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Executive Summary

Southern Region Water Board supplies water to Chikwawa District Centre as one of the 25 water supply centres in the Southern Region of Malawi. Following the mandate given by the Government of Malawi in the Waterworks Act Cap..72.01 of 1995, the Board strives to provide the Best service to the people of Malawi including those of Chikwawa District Centre.

Water Supply at Chikwawa has the challenge of Salinity as the water is sourced from groundwater. The Board has problem treating saline water as such it has always been the intention of the Board to turn to surface water sources as a remedy for the challenge. However the Board took so long to develop a surface water supply plant in Chikwawa because of high investment costs.

The Board liaised with the Shire Valley Transformation Project who showed interest to assist the Board to construct a conventional surface water treatment plant at Chikwawa. The project shall abstract water from a Canal at Mthumba Community Day Secondary School and treat the water through a conventional water treatment plant to be constructed under the Shire Valley Transformation Project. This facility shall replace the groundwater source to supply Chikwawa District Centre and the surrounding areas with fresh water from Shire River.

The Project components shall include among other things the following:

- The water source from the Canal
- A Water Treatment plant
- Two staff houses
- A service Reservoir
- An upgrade and extension to the water Distribution Network.

The estimated cost of the project is in the sum of **US$ 2,026,677**

The project after implementation shall provide fresh water to the people of Chikwawa and shall contribute towards the country meeting the sustainable development goal for water supply to all by 2038.

SOUTHERN REGION WATER BOARD

SURFACE WATER SUPPLY TO CHIKWAWA DISTRICT CENTRE

DETAILED DESIGN REPORT

1.0 Background

Southern Region Water Board was mandated to supply water to the southern Region of Malawi by the enactment of the Waterworks Act Cap..72.01 of 1995. The Board took over the assets of the then District Water Supply Fund which was supplying water to the District Centres of Malawi.

The Board now supplies water to 25 centres within the Southern Region of Malawi. The Board has demarcated its supply area into five administrative and operational zones as Zomba Zone, Mangochi Zone, Liwonde Zone, Mulanje Zone and Ngabu Zone.

The aim for setting out the Southern Region Water Board was to improve the viability and sustainability of the water business by empowering the Board to operate with full financial recovery from the business with a reasonable business profitability. The Government of Malawi financed the implementation of the National Water Development Project phases I and II to improve the productivity and coverage of the existing schemes.

The goal of the Government of Malawi is to improve access to water for all by the year 2030 which is among the Sustainable Development Goals set by the United National Organization to ensure that all people globally have access to clean and potable water for healthy livelihoods.

Chikwawa Boma is one of the centres being supplied by the Board in Ngabu Zone in the Lower Shire. The scheme has a groundwater based water supply facility which sources its water through boreholes. The scheme has suppressed demand as the water supplied is inadequate and saline.

1.1 Location

Chikwawa District Centre is located at 16° 01’ 24”S and 34° 47’ 30”E on the globe. It is on the Banks of the Shire River, South of Blantyre along the M1 Road to Nsanje Boarder with Mozambique. It shares Boarders with Mozambique on the western side.

1.2 Climate

Chikwawa has a hot climate with temperatures getting higher than 40^{O} C in the dry season as it lies along the Lower Shire Valley with height above sea level of around 130m on the high areas and 107m on the South end of the water supply area.

The Vegetation in the area is characterized by tall grass and scattered short trees and shrubs. The area receives relatively low rainfall compared to the areas in the Shire Highlands.

1.3 Topography and Land Use

Chikwawa District is at the foot of the Shire Highlands Mountain range along the Banks of Shire River. The area slopes gently along the Shire River. The drainage in the area is a problem as water moves with very low speeds causing the area to be prone to flooding.

The soils are deep clay soils that favour the growth of sugarcane, cotton and most other crops that do well in black clay soils. The only challenge is erratic rainfall that is characteristic to the area.

The area is good for irrigation and has cane plantations for the sugar manufacturing industry that cover vast areas of the District. The area is now subjected to small scale subsistence farming that is done at household level. Most of the farming communities depend of the fertility of the floodplains of the Shire River. The main food crops are maize, millet, sweet potatoes and water melons. For cash crops the subsistence farmers grow cotton and small holder sugarcane which they sell to the Sugar Estates for sugar manufacturing.

1.4 Hydrology and Water Reasorces

The hydrology of Chikwawa is that the area receives low rainfall. The River pattern is that most rivers have subsurface flows during the dry season. The rivers that flow from the hills have water in the hill but have no flows as they get close to the Shire River.

There are more incidences of floods in the area during downpours as the water flows at low speeds to the Shire River. The Rivers swell up and flood the banks causing devastations to the communities in the land.

1.5 Land Use

Chikwawa Boma and the surrounding areas have land that is mostly used for subsistence farming. The most common crops are maize, millet and sorghum. The area has a large part of its land set for cattle ranching. Cattle rearing is common at subsistence level as well as at large business scale.

