 6. Piped water 77 Other
B. What is the main source of water for other uses for this household?	1. Unprotected springs 2. Unprotected wells 3. Protected wells 4. Streams/river/lake 5. Boreholes 6. Piped water 77. Other
C. Approximately what quantity of water is used per day (drinking and home consumption)?	1. <20L, 2. 20-60L 3. 60-80L 4. 80-100L 5. Above 100L
D. How far is the source of drinking water from the dwelling? (to and from)	1. 0-15 min 2. 16-30 min 3. 31-60 min 4. 60 min+
E. When you get to the water sources, how long do you take to get water?	1. <5 min 2. 6-10 min 3. 11-15 min 4. >15
F. Who is providing water services?	1. NGOs 2. Water User Association 3. Northern Region Water Board 4. Government 77. Other
G. Do people pay for the water?	1. Yes 2. No (skip to I)
H. If yes, how is the payment made?	1. Daily 2. Monthly 3. Yearly 4. When need arise
I. How much do people pay for the water?	(TEXT)

SECTION 6: WATER	
J. If water is made available, would you be willing to pay?	<ol style="list-style-type: none"> 1. Yes 2. No (Skip to L)
K. If yes, how much would you be willing to pay?	<ol style="list-style-type: none"> 1. Less than MK 100 2. MK 100 – MK 200 3. MK 201 – MK 500 4. MK 501 – MK 1000 6. More than MK 1000
L. Do you have challenges with your water supply from time to time?	<ol style="list-style-type: none"> 1. YES 2. No (Skip to section 7)
M. If yes, what challenges do you have?	<ol style="list-style-type: none"> 1. Water shortages 2. Expensive 3. Frequent breakdown (boreholes) 4. Religious beliefs 5. Difficult to access (remote access) 6. Poor water quality (i.e. salty water) 77 Other (specify)
N. How is storm water disposed?	<ol style="list-style-type: none"> 1. Planned drains 2. Unplanned drains 3. None

SECTION 7: SANITATION AND HYGIENE	
A. Do you have a toilet/latrine?	<ol style="list-style-type: none"> 1. Yes (skip to D) 2. No
B. If no, what do you use?	<ol style="list-style-type: none"> 1. Bush 2. Water source (lake, river) 3. Neighbors 77 Other (specify)
C. What are the reasons that inhibit you from owning a toilet/latrine?	<ol style="list-style-type: none"> 1. Cost 2. Tradition 3. No reason 4. Poor soil (i.e. sandy soils) 77 Other (specify)
D. What type of toilet facility does your household use	<ol style="list-style-type: none"> 1. Traditional pit latrine 2. Improved traditional pit latrine 3. Flush toilet 4. Ventilated improved pit latrine

SECTION 7: SANITATION AND HYGIENE	
	5. Eco-San toilets
E. Does your toilet have a hand washing facility?	1. Yes 2. No
F. At what times do you usually wash your hands ?	1. After using the toilet 2. Before eating 3. After eating 4. After changing babies nap 5. Before breastfeeding a baby 77 Other, specify
G. What do you use for washing hands	1. Water only 2. Water and soap 3. Water and ash 77 Other, specify
H. How much solid waste do you generate per week? (Enumerator can guide respondent by giving Kg equivalents)	
I. How do you dispose your solid waste?	1. Rubbish pit 2. Burn 3. Designated place (city council) 4. Make manure 5. Indiscriminate disposal 6. Other (specify)
J. How much liquid waste is produced per day?	1. <20L, 2. 20-60L 3. 60-80L 4. 80-100L 5. Above 100L
K. How is liquid waste disposed?	1. Drains 2. Sock pit 3. Indiscriminate disposal

SECTION 8: GENDER AND ENVIRONMENTAL SUSTAINABILITY

A. Do women participate in	1. Yes 2. No
----------------------------	-----------------

development projects of this area?	
B. Do men and women work together in development activities in this area?	<ol style="list-style-type: none"> 1. Yes 2. No (skip to D)
C. If yes, what development activities do women and men work together? (Text)	<ol style="list-style-type: none"> 1. WASH 2. Education 3. Businesses and loans 4. Agriculture 77 Other(specify)
D. Do women participate in decision making in development activities?	<ol style="list-style-type: none"> 1. Yes 2. No (skip F)
E. If yes, how?	
F. How would you describe the Current Environmental situation?	<ol style="list-style-type: none"> 1. Good 2. Average 3. Poor
G. What is the reason for your rating	Reasons (text)
H. Which components of the environment are polluted or degraded? (Multiple response)	<ol style="list-style-type: none"> 1. Soil 2. Water 3. Trees and vegetation 4. Air 5. General outlook (environmental scenery)
I. What are the main causes of the current environmental situation?	<ol style="list-style-type: none"> 1. Ignorance by individuals 2. Negligence by household or institutions 3. Poor service provision by institutions 4. Poverty 77 Other, Specify
J. What are the likely positive environmental and social impacts which will arise from the implementation of the project?	

<p>K. What are the likely negative environmental and social impacts which will arise from the implementation of the project?</p>	
<p>L. What would be the enhancement measures of the positive impacts</p>	
<p>M. What would be the mitigation measure for the negative impacts</p>	

<p>SECTION 9: ENERGY</p>	
<p>A. What is the main source of lighting for your household?</p>	<ol style="list-style-type: none"> 1. None 2. Wood (fire, grass) 3. Kerosene lamp 4. Torch & batteries 5. Candle 6. Portable Solar lamps 7. Generator 8. Electricity-grid 9. Solar 77 Other
<p>B. What kind of fuel is mostly used for cooking?</p>	<ol style="list-style-type: none"> 1. Gas 2. Biogas 3. Charcoal 4. Kerosene 5. Electricity 6. Saw dust

	7. Firewood 77 Other (specify)
C. If firewood, how do you obtain this? (Multiple response)	1. collect within 1km of village 2. collect over 1km from village 3. buy (skip to E)
D. Who in the household mainly collects firewood?	1. Adult female (>16) 2. Adult male (>16) 4. Children (<15)
E. What challenges do you face in obtaining firewood? (Multiple response)	1. Distance 2. Cost 3. Accessibility 4. Availability 77 Other (specify)
F. Do you have electricity in this household?	1. Yes 2. No
G. If yes, what kind of electricity?	1. ESCOM 2. Solar 3. Generator 77 Other (specify)

Comments and observations

Republic of Malawi



Malawi Northern Region Water Board Water Efficiency Project



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CONSULTING SERVICES

TECHNICAL ASSISTANCE TO SUPPORT THE IMPLEMENTATION OF THE “MALAWI NRW WATER EFFICIENCY PROJECT”

REF: TA2016064 MW IF4

Report on construction of two new offtake weirs - NEW WEIR
AT LANYANGWA

January 2019

Author: M G Richards	Version:
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Statement

The technical assistance operation is financed by the European Union under the Cotonou Agreement through the European Union Development Fund (EDF). The EDF is the main instrument funded by the EU Member States for providing Community aid for development cooperation in the African, Caribbean and Pacific States and the Overseas Countries and Territories.

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Disclaimer

The authors take full responsibility for the contents of this report. The opinions expressed do not necessarily reflect the view of the European Union or the European Investment Bank.

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ACRONYMS AND ABBREVIATIONS

EUR	Euro
MCC	Mzuzu City Council
NRWB	Northern Region Water Board
P&P	Posch & Partners Consulting Engineers
SCADA	Supervisory Control and Data Acquisition
TA	Technical Assistance
TAC	Technical Assistance Consultant
VEI	Vitens Evides International
masl	Metres above (mean) sea level
EI	Elevation
u/s	Upstream
d/s	Downstream
WTP	Water treatment plant (or works)
RB, LB	Right bank, left bank

1 INTRODUCTION

The report at hand has been produced as part of our services under Task 12: Design of two river intakes and deals with the possible upgrading of the river weir adjacent to the water intake in Mzuzu.

The current weir is adjacent to the Lunyangwa water treatment works and resembles a temporary structure; it has been so for a number of years.

It intercepts water in the area between it and the Lunyangwa Dam, leakage from it, and spill water when subject to flooding.