There is large scale agricultural activities such as sugarcane farming by Kasinthula Irrigation Scheme and Illovo Sugar Company. The cane is sold by the small holder farmers to Illovo Sugar while the Prescane Ethanol plant benefits from the sugar molasses discharged from the sugar factory to manufacture ethanol.

1.6 Project Justification

Southern Region Water Board took over the supply of water to Chikwawa Boma from the District Water Supply Fund in 1996. The Board operated with a number of challenges including salinity, low well production of water and electricity outages.

1.6.1 Technical Justification

As the mandate of Southern Region Water Board is to supply potable water of the highest quality to the Southern Region of Malawi, the Board seeks to supply salinity free water to the people of Chikwawa Boma. Therefore to the Board, the use of surface water for supply in Chikwawa is a better option for sorting out the salinity problem in Chikwawa.

1.6.2 Economic Justification

The Board took a long time before implementing a project of this magnitude due to lack of financial resources. The coming of the Shire Valley Transformation Project has been considered as a great opportunity to enable the Board to come up with a solution to the many challenges experienced at Chikwawa. The improvement of the water supply, in Chikwawa shall improve health and occurrence of the diseases to the people of Chikwawa which will result in less money being spent for hospital treatment. Many people shall reduce walking distances that do people go to fetch water.

The area of supply has an ethanol production facility and a Brewery. These two companies have changed the demographic patterns in the area. More people are seeking employment in Chikwawa. The population increase and the low coverage of the existing water supply infrastructure have resulted in a high demand for water and sanitation in Chikwawa.

1.6.3 Health benefits

Chikwawa faces a lot of drainage problems due to the flatness of the land. The rainy water floods the land and ponds in the residential areas developing into breeding areas for mosquitoes. The most common diseases in Chikwawa are malaria, diarrhoea and dysentery. The area is a high risk area for Cholera and Bilharzia.

The improvement of the water supply scheme shall among other things provide protection from the above diseases.

2.0 Existing Water Supply

The existing water supply to Chikwawa District Centre is managed by Southern Region Water Board. The water supply scheme is inadequate to supply the whole demand area to meet the current demand for water. The water supply system has the following components.

2.1 The Water Source

Water supply to Chikwawa District Centre is sourced from groundwater through boreholes. The scheme has three operational boreholes and another one which has been drilled and is awaiting installation of pumping equipment. The existing total production capacity of the boreholes is 20 litres per second. The water is pumped through a pressure pipeline to an elevated pressed steel tank at the local office.

The communities at Chikwawa Boma however do not source their water totally from the Board's facilities but have some traditional sources that include boreholes, natural ponds, unprotected shallow wells and the Shire River.

2.2 Water Treatment

The Water Treatment plant at Chikwawa Boma has a treatment capacity which is dependent on the capacity of the Boreholes. At present the production is at 20 litres per second which translates to 1,728 cubic metres per day. The water after being pumped to the tank is then dosed with chlorine to disinfect it. The groundwater has very low turbidity levels, that does not need sedimentation or any form of filtration. Chlorine dosing is carried out to ensure that there is no harm of contamination due to microorganisms.

The water has a high quantity of mineral salts which makes it not good enough for consumption as a result of the salinity. The salinity of the water is very difficult to treat and the Board supplies the water without removal of the salinity in the treatment process. Southern Region Water Board is in the process of finding a solution to the problem of suppling saline water to the people of Chikwawa.

The people of Chikwawa revert to other alternative water sources as a result of our water salinity problem. This is risky as the other sources are prone to contamination.

2.3 Existing Storage

The water supply network for Chikwawa has one elevated pressed steel tank tank of capacity 250 cubic metres. The tank restricts the supply of water to limited areas that are lower than its height.

There is need for a new tank if the distribution network is to extend to cover new areas of water demand.

2.4 The Distribution Pipeline Network

The Water Supply pipe distribution network at Chikwawa Boma has a total covered distance of about 40 Km. The pipelines are not adequately covering all the areas of demand for water. There is need to extend the pipe network to areas where demand is in accordance with the development of the residential areas which are developing haphazardly without any structured plan.

The pipe sizing has not been adequate as most pipelines were extended long distances without considering their flow capacities. There is need to upgrade the main distribution pipelines in order to allow extension of the network for water to reach demand areas that have developed on the peripheral areas of the existing pipe network.

2.5 Water Metering and Water Tariffing

The Board supplies its water to its customers through water meters that are installed at the customers' premises. The meters are tools for measuring consumption and the basis for tariffing.

Each customer has a water meters and the customers are expected to pay monthly according to the type of property category.

The Board has adopted a step tariff that attempts to vary the rate according to peoples' economic capacities. Those customers who live in Low Density housing categories pay more than those who reside in high density housing areas.

3.0 The Rationale for the Project

Southern Region Water Board has been attempting to put in place solutions to the challenges of water salinity, inadequacy of the groundwater sources, the capacity of the storage tank and water distribution network for the people of Chikwawa Boma. Water desalination is a very expensive technology which the Board cannot afford at the present finance levels. The development of a desalination plant in chikwawa would not make business sense at the ruling performance levels in terms of returns from the system.

The use of surface water was the best solution for the supply of fresh and potable water to the people of Chikwawa. However, the Board could not raise funds for the construction of a Conventional Water Treatment Plant to handle the water quality from the water from the Shire River.

The Shire Valley Transformation Project committed to provide resources for the construction of a Conventional Water Treatment plant which will be sourcing water from one of the canals for the Shire Valley Transformation Project. The Shire Valley Transformation Project advised the Southern Region Water Board to design a water Supply Project for Chikwawa Boma with its water source from the Irrigation Canals.

4.0 Design Criteria

4.1 Design Criteria Development

The design criteria used in the preparation of the Engineering design has been followed in the detailed design for the proposed surface water supply project to Chikwawa Boma. The objective for developing the design criteria is to ensure that the design has followed best practice.

In this report, the major components of the design have been presented for quick reference. The design criteria summarized, has been used as a guide and comparison of water supply components to be designed.

4.2 Design Horizon

The project planning has been taken to be 20 years from 2018 to 2038, assuming that implementation will be done in 2018. The design of the components of the project has considered the 20 year design period. All designs have been based on the year 2038 requirements.

4.3 Population Demographics

According to 2008 NSO Population and Housing Census the population for Chikwawa Boma is 17,177 people. The inter-censal growth rate is 3%. The population projection in the design has been done by applying the following formula below.

$P_n = P(1+r)^n$

Pn = Future Population

P = Base population

n = nth year (number of years)

r = Population growth rate (%)

The population forecasts have been made based on the 2008 housing and population census data and enumeration areas, and maps released by the NSO. In the absence of development structure plans, the actual situation on the ground is analyzed and best conclusions are drawn and used in the design.

4.4 Water Demand

The Design Criteria considered different water demand categories that will be explained in the sections that follow.

Water demand estimates for Chikwawa have been based on domestic and public demand. The determination of water demand for Chikwawa takes into account the percentage of the population that is projected to be served by 2038. The parameters shown in table 4.1 below for calculating water usage have been adopted basing on current water demands used by Southern Region Water Board.

Table4.1: Water Demand Per Capita Consumptions

WATER DEMAND CATEGORY	CONSUMPTION (l/c/d)
Low Density Housing Area (LDHA)	100
Medium Density Housing Area (MDHA)	75
High Density Permanent Housing Area (HDPHA)	50
High Density Traditional Housing Area (HDTHA)	36
Public Demand (Institutional, Commercial, Administrational and Industrial)	20% of domestic demand

4.5 Domestic Water Demand

Domestic water demand by mode of service is categorised according to the level of service to be provided and the amount of per capita water required to satisfy the demand serviced by that level of service as per the categorisation. The per capita water demand for various demand categories have been adopted, taking into account different development factors and standards used by the Ministry of Agriculture, Irrigation and Water Development and Southern Region Water Board.

The percentage of population to be served by each demand category during the design period and the corresponding population figure for Chikwawa has also been adopted and has been used accordingly in the detailed design.

The total domestic water demand category used in the detailed design is based on the demand categories and percentage of population to be used and per capita demands adopted.

4.6 Public Water Demand

The water required for schools, hospitals, lodges, offices, commercial establishments, and industries is classified as public demand. Industrial water demand has been included in the public demand and this generally refers to industries that would consume significant amount of water for processing of their products. The light/service industries that are available in Chikwawa include ethanol production, motor vehicle repair works, carpentry workshops, maize mills, bakeries, tinsmiths, etc, and their demand is considered under the commercial demand.

The general situation related to the public demand is that, it is high at the initial stage of the service installation and gradually reduces as the settlement's socio-economy improves and the number of domestic connections increase. However it is also understood that the percentage of the public demand will be increasing in Chikwawa due to forecasted proliferation of commercial activity in the area. Therefore public demand has been taken to be at 20%.

4.7 Water Requirement for Fire Fighting

The project is proposing to provide hydrants at some critical places of public interest such as commercial areas, market places, industrial areas as appropriate depending on the pressure in the distribution system.

The amount of water required for fire fighting for one fire outbreak will be more than the amount of water distributed during the maximum day water demand for the period of fire. Therefore, the water required for fire fighting would be stored in distribution storage as a reserve for critical days when the reservoir is empty. For this purpose an additional 10% reserve capacity would be provided in the distribution reservoirs.

4.8 Unaccounted-for-Water (UFW)

Water losses (Unaccounted for Water-UFW) are normally calculated as a percentage of the sum of the domestic water demand and public demand.