The regular flow past the weir is estimated at 500 l/s; about 50% of this is abstracted via a 150 mm dia pipe and pumped to the

Lunyangwa water treatment works - effectively supplementing water taken from the Lunyangwa Dam via the Intake Tower.

It is proposed to increase the water being abstracted, by reducing the flow lost - ie which is currently passing around the weir or under it - by constructing a more watertight structure and a grout curtain.



Figure 1 – General view of weir and area u/s, viewed from the road bridge, d/s

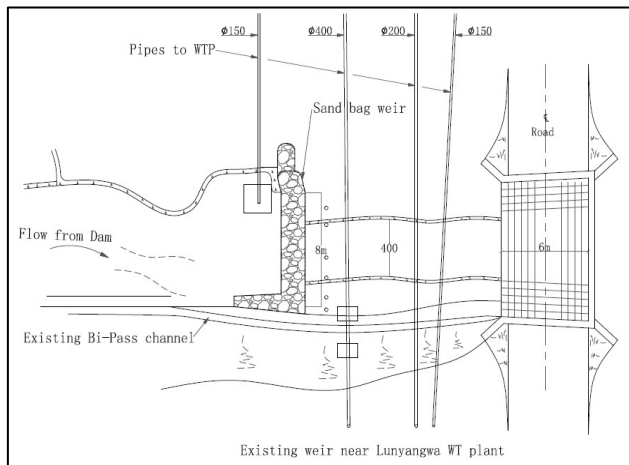


Figure 3 – Layout of existing weir and offtake



Figure 2 – Road bridge, WTP, and weir u/s on the left

2 NEW WEIR STRUCTURE

The current sandbag arrangement will be replaced by a concrete structure, complete with stilling basin and a sand-trap. Layout would follow convention, an ogee weir creating a back-up of water upstream, sitting on a raft foundation, with 1m high training walls, and an offtake canal on its left bank, with sluicing facility.

A 1m deep cut-off wall would be built at the u/s end, to provide stability and reduce seepage beneath the structure.



Figure 4 – Existing weir viewed from d/s RB

Bedrock is at 4.5 to 5.5 m below ground level. The intervening soil is a mixture of clays, sand and gravel. For the cut-off, a trench should be dug with a narrow bucket and then quickly backfilled with plastic concrete. For the rest of the structure, normal practise would be to excavate to say 20cm below formation and backfill with hardcore, or granular road base type material to give a firm working platform.

2.1 Location

2.1.1 Between current weir and road crossing

There is room between the current structure and the road crossing a few metres downstream of it, and one option would be to build it just d/s of the current one, using it to divert water while the foundations of the new structure are being formed. There are two problems with this:

- a) the current weir is not very watertight, and it would be impossible to get a dry formation on which to build the new structure;
- b) as can be seen from fig 1, there are 3 pipes crossing the river at this point, which will interfere with construction and in the long term will be vulnerable during high flows.

2.1.2 Upstream of the current weir

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There are no obstructions in this case, but the biggest problem will be to divert water away during construction. Classic way is by means of a sheet pile wall across the water course and excavate a sump at the left corner. Water could be pumped from here to the WTP and any excess pumped via a temporary pipeline round the construction works downstream. Piling needs access and special equipment; a cheaper solution would be to use sandbags and an earth bund upstream of them using material excavated for the weir structure.

2.1.3 At the road crossing

This would put the new weir downstream of the pipes traversing the site, and has several advantages:

The immediate attraction is that the side walls could be designed to act as abutments for a new bridge forming the road crossing. The current bridge comprises a simple timber decking 4m wide spanning 6m, sitting on abutment beams below the road surface. The bridge is again vulnerable to high flows, (although local people, when asked, had no recall of it ever being swept away).



Figure 5 Road bridge, viewed from u/s

Current weir and canals could be used to divert water.

Main disadvantage is that the $\Phi 20$ and $\Phi 40$ pipes crossing the site would need to be accommodated in the training walls and will be submerged during high flows.

2.1.4 Optimum location

For now, the structure is proposed in the area just u/s of the existing structure.

2.2 Basic dimensions

The current bridge measures approximately 5m by 2m and could accommodate a maximum flow through of 25 m³/s; any more than this and water will back up and flood the area upstream, high flows will erode the bridge abutments and eventually wash the bridge away.

As part of the weir construction work, it would be prudent to strengthen the bridge abutments, eg by means of some rip rap and pitching - to increase erosion resistance.

The main thing is that there is no point in designing the weir and stilling basin for any larger flow than 25 m³/s.

2.2.1 Weir

A weir with a crest length of 8m (~2m longer than the current one) will accommodate a flow of 20 m³/s with a depth of water (H) of 1.1 m, or a flow of 25 m³/s with a depth of 1.3m.

It is proposed to design the weir on the basis of 20 m³/s flow, and then adopt a 40cm freeboard.

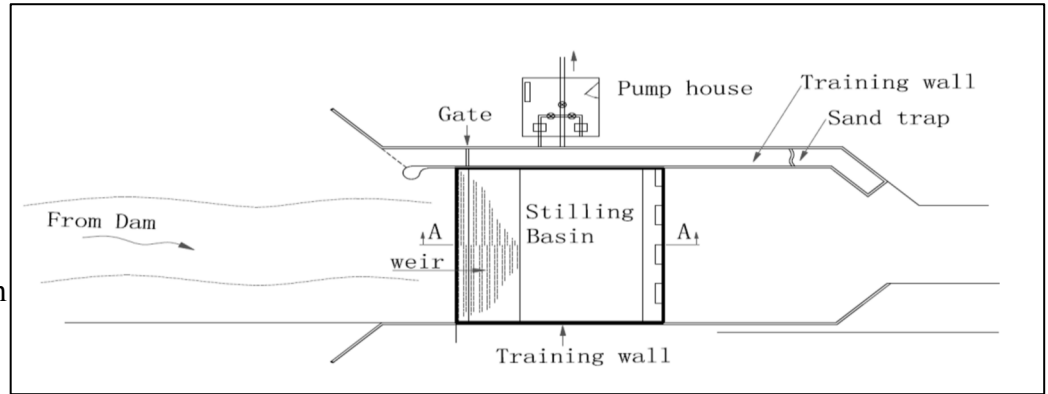


Figure 6 Proposed new weir and offtake

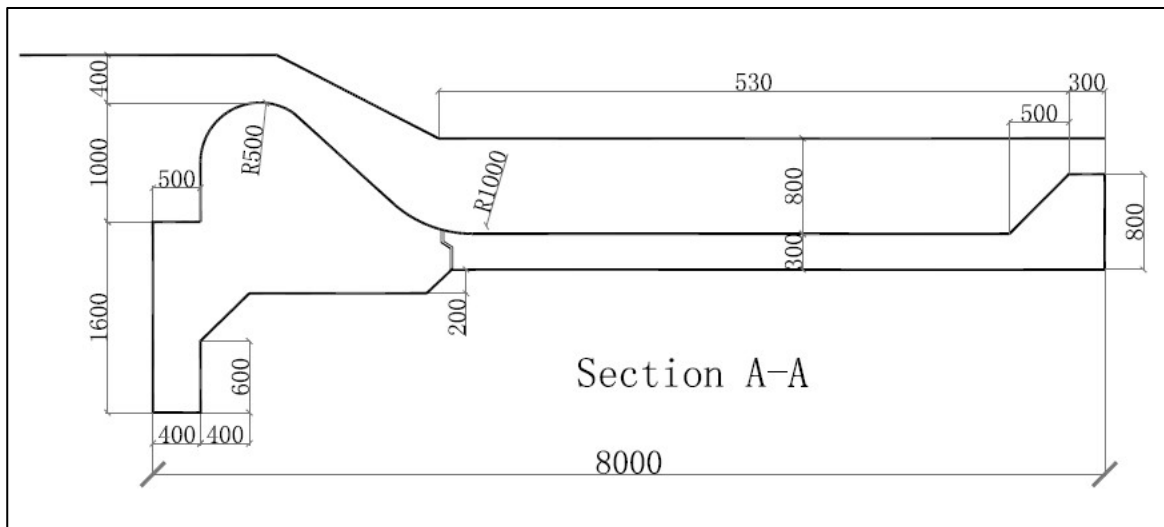


Figure 7 - Typical cross section

2.2.2 Stilling basin

A stilling basin is not mandatory, but anything that reduces turbulence downstream of the weir is important, and a nominal basin 5m long is proposed.