The existing water production and consumption data indicates that water losses were over 15% during the year 2017. The apparent loss could be through system technical leakage, losses during network breaks, faulty bulk supply meters, under-registering consumer meters and probably illegal connections to the system. With proper system management it is possible to bring the level of losses to about 15% which is acceptable as normal operational loss. This being a new system, it has been proposed that water losses range from 10 percent in 2018 rising to 20% in 2038.

4.9 Water Demand Patterns

Each demand category can be considered not only from the perspective of its average demand but also with respect to the time table of when the water is used. Demand variations are commonly described by the peak factors. These are the ratios between the demand at particular moments and the average demand for the observed period (hourly, daily etc). The water demand patterns are described below.

4.9.1 Average Day Demand

The average day demand is obtained as the sum of the domestic demand, the public demand plus the losses.

4.9.2 Maximum Day Demand

The water consumption varies from day to day throughout the year. The ratio of the maximum day consumption to the mean annual day consumption is the maximum day factor.

Maximum day factor usually varies from place to place and ranges from 1.20 up to as high as 2.0 in certain cases depending on the size of the settlement. In most cases the smaller the settlement the higher the maximum day factor will be. For Chikwawa Water Supply Scheme, it was recommended to use a maximum day factor of 1.3 based of our experience from other similar schemes. The maximum day demand has been used to design proposed water treatment facilities.

4.9.3 Peak Hour Demand

The peak hour demand is greatly influenced by the size of the supply area, mode of service and social activity in the project area. The peak hour factor normally varies between 1.1 and 1.4 and sometimes may go beyond in special cases. It should be noted that in most cases the smaller the number of consumers, the higher the peak hour factor. For Chikwawa Water Supply Scheme the domestic consumer base will be quite low and accordingly a peak hour factor of 1.3 on the average day demand was adopted for this project.

4.10 Pipelines

The rising and gravity mains have been designed for the maximum day demand of the target year 2038.

4.10.1 Conveyance System

The rising and gravity mains have been designed for the maximum day demand of the target year 2038.

4.10.2 Distribution System

The distribution network has been designed for the peak hour demand of the year 2038. The minimum pipe size considered in the network design is of DN 63 mm internal diameter. Sizes under DN 63 mm were considered only for tertiary pipes which would be laid as required during implementation. The construction of the distribution network will be executed in two stages depending on the pace of proposed physical development at Chikwawa.

In general, the network will be designed as a looped system as much as possible so that it will be suitable and advantageous in operation.

4.10.3 Pressure in Pipelines

The minimum and maximum pressures in the distribution network have been designed not to be below 10 m and not above 70m manometric head. The static pressure in the distribution network shall not be more than 70 m manometric head.

Values of the Hazen-Williams Roughness Coefficient given in Table 7 will be used for hydraulic calculations of flows in pipes. The values given below are also considered to include the losses in fittings.

Table5.1: Pipe Roughness Coefficients

Type of pipe	uPVC	Steel	DCI/GI
New pipe	130	100	110
Existing pipes	110	60	100

4.11 Flow Velocities

The design of the distribution network shall be such that the minimum velocity of flow in pipelines during peak hour shall not be less than 0.3m/s and the maximum velocity not greater than 2 m/s.

Design velocity in the transmission and or gravity pipelines will have a minimum of 0.6 m/s and a maximum of 1.2 m/s for economic operation of the system. Suction velocity shall be 1.5 m/s and discharge velocity in the delivery pipe shall not be more than 2.8 m/s

4.12 Storage Capacity

Chikwawa Boma is fast growing town with urban activities needing water throughout the day. The current storage capacity needs to be increased to serve the people better. The design has provided for another elevated storage reservoir of capacity 500 cubic metres.

The storage volume of 10% will be reserved for fire fighting and incorporated in the total storage.

4.13 Communal Water Point

One Communal Water Point with adequate number of faucets discharging not less than 0.25 l/s will be provided for every 120 people depending on the local population density and physical situation. The maximum walking distance to a Communal Water Point shall not exceed 250 meters.

4.14 Location of Flushing Devices

Flushing devices shall be located at low points of the distribution network except where fire hydrants are to be placed at low points which will also serve as flushing device. Flushing devices shall also be installed at low points of the transmission or gravity lines.

4.15 Location of Fire Hydrants

Fire hydrants shall be located at selected places of public interest such as school, hospitals, shops, market areas, parks, etc. The location of fire hydrants will be related to availability of sufficient pressure in the distribution network at that particular point in order to fill a fire truck in a shortest period possible, during fire breakdown.

4.16 Flow Measurement

Flow measurement devices shall be provided at raw water inlet point to the treatment plant, all pumping stations, and outlet from treatment plant to clear water collection reservoir, inlet to and outlet from service reservoirs located in different supply areas, major connection to respective distinct water supply zones (Supply Zone Water Meters) and at all Communal Water Points.

4.17 Treatment Plant Capacity

The treatment plant has been designed for the maximum day demand; all chemical dosing units will be designed to have minimum two units with 100% standby capacity.

4.18 Pumping Stations

The capacity of the pumps has been designed for the maximum day demand. The main pumping stations will have a stand-by capacity as follows:-

a) Station with submersible pump will have a stand-by capacity of 100%
b) Station with two submersible pumps will have a stand-by capacity of 50%.
c) Station with three submersible pumps will have a stand-by capacity of 33%.
d) Station with four or more pumps, the stand-by capacity will be decided on the basis of the submersible pump types and amount of water pumped.

4.19 Water Losses

Loss factors have been added to the projected demand for Chikwawa Water Supply Scheme as follows:

- Within the pipe work of the reticulation system – 10 % of the water supplied from the reservoirs.
- Within the transmission main to the water treatment works – 5 % of flow in main.
- Within the water treatment works – 5 % of the flow through the works.

The following allowances have been made for volumetric losses as a result of water treatment process and water distribution process.

Table5.2: Water Losses Per Component

INFRASTRUCTURE COMPONENT	WATER LOSS (%)
Treatment Works	5 % of incoming raw water
Distribution losses	10 % of production water
Reservoir losses	5%

The above losses have been added to the projected water demand at the service reservoirs.

4.20 Design Peak Factors

The following peak factors were assumed:

F_s (seasonal peak factor) – 1.1

F_d (daily peak factor) – 1.2

F_h (hourly peak factor) – 1.3

5.0 The Proposed Project

The current situation of Water Supply at Chikwawa Boma is such that there is need to upgrade and extend the existing Water Supply infrastructure to meet the ever growing demand which is at present suppressed.

Southern Region Water Board proposes to construct a Water Supply facility that treats surface water at Chikwawa Boma. The proposed project shall have the capacity to supply water for the next 20 years from 2018 to 2038.

5.1 Water Supply Coverage

The water supply coverage shall be 100% in the areas supplied now and around 80% in the areas where the water supply project shall be extended to.

5.2 Population Projections

The population figures in Malawi as projected from the results of a population census which was done in the year 2008. The 2008 population figure for Chikwawa Boma was 17137 people. The projected population figure for the next twenty years in 2038 shall be 43,052 people.

SOUTHERN REGION WATER BOARD							
POPULATION PROJECTIONS							
YEAR	**2008**	**2018**	**2025**	**2030**	**2035**	**2036**	**2038**

GROWTH RATE	3	3	3	3	3	3	3
POPULATION	17737	23837	29316	33985	39399	40580	43052

The water supply at Chikwawa under the proposed project shall be targeted to supply 43,052 people in the project design life year of 2038.

5.3 Environmental and Social Impacts

The Environmental and social Impacts for the project have been considered in the studies that have been conducted in the main project the Shire Valley Transformation Project. Environmental audits shall be conducted and appropriate interventions shall be implemented along with the project to minimize the impacts.

5.4 Water Demand Criteria

The water demand design criteria has been adopted from the guidelines from the Ministry of Agriculture, Irrigation and Water Development as follows:

Low Density Areas	100 Litres per capita per day
Medium Density Areas	75 Litres per Capita per day
High Density Permanent Areas	50 Litres per capita per Day
High Density Traditional Areas	30 Litres per capita per Day

5.5 Water Population and Demand Projections

The Population and Demand projections are shown in the table below:

SOUTHERN REGION WATER BOARD								
WATER DEMAND PROJECTIONS FOR CHIKWAWA								
YEAR		**2008**	**2018**	**2025**	**2030**	**2035**	**2036**	**2038**
GROWTH RATE		3	3	3	3	3	3	3
POPULATION		17737	23837.04	29316.56	33985.93	39399	40580.97	43052
TRADITIONAL HOUSING AREAS								
POPULATION %	40%	7094.8	9534.818	11726.62	13594.37	15759.6	16232.39	17221
DEMAND PER CAPITA PER DAY	30L/c/d	212844	286044.5	351798.7	407831.1	472788	486971.7	516628
HIGH DENSITY PLANNED AREAS								
POPULATION %	30%	5321.1	7151.113	8794.968	10195.78	11819.7	12174.29	12916
DEMAND PER CAPITA PER DAY	50l/c/d	2660.55	3575.557	4397.484	5097.889	5909.85	6087.146	6458
MEDIUM DENSITY PLANNED AREAS								
POPULATION %	20%	3547.4	4767.409	5863.312	6797.185	7879.801	8116.195	8610
DEMAND PER CAPITA PER DAY	75 l/c/d	266055	357555.7	439748.4	509788.9	590985	608714.6	645785