Discharge Q m ³ /s	Ht of weir	Depth	Length of crest m	Specific discharge q m ³ /s/m	Length of stilling basin L m	Length of d/s apron	Depth of water:		
		water over crest H					at toe of weir y ₁	d/s end of SB y ₂	d/s: y ₀
20.0	1.0	1.08	8.0	2.5	4.94	3.69	0.35	1.76	1.61
25.0	1.0	1.26	8.0	3.1	5.28	4.66	0.42	1.97	1.84

Table 1 - Main dimensions for the Stilling Basin

The design has been done similarly to the weir at Ekwendeni, for details, please see Appendix 1.

2.2.3 Sandtrap

Sediment load will be relatively small, since most particles will have been trapped by the dam a few km upstream, and any subsequent silt will have settled with the slow-moving flows downstream of it. However, a long bi-pass channel is required, not only for the intake (abstracting water for the WTP), but also for the diversion during construction.

A channel 15m long, 1m wide, with depth of water 0.5m will suffice, constructed in concrete.

The design is similar to that for the Ekwendeni weir offtake structure.

3 CONSTRUCTION

3.1 Diversion works

There is a small channel draining down the right bank of the current weir. It is proposed that water be diverted along it while the sand trap channel is being constructed on the left bank. A sheet pile wall is one way of cutting off flows across the valley, but with problems of access and the fact that weathered rock is only a few (~4 - 5m) metres below ground level, they would probably be difficult to drive. A wall of sandbags laid across the valley is considered the best line of defence, and consistent with local resources. Some of the existing sand bags could probably be used.

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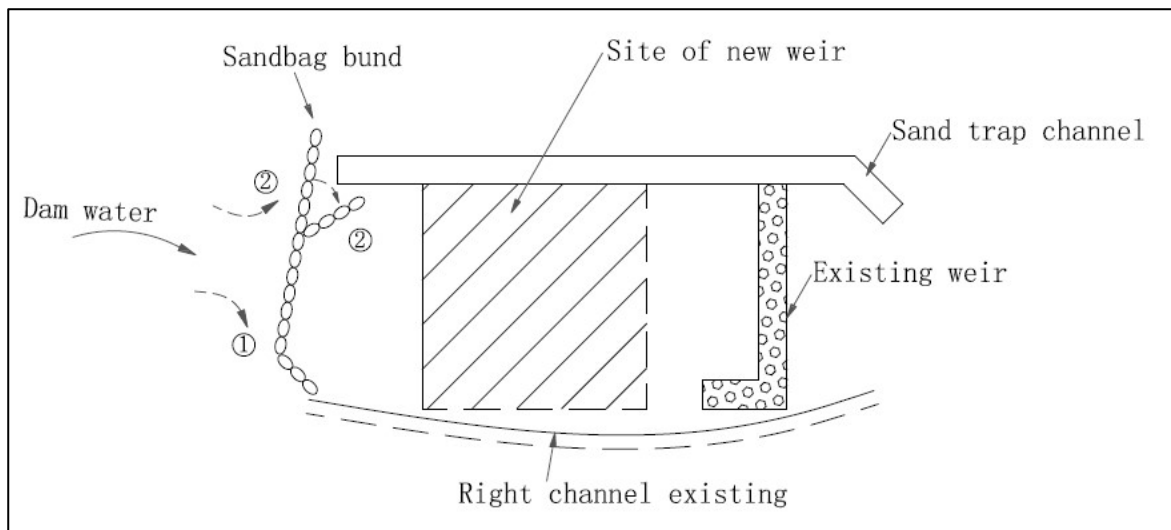


Figure 8 – Diversion principle

A sump would still be needed, with a small pump going 24/7, the seepage water drawn off and, if clean, directed to the WTP, otherwise piped downstream.

As soon as the concrete channel (sandtrap) is constructed on the left bank, the right channel can be blocked off and all flows directed to the left bank.

When the weir is completed, the sand bags can be removed and levelled out to form a kind of apron, or realigned to form extended training walls.

3.2 Sandtrap channel

The foundation for this would be approximately 50cm deep, removing vegetation/top soil and silt, before reaching coarser sand/alluvial material. A blinding layer 50mm thick would create a suitable working area, followed by shutter, wire mesh reinforcement and concrete for slab and walls 1m high and 15 – 30 cm thick.

3.2.1 Weir

First stage is to excavate and backfill the cut-off wall. Bedrock is expected about 3 - 4m down, but there is no need to excavate so deep; cut-off depth is normally 1.5 x head of water, which is 1m. Anyway, it should be easy dig for an excavator, and actual depth can be decided on site. Width would be bucket width say 30cm and the trench should be backfilled straight away with plastic low strength concrete.

Formation of the weir and stilling basin will be on top of the coarse sand/alluvium; loading will be very light, of the order 25 kN/m² (allowable bearing capacity of even soft clays and silts is 50 kN/m²).

If the material is seen to be low strength silty clay, excavation should be taken down a further 30 - 50 cm or so, then backfilled with more granular fill (like road sub base material) and compacted in 20 cm layers.

Concrete for the weir will be mass concrete 15 MPa, the stilling basin lightly reinforced with mesh to prevent cracking.

3.2.2 Training walls

Wall will be required 40 cm above the weir crest, extending a nominal 5m upstream of the weir. In the vicinity of the weir and stilling basin, they will share the same foundation, ie acting as a raft, so no great depth to wall foundation is anticipated. External moment due to loading of earth backfill will be resisted by the basin slab.

3.2.3 Hydraulic gates

A 1m square penstock will be required at the u/s end, and a 40cm square one at the downstream, for flushing the settled sand/silt. Manually operated type as shown in fig 9 will suffice.

3.2.4 Extraction

A small pump house by the side of the sand trap will be needed, suggested measuring 3 x 4m, on a concrete slab, with tin roof over, window and door. A new $\Phi 150$ mm pipe line is proposed leading to the WTP; 2 pumps installed, one duty, the second standby, together with 2 control valves and a 3rd for draining.

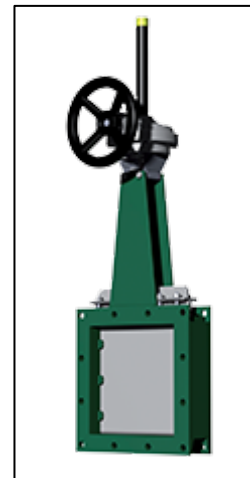


Figure 9 – Penstock valve

4 COSTING

A budget figure of €51,440 is derived, using rates from similar works in Ethiopia and Oman.

Please see Appendix 2 for breakdown and estimate of costs.

APPENDIX 1 – STILLING BASIN DESIGN

L_{crest}		8.0		8.0
Q	m ³ /s	20.0		25.0
q	m ³ /s/m	2.5		3.1
C_d		0.75		0.75
H	$= (q / (2C_d (2g)^{0.5}))^{2/3}$	1.084		1.258
S		1.000		1.000
S_0 bed slope		0.001		0.001
Psi ϕ velocity coeff	$\phi = 1 - 0.0155 * S/H$	0.986		0.988
n	Mannings roughness coeff for the river	0.028		0.028
$n = 0.04 * d^{1/6}$	d is roughness			
	$d = (n/0.04)^6$	0.118	M	0.118
Using Manning:				
	$q = y_0^{5/3} S_0^{0.5} / n$, to get y_0 :	1.611		1.842
$RS / (d(2.65-1))$	if < 0.05 (Shields) river bed is stable	0.008		0.009
Energy head =	$E = S + H$	2.084		2.258
Also =	$E = q^2 / 2g \phi^2 y_1^2$	2.084	0.00	2.259
	y_1 by trial & error =	0.537		0.660
Calculate Froude Nr	$F_{r1}^2 = q^2 / g y_1^3$	4.1		3.5
	$y_2 = y_1 / 2 (-1 + (1 + 8 * q^2 / g y_1^3)^{0.5})$	1.296		1.438
	$y_2 < y_0$, so a SB is not really required	-0.315		-0.403
σ , Coriolis coeff	should be:	1.1 - 1.25	(σ is nor	1.1 - 1.25
Assume $\sigma = 1.2$,	$y' = \sigma y_2 - y_0$	-0.056		-0.116
Assume $y' =$		1.100		1.100
Repeat E	$E = S + H$	3.184		3.358
	$E = q^2 / 2g \phi^2 y_1^2$	3.184		3.359