LOW DENSITY PLANNED AREAS								
POPULATION %	10%	1774	2384	2932	3399	3940	4058	4305
DEMAND PER CAPITA PER DAY	100 l/c/d	177370	238370.4	293165.6	339859.3	393990	405809.7	430524
TOTAL DEMAND		**658930**	**885546**	**1089110**	**1262577**	**1463673**	**1507583**	**1599395**
PUBLIC DEMAND	**20%**	**131786**	**177109.2**	**217822**	**25252**	**29273**	**301517**	**319879**
UNACCOUNTED FOR WATER (L/DAY)	**15%**	**98839**	**221387**	**272277**	**315644**	**365918**	**376896**	**399849**
TOTAL DESIGN DEMAND (LITRES/DAY)		**889554.9**	**1284042**	**1579210**	**1830737**	**2122326**	**2185996**	**2319123**
DAILY DEMAND (M3/DAY) **Factored Peak demand factors (1.3)**		**890** **1156**	**1284** **1669**	**1579** **2053**	**1831** **2380**	**2122** **2759**	**2186** **2841**	**2319** **3015**

The current water demand projection has been based on the population projection and the demand criteria outlined above. The total population has been segmented into demand categories that suits the life pattern of the people and the type of housing the people have in the town. The population therefore was apportioned to the demand categories as can be seen in the table above. The demand was then added together and to it was added the estimated public demand which is 20% of the domestic demand. The systems water losses were estimated at 15 % of the total demand and have been added to the total demand.

The year 2038 projected demand for the population at Chikwawa Boma is 3015 cubic metres per day. The design demand for the water supply project has been rounded off to 3000 cubic metres per day.

5.6 Water Source

The Project will source its water from a proposed Irrigation Canal to be constructed by the Shire Valley Transformation Project, at Mthumba near Mthumba Community Day Secondary School. The water source shall have a pumping station that will be pumping water to treatment works that is proposed to be constructed at a high ground near Mthumba Community Day Secondary School.

The intake point on the Canal shall pump the water to treatment plant where there is a designed water mixing structure to mix the water and chemical coagulants for turbidity removal. The structure has been sized to carry the maximum design flow of 3000 cubic metres per day for the year 2038.

5.7 Water Quality

The water quality is that of Shire River which has no salinity but has high silt content especially during the rainy season. The Board uses the water at two of its existing water treatment plants of Mangochi and Liwonde and the quality is treatable using the normal conventional Water Treatment technologies of sedimentation, clarification filtration and chlorination.

The water quality parameters used in the design are based on the critical analysis that was conducted on the water sample taken at Zalewa.

The critical analysis for the quality of water from the Shire River is shown shaded in the table below.

Parameter	Units	Shire river
pH	pH value	7.43
Temp	°C	18.9
EC	µs/cm	317
Turbidity	NTU	1.44
TDS	ppm	159
FC	Cfu/100ml	231
T.hardness	ppm	104
Chlorides	ppm	32.99
T/alkalinity	ppm	108
Carbonates	ppm	0
Bicarbonate	ppm	131.76
Iron	ppm	ND
Manganese	ppm	ND
Nitrates	ppm	4.52±0.12
Fluoride	ppm	ND
Magnesium	ppm	8.01±0.12
Potassium	ppm	8.55±0.33
Sodium	ppm	25.64±0.58
Zinc	ppm	<0.005
Lead	ppm	<0.1

Copper	ppm	<0.02
Cadmium	ppm	<0.005
Aluminium	ppm	<0.1
Arsenic	ppm	<0.02

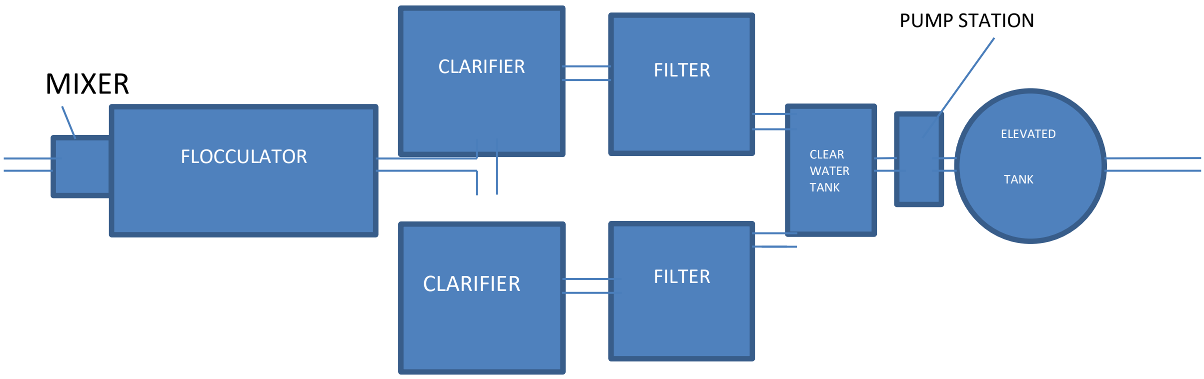
The water

Abstraction point into the Irrigation Canal shall be at Kapichira Hydropower station on the Shire River. The Canal shall extend all the way to Chikwawa Boma where the water shall be pumped to a Water Treatment Plant to be constructed at Mthumba CDSS. It is expected that some silt load shall be offloaded at Kapichira Dam and some along the Canal before being pumped to the Treatment Plant in Chikwawa.