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	y_1 by trial & error =	0.345	0.00	0.423
	$\varphi = 1 - 0.0155 * S / H$	0.970		0.974
recalc Froude:	$F_{r1}^2 = q^2 / g y_1^3$	15.5		13.2
	$y_2 =$	1.756		1.969
Coriolis coef.	$\sigma = (y' + y_0) / y_2$	1.544	Ok	1.494
New y'	$y' = \sigma' y_2 - y_0$	1.100		1.100
Length of SB:	$L = K (y_2 - y_1)$	4.94		5.28
$4.5 < K < 5.5$	$F_{r1} =$	3.9		3.6
$> 10 \quad F_{r1} < 3$				
y_0 depends on an assumed value of Manning's n for the river d/s				
If being conservative, ie, n low, and φ high, a lower value of σ say 1.11 is sufficient				
If degradation of river, can make y_0 lower				
Scour depth y_s , (based on research by Jaeger/Novak)				
$= 0.55 * (6H_a^{0.25} q^{0.5} (y_0/d90)^{0.333} - y_0)$		0.61		0.78
Length requiring scour protection	$D = 6 \times y_s$	3.69		4.66

APPENDIX 2 COSTING

Item N°	Description	Quantity	Unit	Rate €	Amount
BoQ for Lunyangwa Weir					
Diversion					
1	Create bund wall just u/s of new weir site, using existing and new sandbags	106.67	No	10.00	1,067
2	Excavate lead-in channels, improve right bank channel	30.00	m ³	4.41	132
3	Rearrange sandbags for phase II	20.00	No	10.00	200
4	Remove sandbags when weir is complete	60.00	No	5.00	300

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	Total for diversion work				1,699
Excavation					
5	Excavate cut-off trench, 40cm wide	5.40	m ³	4.41	24
6	Excavate 30cm in soil to formation of weir and stilling basin	24.30	m ³	4.41	107
7	Excavate for sandtrap	45.00	m ³	4.41	198
8	Excavate for RB retaining wall	22.50	m ³	4.41	99
	Total for excavation work				429
Fill					
9	Supply granular fill, backfill over structure footprint, level and compact it	16.20	m ³	7.17	116
10	Backfill behind retaining walls on completion	240.00	m ³	7.17	1,721
	Total for fill work				1,837
Concrete work					
11	Place plastic concrete (10 MPa) for cut-off wall	5.40	m ³	152.00	821
12	Formwork for weir, training walls and sandtrap, ie 3 walls ave 3m high	270.00	m ²	0.00	0
13	Mass concrete 20 Mpa for weir	27.00	m ³	171.00	4,617
14	Steel reinforcement for stilling basin	1.70	t	2,195.00	3,734
15	Steel reinf for training walls	5.67	t	2,196.00	12,451
16	Concrete (24 MPa) for stilling basin	19.80	m ³	180.50	3,574
17	Concrete (28 MPa) for training walls	16.20	m ³	190.00	3,078
	Total for concrete work				28,275
Hydro-mechanical					
18	Supply and install 2 No 1m square gates	0.50	T	10,000.00	5,000
19	Supply and install 2 No suction pumps	2.00	No	3,500.00	7,000

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20	Supply and install all necessary 150 dia pipework	100.00	m	15.00	1,500
21	Provide and install electrical switchgear and panel	1.00	LS	4,500.00	4,500
	Total for electro-mechanical work				18,000
Building work					
22	Construct 4m x 3m x 2m high concrete blockwork, on 20 thick concrete slab, with sloping tin roof on wooden rafters, c/s door and window	12.00	m ²	100.00	1,200
	Total for building work				1,200
	Total:				51,439

Republic of Malawi



Malawi Northern Region Water Board Water Efficiency Project

Author: M G Richards	Version:
Date: 29 January 2019	For submission to NRW for comments



CONSULTING SERVICES

TECHNICAL ASSISTANCE TO SUPPORT THE IMPLEMENTATION OF THE “MALAWI NRW WATER EFFICIENCY PROJECT”

REF: TA2016064 MW IF4

**Report on design of proposed Intake Weir at
Ekwendeni**

January 2019

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Statement

The technical assistance operation is financed by the European Union under the Cotonou Agreement through the European Union Development Fund (EDF). The EDF is the main instrument funded by the EU Member States for providing Community aid for development cooperation in the African, Caribbean and Pacific States and the Overseas Countries and Territories.

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ACRONYMS AND ABBREVIATIONS

EUR	Euro
MCC	Mzuzu City Council
NRWB	Northern Region Water Board
P&P	Posch & Partners Consulting Engineers
SCADA	Supervisory Control and Data Acquisition
TA	Technical Assistance
TAC	Technical Assistance Consultant
VEI	Vitens Evides International
masl	Metres above (mean) sea level
El	Elevation
u/s	Upstream
d/s	Downstream
WTP	Water treatment plant (or works)
RB, LB	Right bank, left bank

“MALAWI NRWB WATER EFFICIENCY PROJECT”

Ref: TA2016064 MW IF4

NEW WEIR AT EKWENDENI

1 INTRODUCTION

Ekwendeni is a town in the Northern Region of Malawi, some 20 km northwest of Mzuzu, in the Mzimba district.

Since Scottish missionaries arrived in 1889 and opened a mission station at Ekwendeni, built one of the oldest churches in Malawi there followed by the general hospital, the town has developed substantially. Residents of Ekwendeni were often attracted there because of the hospital, the theological college, the college of nursing and the technical training school.

Ekwendeni is largely surrounded by tobacco growing farms and is a favourite resting place for truck drivers travelling along the M1 road between Malawi and Tanzania, Kenya and beyond.

It is booming with small businesses; international donors are helping in the development of this area, and the town has beautiful surroundings, which make the area a good destination for tourists.

Ekwendeni and its environs have seen a rapid growth in the population, which in 2016 was estimated at 19,000, and this has resulted in an increased demand for water supply.



Figure 1 - Lunyangwa River and weir at Ekwendeni

2 WATER SUPPLY SYSTEM

Ekwendeni Town has a water treatment plant (WTP) with a capacity of some 700 m³/day against a current demand of some 1,400 m³/day. Water for the area is supplemented from the Mzuzu water supply system, to meet the shortfall in the supply, which of course exerts pressure on water supplies meant for Mzuzu City. To alleviate the problem, the Northern Region Water Board (NRWB)

intends to construct a new WTP and associated pumping, storage and transmission facilities to satisfy current and near future demand from Ekwendeni Town and the surrounding area plus new raw water abstraction facilities to suit. The proposed abstraction facilities are a small concrete weir and integral sand trap, from which water will gravitate to a new raw water pump house.

The NRW commissioned the Department of Civil Engineering - University of Malawi to carry out the hydrological analysis of the abstraction works on Lunyangwa River at Ekwendeni to confirm availability of water in the River at Ekwendeni. The study was completed during August 2016.

Its findings from both low-flow and flood frequency analyses, showed that current flows in Lunyangwa River are adequate to sustain the Ekwendeni Water Supply Scheme in the medium and long term, with appropriate design of the weir. Projected future demand indicates there will be a need to boost the limited raw water supply available from normal flow in the Lunyangwa river during the dry season by supplementing it, in due course, with water pumped into an off-river storage dam during the wet season.

The Department of Water Resources recommended that the hydrological assessment take into consideration an additional 8% to cover for environmental flows, ie the river should not be allowed to dry up.