The treatment chemicals of Aluminium Sulphate, Soda, Algaefloc, Sudfloc and HTH Chlorine can effectively treat the water to the required standards.

5.8 Water Treatment

The water having being pumped from the intake will be treated at the Water Treatment Plant to be constructed at a high ground near Mthumba Community Day Secondary School. Below is a schematic presentation of the layout of the treatment Plant. The water treatment plant shall be a full conventional water treatment plant that shall have the following components:



5.8.1 Chemical Dosing and Mixing Structure

Raw water from the source shall be dosed with aluminium sulphate and soda and then mixed in the Chemical dosing and mixing structure of the treatment plant. The sizing of the structure shall be as to allow 3,000m3/day.

The Chemical dosing and Mixing Structure has been designed with a 3.0 m3 capacity to allow for proper mixing of the chemicals before flocculation takes place in the flocculation chamber.

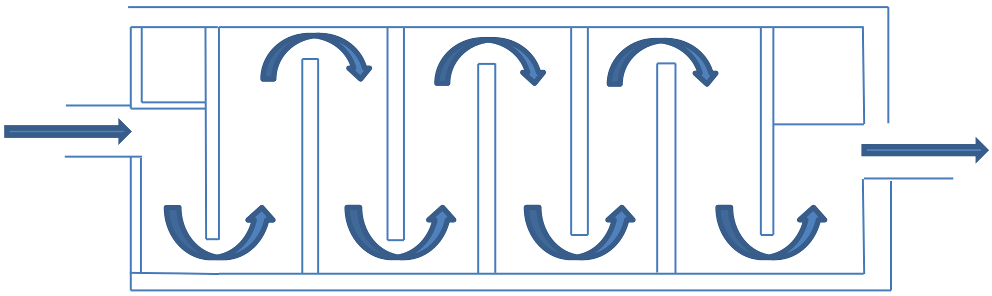
The water mixing structure has been designed to give detention time of 1.5 minutes to allow for proper chemical mixing.

5.8.2 Flocculation Chamber

From the mixing Chamber the water passes through a flocculation chamber to enhance formation of flocs.

The chamber consists of a passage 600mm wide which allows the water to pass at low velocities and to allow growth of the flocs so that as the water gets to the clarifiers the flocs should be heavy enough for easy settling to the bottom of the clarifiers.

The design has provided for a flocculation chamber of 5.8mx 4.2m with buffer walls that provide a 600mm width passage of length 29.4m to allow formation of flocs before the water gets into the clarifiers. The schematic drawing of the flocculator is given below:

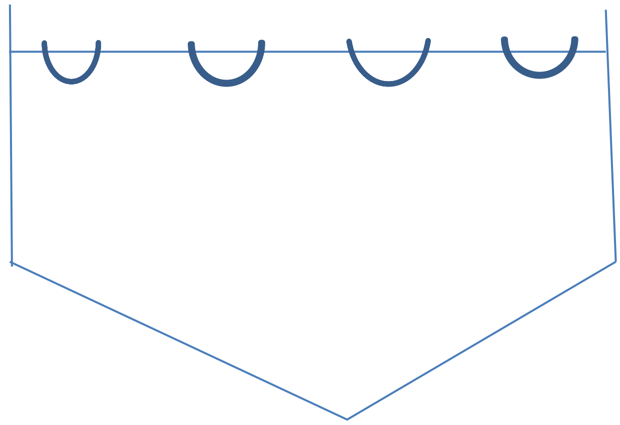


The drawing for the flocculator is given in the appendices with elevations and all construction details including dimensions and elevations.

5.8.3 The Clarifiers

The water from the flocculation chamber shall move to the clarifiers where the flocculation and coagulation processes shall take place. Sedimentation of solids shall be achieved at this treatment stage.

The clarifiers shall be flat hopper and upward flow into the decanting troughs. These shall be reinforced concrete structures that will achieve very low velocities of water.



Two clarifiers have been provided in the design. Each of the clarifiers has a surface area of 6m x 4m and will be working together with the other one. During the cleaning of the clarifiers one clarifier shall remain on duty. The clarifiers shall be designed for a flow of 3,000 cubic metres per day. The design has provided for two clarifiers each with a surface area of 24 m2 and a depth of 6.5 metres. The clarifiers have been designed using the following formulae:

Detention Time (DT) = Tank Volume/Flow into the Tank

The designed Clarifiers have allowed a detention time of 3 hours.