The study concluded in essence, quote:

- (i) *The extent of sediment loading on the existing intake weir should be confirmed and a robust design with sediment exclusion facilities for the proposed abstraction works should be provided;*
- (ii) *The catchment should be protected from non-sustainable human activities that could influence the water quality;*
- (iii) *A verification and validation exercise of the existing water allocations downstream should be undertaken - mainly for irrigation.*
- (iv) *Balancing storage either by raising of the abstraction weir or using balancing tanks should be considered in the detailed design to deal with periods of low flows.*

3 EXISTING ARRANGEMENT

The current weir is 8m wide, and about 1m high, with a small sand catch chamber. The stilling basin is thought to be a thin concrete slab, or plastered over stone pitching, but it was silted over when visited, and difficult to see what sort of construction it comprises.

The weir is cracked in places and appears to be of flimsy construction; not founded on rock, and likely to be washed away in the first big flood.

There were 3 chambers on the right

bank, but all were redundant, and the design intent unclear.

The offtake was via a 100 mm diameter pipe laid on the top of one of the chambers.

Clearly some rehabilitation work is called for, and the capacity needs increasing by some 200%. It is therefore proposed to build a more robust structure, better able to resist large floods; increase the intake



Figure 2 – Existing weir, viewed from the right bank

size; make it easier to run and maintain, and incorporate a more effective sand trap.

4 THE WEIR

The new weir is proposed about 100 m downstream of the existing one, where there is rock evident near the surface. Recent site investigation work using hand augers, shows bedrock to be between 0 at the river and 3m below ground level on the right bank. The rock is assumed to be granulite and gneiss with quartz outcrops; these rocks are visible at the bend of the river, selected as the site for the new weir.

Some consideration was given to increasing the height to 5 or 6m, to provide some storage capacity but this would mean inundating the area unnecessarily; some 12,000 – 15,000 m³ could be stored, but this would only be enough for a day or two at the most. Eventually it was decided to make the height 1.5m above river bed level and increase the width from the current 8m to 15m.

The Hydrology report recommended considering the 1:50 year return flood of 265 m³/s for the weir design. Whilst this can be done, there would be some 4m depth of water over the 15m wide weir (or 2.5m if the weir were increased to 30m width). But the problem is, there is a road bridge 150m downstream, measuring 6m wide by 5m high, and the maximum discharge through this is 120 m³/s. The bottle-neck caused by this bridge will result in whole area upstream for 200 or 300 m being flooded once that flood flow is exceeded, resulting in the weir being submerged under more than 4m of water. Due to this constraint, designing of the weir for the recommended 1:50 year return period flood is not feasible.

The 1:5-year flood is estimated at 94 m³/s, and the weir has been designed for a nominal 100 m³/s flood. Any bigger flood will flow over and around the weir but will be relatively slow moving, so erosion will be minimal, in fact there is likely to be heavy silt deposition.

It is proposed to upgrade the existing structure and increase its capacity to 15,000 m³/day, equivalent to 634 m³/h, this being the design raw water pumping rate for the proposed WTP and associated facilities for the project design horizon of 2035.

5 THE SAND TRAP

Sediment load in the Lunyangwa River, in common with most other rivers on the continent, is not considered abnormal, but will be high during the flood season, and can be expected to be around

1000 mg/l; during normal flows it should reduce to around 200 mg/l. Sogreah's Mzuzu and Mzimba Feasibility Study Report V5 part 1, chapter 4.6 discusses sedimentation and, whilst no measurements have been made at the site, their research on similar rivers elsewhere in Africa lead them to conclude some 100 T/km² of catchment/year would be washed into the river (assuming 50% of the catchment is forested and 50% cultivated/bush).

The catchment at Ekwendeni is 537 km² so silt load is: $537 \times 100 \times 10^6 \text{ gm} / 365 \times 24 \times 3600 = 1700 \text{ g/s}$, carried by the River. This translates into $1700 \times 10^3 / 3.48 \times 10^3 = 490 \text{ mg/l}$, based on the average daily flow of 3.48 m³/s. Assuming 50% is carried as bedload, and deposited before reaching Ekwendeni, it means some 245 mg/l is carried by the river itself.

Sediment is a generic term, and includes all sizes transported by a river, either in suspension or as bedload. In terms of size, anything less than 0.2 mm is difficult to remove by settling out in flowthrough chambers; coarse to fine sand sizes range from 2mm down to 0.06mm, so at least the medium sand can be effectively removed, while anything smaller requires settling beds.

If 15,000 m³/day is being abstracted, the sediment to be removed will be: 15,000 x say 70% of 245 g/m³ = 260 kg daily, with a volume of about $0.26 / 1.3 = 0.2 \text{ m}^3/\text{day}$.

The available length of sand trap for Ekwendeni is approximately 12m and can be designed such that it will remove particles down to 0.15mm. The pump taking the water to the water treatment works will be low pressure, so, with such a large proportion of the fine sand removed, the pump will have a much-extended life.

6 ASPECTS OF CONSTRUCTION

Excavation of the weir will amount to some 200 – 300 m³ of soft material, and 50 m³ of weathered rock. This material can be used as backfill to level the area on the right bank of the weir, up to el 1166. Some 100 m³ of rip rap will be needed downstream of the weir, so if any blasting is required or boulders found, these can be used accordingly. Weathered rock (class IV) should suffice for founding the weir and stilling basin, but the upstream cut-off wall should extend down to fresh rock, or anyway at least 2.5m. The sand trap should be founded on firm material, or weathered rock; it can be made even deeper if bedrock is lower than design, if the bedrock is lower than what the investigation shows when excavating.

The sand trap should be constructed first, complete with the integral right training wall, and it will then work as a diversion channel during construction of the weir and stilling basin.

Capacity will be >9.5 m³/s assuming a width of 1.5m, depth of 1.9m.

7 DESIGN

Ekwendeni – weir, intake and sand trap

7.1 Weir

River bed at the deepest point at the location selected is at El 1162.50

Crest level is proposed at El 1164 masl, height of weir is then 1.5 m above river bed level.

Depth of water H over the crest is derived from the basic weir discharge equation:

$$Q = C_v L H^{3/2}; \text{ rearranging gives } H = [Q/(C_v L)]^{2/3}.$$

Working on the basis of a 1:5-year return period flood, $Q = 94 \text{ m}^3/\text{s}$;

Assuming a crest length $L = 15 \text{ m}$, C_v is a loss coefficient = 0.385; this $\times \sqrt{(2g)} = 1.7$ for a broad crested weir, then $H = 2.4\text{m}$

If an ogee section is used, where the profile mirrors that of a jet of water:
 $Q = \frac{2}{3} C_v \sqrt{(2g)} L H^{3/2}$; where C_v varies according to whether the discharge head H_d is greater, equal or less than the design head (used to design the shape of the ogee);
 assuming the max discharge = the designed one,
 C_v is 2.2; then for the $94 \text{ m}^3/\text{s}$ flood, $H = 2.0 \text{ m}$, for a 15m wide spillway.

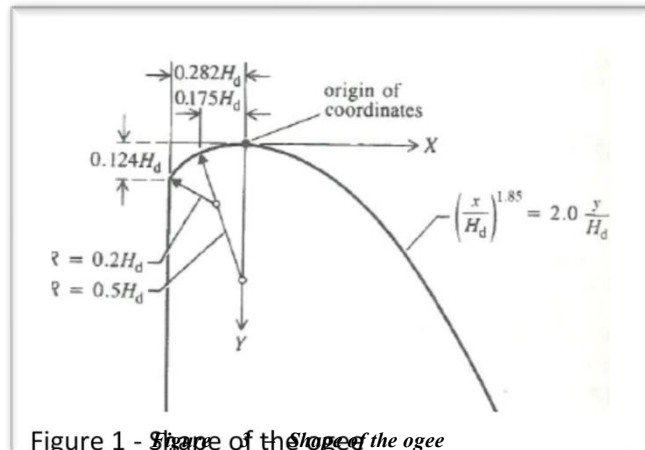


Figure 1 - Shape of the slope of the ogee

The shape of the ogee is derived using recommendations of US Bureau of Engineers, in 'Design of Small Dams'