Surface Overflow Rate (SOR) = Flow (m3/Day)/Surface Area of Clarifier (m2)

= 3000/24

= 125m3/day/m2

Weir Overflow Rate (WOR) = Flow (m3/day)/Length of Weir (m)

= 3000/48

= 62 m3/day/m

5.8.4 Filtration Process

Water filtration shall be through rapid gravity sand filters. The filter media shall be ordinary sand graded to the required sizes to allow proper filtering capacities and the required throughput of the system.

The Gravity sand filters have been designed basing on the 2038 demand of 3000m3/day. The system has been designed to have two filters each with a sand bed of 4x 3 metres operating at 3000 litres /m3.hr.

The design for the sand depth in the filter has been calculated using the formula below

Q*D3*H/L = Bi *29323

Where Q = Filtration Rate in m3/m2/h

D = Sand size in mm

H = Terminal headloss in metres

L = Depth of sand bed in metres

Bi = Break through index whose value ranges from .00004 to 0.006 depending on response to coagulation and degree of pretreatment in filter influent.

5.8.5 Disinfection Stage

The water after filtration shall be disinfected by the dosing of HTH Chlorine to make it fit for consumption. The chemical dosing system shall have chemical mixers and mixing troughs. The mixed chemical solution shall be pumped into the treated water through chemical dosing pumps one duty and one stand by.

The chemical dosing pumps characteristic duty points shall be at a pressure of 16 bars pumping at a variable rate of 0 to 20 ppm. The pumping head shall be a maximum of 8 metres.

The design has provided for a well ventilated chemical store room for safe keeping of the chemicals which include aluminium Sulphate, soda and HTH chlorine.

There shall be a separate room to house the chemical dosing operations that has been designed to provide health and safety safeguards against chemical and mechanical hazards.

5.8.6 Clear Water Tank

The treatment plant shall be provided with a clear water tank which shall store the treated water to allow for the even mixing of the water before the water is distributed to the consumers through the distribution network.

The water supply distribution network needs an additional water storage tank of capacity 120m3 to increase supply capacity of the system.

5.8.7 Pumping Station

After treatment the water shall be pumped into an Elevated Tank at the Treatment Plant. The Pumping Station is designed to pump water from the Clear Water Tank to the Elevated Tank at Mthumba.

The capacity of the pumps is 3000 cubic metres per day which translates to 125 cubic metres per Hour at a Head of 40 metres.

The pump house has been design to have two pumps one duty and one standby. This is in line with the criteria that where there shall be one pump then the standby capacity shall be 100%.

5.8.8 Water Storage Tank

The design has provided for a pumping station at the treatment plant to pump water from the clear water Tank to an Elevated tank at Mthumba to ensure that there is enough distribution pressure in the Supply area. The tank Capacity is 500 cubic metres.

The levels of the land at Mthumba are higher than the level of the existing tank at Chikwawa Boma by twenty metres. Considering frictional losses it is necessary that the water at the treatment plant at Mthumba should be raised. The design proved that raising the water at Mthumba is cheaper that raising it at the Boma.

5.8.9 The Water Distribution Network

The design for the distribution network considered pipelines of diameter ranging from 63mm to as high as 250mm to run the system properly. The pipelines shall be classified according to pressure classes. All pipes shall be laid to work at 10% less pressure than the test pressures.

The pipe size for the pipes through treatment works shall be 250mm in diameter. The 250 mm diameter pipe shall run from the storage tank at treatment works to the existing tank at the office, a distance of 14 Kilometres. The water distribution shall be extended by laying 110mm pvc pipes from Dyeratu to Chapananga Road through the residential areas, a distance of 1.6 Kilometres. A 90mm diameter pvc pipe shall be laid from Prescane gate to Dyeratu through the Brewery Road, a distance of 900 metres. Another 90mm diameter pvc pipe shall be laid from Prescane Club to Kasinthula Irrigation Schem,e a distance of 1900 metres.

5.9 Ancillary Buildings

The treatment plant shall have ancillary buildings that will include Chemical dosing equipment, Chemical Stores and Operators store room. The water treatment plant shall have office space for plant operators and their supervisor. The office space shall include store room and change rooms for the operators. The sanitary facilities shall include toilets and shower rooms.

5.9.1 Office Accommodation

The Treatment plant operators’ offices shall include the Plant In-charge’s office and a general office for the plant operators to accommodate shift operators. There shall be provided one additional office to accommodate cleaners at the plant with a separate store room for cleaning materials.

5.9.2 Laboratory Room

The project shall provide a room for laboratory operations for quality monitoring within the office building. The office shall be equipped with basic laboratory equipment including beakers, conical flasks, a table mixing apparatus with mixers for sample treatment.

The laboratory shall also be provided with chlorine comparator apparatus and one biological test kit to assist the laboratory personnel to conduct basic biological tests by culturing samples.

5.9.3 Accommodation for Plant Operators

Along with the office space the project shall provide two houses for plant operators who shall reside close to the treatment plant so that they can easily perform as shift supervisors during the operation of the plant.