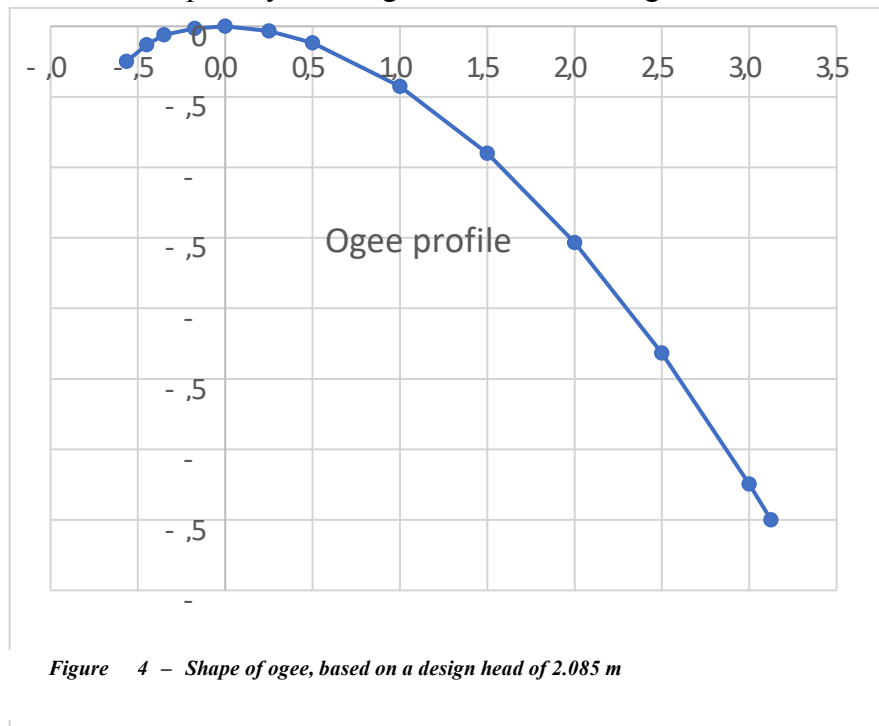
Various lengths of weir were investigated, assuming a $94 \text{ m}^3/\text{s}$ discharge, and their related depths of discharge; decreasing the weir length saves cost of excavation and concrete, at the expense of higher training walls and a longer stilling basin.

Results are summarised below, and in more detail in Appendix I.

Crest In	$Q = \frac{2}{3} * (2 * 9.81)^{0.5} * C_d * L * h^{3/2}$			C_v	$C = C_v C_d$	$H_d = H_{max}$
Lw m	$Q \text{ m}^3/\text{s}$	$q \text{ m}^3/\text{s}/\text{m}$	C_d	$\frac{2}{3} * (2 * 9.81)^{0.5}$		$H_d \text{ m}$
30	94	3.15	0.745	2.95	2.20	1.27
30	100	3.34	1.745	2.95	5.15	1.32
25	94	3.76	2.745	2.95	8.11	1.43
25	101	4.04	3.745	2.95	11.06	1.5

15	94	6.27	4.745	2.95	14.01	2.01
15	100	6.69	5.745	2.95	16.96	2.1
15	150	10.03	5.745	2.95	16.96	2.75
15	201	13.43	5.745	2.95	16.96	3.34

Table 1 – Spillway discharges and different lengths of crest



Freeboard is normally taken as 0.50m, added to the level of the approaching water - slightly higher than the depth of water at the crest, by 0.035m - associated with a calculated 1m/s approach

velocity, and a 50m wide river when carrying a 100 m³/s flood.

7.2 Stilling Basin

A stilling basin is necessary to remove some of the energy when faced with a large flood at the weir, particularly with respect to the road bridge some 100m downstream.

Design process uses the hydraulic energy equation: $v = q / y_1 = (2g (E_0 - y_1))^{1/2}$; trial and error gives the depth of water at the toe of the weir, y_1 ; the sequent depth y_2 is then given by $y_2 / y_1 = 0.5 (1 + F_{r1}^2)^{1/2} - 1$, where F_{r1} is the Froude number. An excel spreadsheet is used to enumerate the various discharges, see Appendix II, summary of results is shown overleaf

An end sill will be provided to improve efficiency and reduce scour downstream; rip rap protection of the channel downstream is recommended for 15m to resist tendency to scour during large floods.

Discharge Q m ³ /s	Ht of weir	Length of crest m	Specific discharge q m ³ /s/m	Length of stilling basin L m	Length of d/s apron
100.0	2.5	30.0	3.3	7.91	6.95
100.0	2.5	25.0	4.0	8.67	8.13
100.0	2.5	20.0	5.0	9.05	9.85
100.0	2.5	15.0	6.7	10.01	12.64
100.0	1.5	15.0	6.7	7.72	11.49

Table 2 – Weir dimensions depending on height of crest -

7.3 Weir dimensions

Crest length is 15m, width of stilling basin, the same.

Left bank training wall is 5m high, (2.5m above weir crest)

Right bank training wall is 3m high

Upstream apron length is $>2 H_{max}$, ie say 5m;

Radius of curvature of left approach wall is similarly deduced at 5m.

Ogee length is 4.15 m,

Stilling basin 7.72 m; downstream scour protection 11.5 m.

7.4 Sand trap

A sand trap is proposed adjacent to the weir structure; approximately 12 m is available, obviously the longer it is the smaller the grain size that can be allowed to settle out, which not only reduces pump wear, but reduces cost of later removal (during the treatment process).

A grain-size of 0.2 mm is normally adopted for hydropower plants. If the length is not excessive, a smaller grain size could be accommodated.

The flow velocity v_d in the sand trap should not exceed a certain value given by:

$$v_d = a \sqrt{d} \text{ m/s, where } d = \text{particle diameter, and } a \text{ is a coefficient as a function of } d$$

$$a = 0.36 \text{ for } d > 1 \text{ mm} \quad a = 0.44 \text{ where } 0.1 \text{ mm}$$

$$< d < 1 \text{ mm} \quad a = 0.51 \text{ for } d < 0.1 \text{ mm}$$

$$\text{With } d = 0.2 \text{ mm: } v_d = 0.44 \times 0.2^{0.5} = 0.197 \text{ m/s}$$

In practice, with a limited grain size of 0.2 mm, a flow velocity of 0.200 m/s has proved to be suitable.

$$\text{At Ekwendeni, } Q = 634 \text{ m}^3/\text{h, ie } /3,600 = 0.176 \text{ m}^3/\text{s};$$

In a chamber 1m by 1m, v_d through the sand trap is 0.176 m/s, (ok, < 0.2 m/s)

Length of sand trap is given by $L = v_d \cdot h / (v_s - 0.04 \cdot v_d)$ m where $L =$
 effective settling length (m) $h =$ settling depth, say 1.10 m $v_d =$ flow
 velocity, 0.20 m/s $v_s =$ sinking velocity of the limited grain size in m/s according to
 the chart, dependent on $S = g_s / g_w$, where:

g_s and g_w are the specific weights of the particles and water respectively Sinking velocity of spherical particles in still water is shown in fig 2 at 10°C.

At other water temperatures, the values in the range of Stokes' law are multiplied by the ratio of the kinematic viscosities of water, ie $v_t / (v_{10} = 1.3037 \cdot 10^{-2})$. Where v_t is the value at temperature t , assumed here as 15°C

$$\text{For } d = 0.20 \text{ mm, } S = 2.7, v_s = 0.028 \text{ at } 10^\circ\text{C from the chart; at } 15^\circ\text{C, } v_s = 0.028 \times 1.1369 / 1.3037 = 0.024 \text{ m/s}$$

$$\text{Thus } L = 0.176 \times 1.10 / (0.024 - 0.04 \times 0.176) = 11.42 \text{ m}$$

$$\text{If the width is increased to } 1.5 \text{ m, } v_d = 0.176 / 1.5 = 0.12 \text{ m/s}$$

$$\text{And required } L = 0.12 \times 1.1 / (0.024 - 0.04 \times 0.12) = 6.25 \text{ m}$$

At this width, there is clearly room to make the sand trap longer, so particles of say 0.15mm could settle:

$$\text{For } d = 0.15 \text{ mm, } a = \text{say } 0.45 \text{ then limiting velocity } v_d = 0.45 \times 0.15^{0.5} = 0.174 \text{ m/s}$$

$$\text{At Ekwendeni, } Q = 0.176 \text{ m}^3/\text{s}; \text{ breadth then must be } > 0.176 / 0.174 = 1.01; \text{ keep it at } 1.5\text{m}$$

Taking $S = 2.7$ sand, $d = 0.15$ mm, $v_s = 2$ cm/s, ie 0.02 m/s; at 15°C , $v_s = 0.02 \times 1.1369 / 1.3037 = 0.017$ m/s

With the width at 1.5 m; $v_d = 0.176 / 1.5 = 0.117$ m/s

And required $L = 0.117 \times 1.10 / (0.017 - 0.04 \times 0.117) = 10.5$ m

In fact, there is space to make it up to 12 m long, by 1.5m wide, 1.1m deep, which will effectively settle out particles < 0.15 mm.

7.4.1 Head losses through the sand trap

At intake: The intake orifice will be situated in the right-wing wall in the approach apron just upstream of the weir. Entry will be oblique, the upstream edge taking the form of a bell mouth; losses occur due to change in direction of flow, the contraction, and type of trash rack; Due to change in direction: h_{a1} is: $V^2 / 2g - \epsilon V_0^2 / 2g$; where V is velocity through intake, = 0.176

$/(1 \text{ wide} \times 0.5 \text{ deep}) = 0.352$ and V_0 is main stream velocity 0.5 m/s; ϵ is 0.8 for 30° and 0.4

for 90° angle of deviation; with a sill and curved abutments, $h_c = 0.3 V^2 / 2g$; adding: $h_{a1+2} =$

$1.3 (0.352 - 0.8 \times 0.5) \times 10^3 = 58$ mm.

At trash screen: $h_s = \beta (s/b)^{4/3} \sin \delta / V^2 / 2g$; (Kirschmer's formula); β is a coefficient depending on type of rack bar = 1.79 for round bar, s the diameter, say 25 mm, b the spacing, say 50 mm, and δ is the angle of inclination, suggest 60° , (so that when flow stops, any trash floats to the top – theory; at any rate it is easier to clean). Thus:

$h_s = 1.79 \times 25 / 50 \times 4 / 3 \sin 60 0.352^2 / 2g \times 10^3 = 6$ mm

Along the sand trap chamber; given by Manning: $V = 1/n R^{2/3} S_0^{1/2}$

$S_0 = h_f / L$, where h_f is head loss, and L total length of sand trap and entry connecting canal; Manning's n for the sand trap with concrete side walls and sand bottom is 0.0175; $V = 0.176 / (1.5 \times 1) = 0.117$ m/s. Hydraulic radius is area A / Perimeter $P = 1.5 \times 1 / (1+1.5+1) = 0.429$
Rearranging: $S_0 = (v n / R^{2/3})^2$; substituting: $(0.176 \times 0.0175 / 0.429^{2/3})^2 = 2.94 \times 10^{-5}$; thus $h_f = 2.94 \times 10^{-5} \times 15 \times 10^3 = 0.44$ mm

At the outlet; $h_o = 0.5 V^2 / 2g = 0.5 \times 0.352^2 / 2g = 3.16$ mm

Total $58 + 6 + 0.44 + 3.16 = 68$ mm

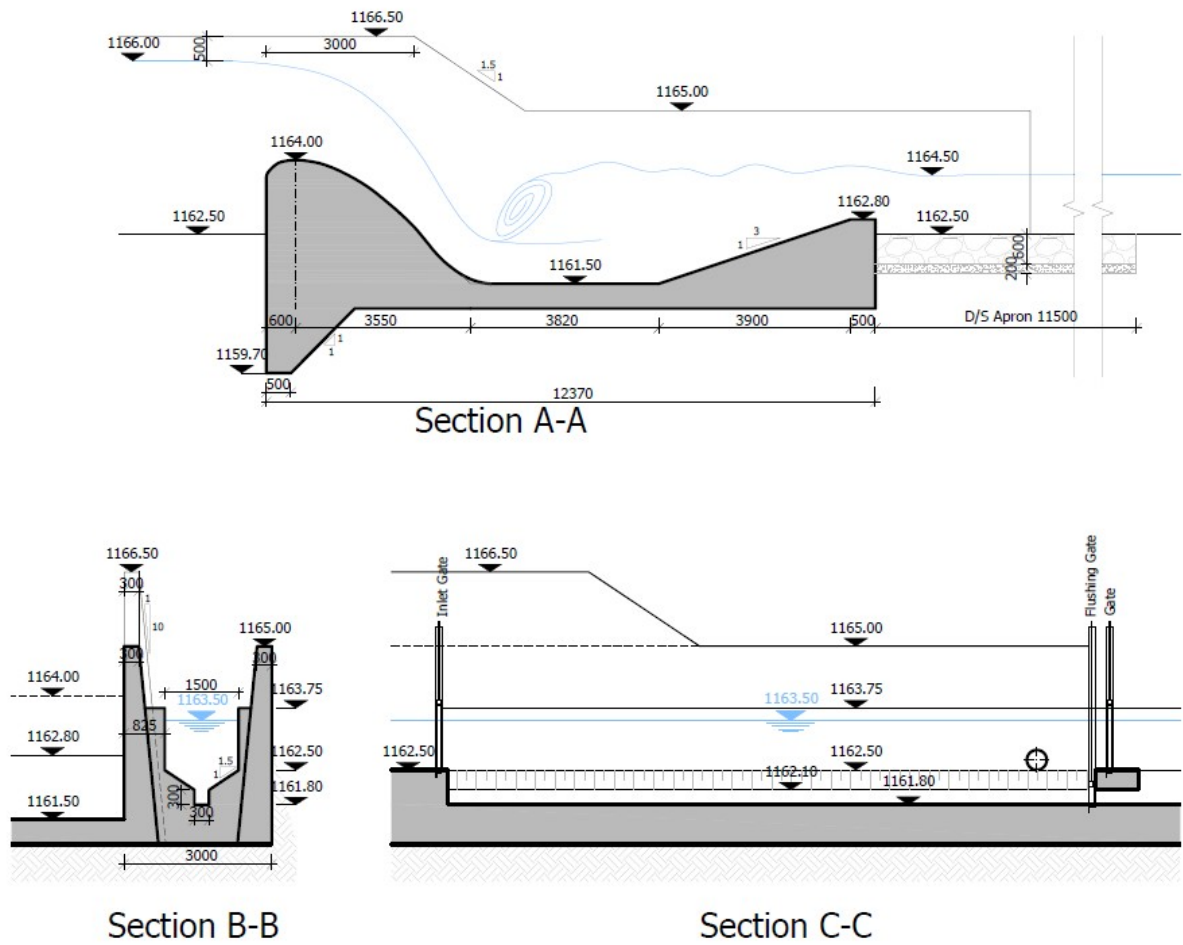


Figure 5 – Typical cross sections

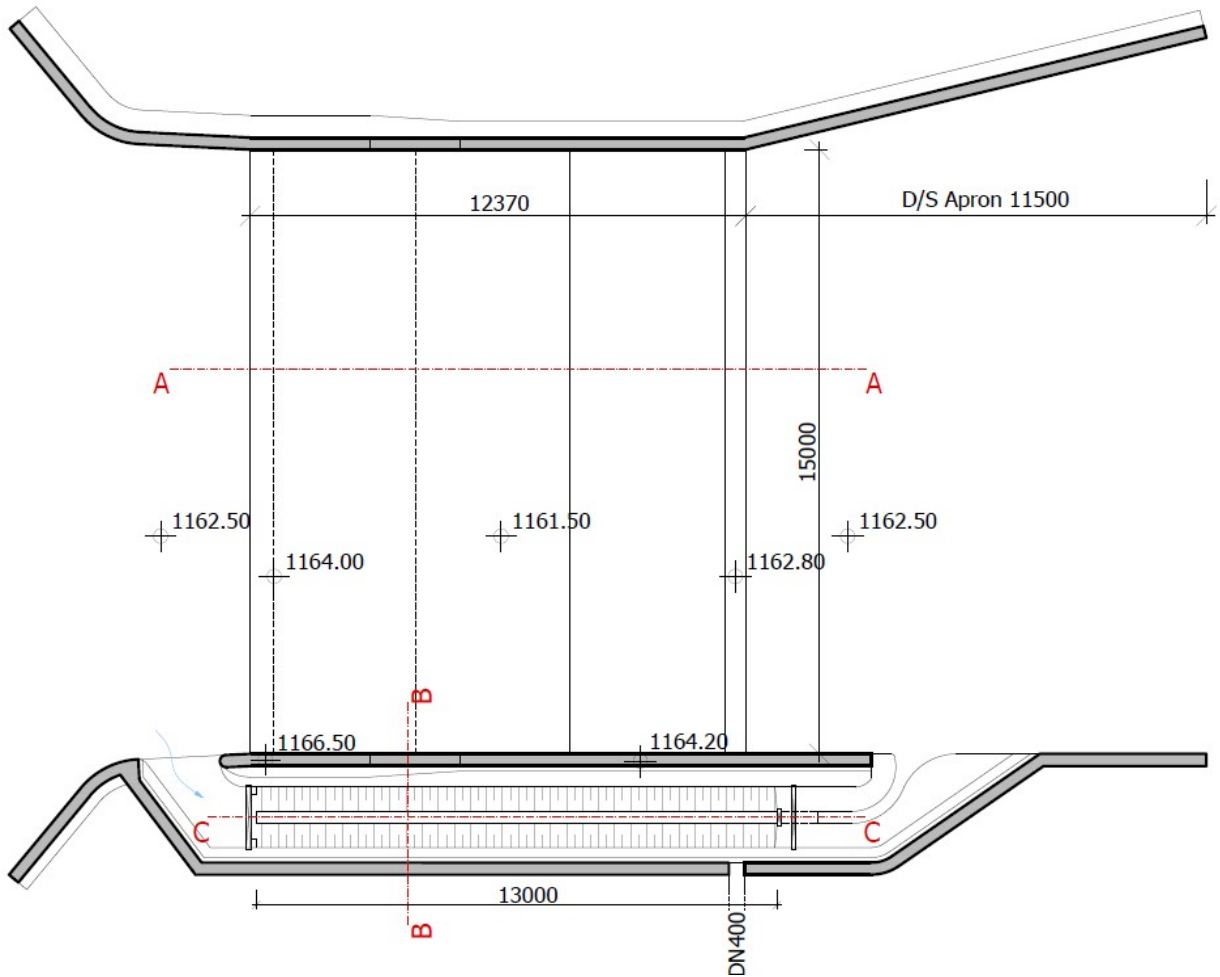


Figure 6 – Plan of weir, stilling basin and sand trap

8 APPENDICES

Weir	Broad crested		$Q = C_v C_d L h^{3/2}$				
	h	L	Q m ³ /s	q m ³ /s/m		Cd	C
	1.5	30	94	3.12	0.385	4.43	1.70
	2	19.5	94	4.81			
	2.5	14	94	6.72			
Weir	Ogee	$Q = 2/3 * (2 * 9.81)^{0.5} * C_d * L h^{3/2}$			Hd = Hmax	Cv	C = CvCd
	Hd m	Lw m	Qm ³ /s	q m ³ /s/m	Cd	$2/3 * (2 * 9.81)^{0.5}$	
	1.27	30	94	3.15	0.745	2.95	2.20
	1.5	30	121	4.04	0.745	2.95	2.20
	1.5	23.2	94	4.04	0.745	2.95	2.20
	1.5	25	101	4.04	0.745	2.95	2.20
	2	15	93	6.22	0.745	2.95	2.20
	2.1	15	100	6.69	0.745	2.95	2.20
	2.5	15	130	8.70	0.745	2.95	2.20
	3	30	343	11.43	0.745	2.95	2.20
					Hmax < Hd		
	1.5	15	49	3.25	0.6	2.95	1.77
	2	15	75	5.01	0.6	2.95	1.77
	2.5	15	105	7.00	0.6	2.95	1.77
					Hmax > Hd		
	1.5	15	66	4.39	0.81	2.95	2.39
	2	15	101	6.77	0.81	2.95	2.39

	2.5	15	142	9.45	0.81	2.95	0.00
		Ref: Hydraulic structures	by Novak et al				

Table 3 – Spillway discharges using various depths of water over weir H, crest lengths L, and discharges Q

L_{crest}		25.0		30.0		20.0		15.0		15.0	
Q	m ³ /s	100.0		100.0		100.0		100.0		100.0	
q	m ³ /s/m	4.0		3.3		5.0		6.7		6.7	
C_d		0.75		0.75		0.75		0.75		0.75	
H	$= (q / (2C_d (2g)^{0.5}))^{2/3}$	1.483		1.313		1.721		2.085		2.085	
S		2.500		2.500		2.500		2.500		1.500	
S_0 bed slope		0.003		0.003		0.003		0.003		0.003	
Psi ϕ velocity coeff	$\phi = 1 - 0.0155 * S/H$	0.974		0.970		0.977		0.981		0.989	
n	Mannings roughness coeff for the river	0.028		0.028		0.028		0.028		0.028	
n =	d is roughness										
	$0.04 * d^{(1/6)}$										
	$d = (n/0.04)^6$	0.118	m	0.118	m	0.118	m	0.118	m	0.118	m
Using Manning:											
	$q = y_0^{(5/3)} S_0^{0.5} / n$, to get y_0 :	1.488		1.334		1.701		2.022		2.022	
RS/(d(2.65-1))	if <0.05 (Shields) river bed is stable	0.008		0.007		0.009		0.010		0.010	
Energy head =	$E = S + H$	3.983		3.813		4.221		4.585		3.585	
Also =	$E = q^2 / 2g \phi^2 y_1^2$	3.983	0.00	3.814	0.00	4.221	0.00	4.585	0.00	3.586	0.00

	y_1 by trial & error =	0.579		0.488		0.713		0.931		1.138	
Calculate Froude Nr	$F_{r1}^2 = \frac{q^2}{gy_1^3}$	8.4		9.7		7.0		5.6		3.1	
	$y_2 = \frac{y_1}{2}(-1 + (1 + 8 \cdot \frac{q^2}{gy_1^3})^{0.5})$	2.102		1.924		2.341		2.688		2.310	
	$y_2 \gg y_0$, so a SB is required	0.614		0.590		0.640		0.666		0.288	
σ , Coriolis coeff	should be:	1.1 - 1.25	(σ is normally determined in the lab)								
Assume $\sigma = 1.2$,	$y' = \sigma y_2 - y_0$	1.034		0.975		1.108		1.204		0.750	
Assume $y' =$		1.100		1.000		1.150		1.200		1.200	
Repeat E	$E = S + H$	5.083		4.813		5.371		5.785		4.785	
	$E = \frac{q^2}{2g} \frac{\varphi^2}{y_1^2}$	5.083		4.814		5.371		5.785		4.785	
	y_1 by trial & error =	0.435	0.00	0.372	0.00	0.531	0.00	0.685	0.00	0.766	0.00
	$\varphi = 1 - 0.0155 \cdot \frac{S}{H}$	0.962		0.959		0.967		0.972		0.980	
recalc Froude:	$F_{r1}^2 = \frac{q^2}{gy_1^3}$	19.8		21.9		17.1		14.1		10.1	
	$y_2 =$	2.529		2.287		2.846		3.310		3.077	
Coriolis coef.	$\sigma = \frac{y' + y_0}{y_2}$	1.024	ok	1.021		1.002		0.974		1.047	
New y'	$y' = \sigma' y_2 - y_0$	1.100		1.000		1.150		1.200		1.200	
Length of SB:	$L = K (y_2 - y_1)$	8.67		7.91		9.05		10.01		7.72	
$4.5 < K < 5.5$	$F_{r1} =$	4.4		4.7		4.1		3.8		3.2	
$> 10 \quad F_{r1} < 3$											
y_0 depends on an assumed value of Manning's n for the river d/s											
If being conservative, ie, n low, and φ high, a lower value of σ say 1.11 is sufficient											
If degradation of river, can make y_0 lower											

Scour depth y_s , (based on research by Jaeger/Novak)									
= $0.55 \cdot (6H_a)^{0.25} q^{0.5} (y_0/d90)^{0.333} - y_0$		1.35		1.16		1.64		2.11	1.91
Length requiring scour protection	$D = 6 \times y_s$	8.13		6.95		9.85		12.64	11.49

Table 4 – Calculation of stilling basin parameters

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