

**DESIGN OF A WATER SUPPLY SYSTEM FOR MUKO IKAMIRO
PARISH IN RUBANDA DISTRICT.**

**FINAL YEAR PROJECT REPORT SUBMITTED TO KAMPALA
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DECLARATION

We hereby declare that this project report is our original piece of work and that any other assistance we received in its preparations and compiling is fully acknowledged and discussed.

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APPROVAL

This project report has been submitted to the school of engineering and applied sciences for examination with the approval of our supervisor

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Signature.....

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DEDICATION

To our parents, siblings, guardians, mentors and friends for their continued support throughout our academic endeavors.

ACKNOWLEDGEMENT

We would like to express our profound sense of deepest gratitude to our guide and motivator

Mr. **Musiime Enos Bahati** Civil Engineering Department for providing necessary guidance and knowledge during the entire period of this project.

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We express our thanks to all those who helped us in one way or the other.

Last, but not the least, we would like to thank the authors of various research articles and books that we referred to.

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ABSTRACT

The study was to design a water supply system for Muko Ikamiro parish in Rubanda district. The study was guided by the following objectives mainly to increase access to safe adequate and sustainable water, sanitation and hygiene service delivery. And specifically to characterize and determine the quality of the available water sources, to determine water demand for the community and to design an effective water supply system. The project was carried out with in Ikamiro parish and covered a design and layout distribution of the pipes. The project consisted of design of accessing water demand for water supply, design of storage reservoirs, selecting suitable source and design pipe network system. Desk study was employed in collecting data related to Population of Muko Ikamiira parish, operation and maintenance of water supply system among others. It included thorough search through the internet, reading the available journals, Lecture notes from KIU and different university concerning the subject under study. The Uganda Water Supply Design Manual second Edition (2000) was used in the design of the system. The researchers recommend that the local council authorities and the community should fully be involved in the implementation of the design alongside the contractors. This is to instill ownership of the scheme in the community minds and provide community members with the skills for the upcoming tasks.

CHAPTER ONE

1.1 Introduction

This chapter contains introduction and background, problem statement, objectives of the project, project scope, justifications and significance of the project.

1.2 Problem statement.

Water is the most valuable resource in the world. It is what separates earth from the other planets and allows life to thrive.

Muko ikamiro parish has a problem of inadequate and unclean water, whereby its main source of water is surface water that includes Lake Bunyonyi, shallow wells and springs which are seriously polluted by agricultural wastes from agricultural activities of nearby communities. Even people travel long distances from 1 to 4 kilometers to access these sources looking for water for home consumption and human activities.

Another source of water for Muko is harvested rain water but due to weather changes especially dry season, water becomes scarce and expensive in terms of cost, whereby a jerry can that is sold at 100 ug shillings increases up to 700 ug shillings.

Inhabitants have always suffered from water borne diseases for example typhoid, cholera and dysentery. Therefore, there is an urgent need for a well-equipped, advanced and designed water supply system to solve the problem of these diseases, domestic water demand and human activities after implementation.



Figure 1: People sharing water with animals

1.3 Project objectives

Main objective

To increase access to safe adequate and sustainable water, sanitation and hygiene service delivery.

Specific objectives

- ✓ To characterize and determine the quality of the available water sources.
- ✓ To determine water demand for the community.
- ✓ To design an effective water supply system.

1.4 Project scope

The project was carried out with in Ikamiro parish and covered a design and layout distribution of the pipes.

The project consisted of design of accessing water demand for water supply, design of storage reservoirs, selecting suitable source and design pipe network system.

Time scope

The project was carried out with in Ikamiro parish from November 2018 to September 2019.

Geographical scope

Ikamiro parish is hilly and gently sloping.

1.5 Project significance

The project will improve on the quality service which will improve on the standards and competitiveness of the Ikamiro parish.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents the literature review based on the specific objectives of the project. The ministry of water and environment published the first edition of the water supply design manual in the year 2000. This manual has been extremely useful in meeting the needs of those engaged in the planning and design of water supply .

2.1 Water demand

Water demand is the quantity of water that the water supply scheme must produce in order to meet all water needs in the community

2.1.1 General

Estimation of the water demand for a community is the first activity of the design process. It starts with the delineation of the proposed supply areas and followed a socioeconomic baseline survey. This survey involves counting the number of potential users. It is impractical to count all the potential consumers; however, static methods and sampling, information obtained from UBOS, from the district and local councils may be used to improve on estimates.

To calculate the water demand for water supply scheme, it is necessary to:

- Determine the number of consumers falling within the different consumer categories at various stages of the design period.

Determine the average day unit water demand for the various consumer categories concerned.

The formula to be used is as follows:

$$P_n = p (1 + r)^n \text{ eqn (1) where}$$

p_n = population after n years,

P = present population, and

r = annual growth rate

For the purpose of estimating total requirement of water of a community, it is usual to calculate the consumption on an average basis and express it in liters percapita per day.

If Q is the total quantity of water in litres, required by a community per year having 'P' as its population, then percapita consumption or rate of demand in litres

Percapita per day is given as $= Q / (P \times 365)$ (lpcd (litres percapita per day))

2.1.2 Factors and the way they affect the percapita consumption

- Climate
- Class of consumer
- Industries and Commerce
- Quantity of water
- Pressure in the distribution system
- Metering system
- Sewage facilities
- System of Supply
- Number of Inhabitants
- System of supply

Climate

Hotter places require higher consumption, in domestic use there is more of bathing, in public use of more lawn and street sprinkling.

Hotter temperatures also lead to greater use of air conditioning.

Class of consumer

For people having higher economic status and better standards of living requirements of water supply would be greater.

Industries and Commerce

Consumption is usually higher when water supply has to provide for larger industries and commercial uses.

Quantity of water

A water works system having a safe and wholesome water supply always be more popular with consumers who would, consequently, depend less for their requirements upon such sources of water supply as private wells

Pressure in the distribution system

These would be of greater importance in the case of localities having a number of two or three stored building.

Adequate pressure would mean an uninterrupted and constant supply of water.

Metering system

Good quality and high pressure of water supply encourages more liberal use of water. Meters also help in cutting down waste or loss of water through leakages in the pipes. A metered supply ensures minimum of waste as the consumer then knows that he has to pay for the water used by him and consequently is more careful in use.

Sewage facilities

Where various facilities of a water borne sewerage system exists, residence and buildings require more water for flushing of sanitary appliances i.e., water closets, urinals etc. and for efficient drainage through pipes and sewers.

System of supply

When water is supplied for certain fixed hours of the day, results in some reduction in Consumption.

This may be due to decrease in losses and other wasteful use.

Number of Inhabitants

This would affect the extent to which use is made of private water supply. Thus, in large cities, the public water supply is almost a necessity while in small towns and villages, the private supplies may remain in use, even after the introduction of public water supply. Generally, the per capita consumption is found to increase with increase of population.

2.1.3 TYPES OF WATER DEMAND

2.1.4 Domestic Demand

S/No.	Description	Amount of water in liters per head
1	Bathing	55
2	Washing clothes	20
3	Flushing	30
4	Washing the house	10
5	Washing utensils	10
6	Cooking	5
7	Drinking	5
	Total	135

Table 1: domestic demand

2.1.5 Population Projections

The present populations in a proposed water supply scheme area should be estimated based on the latest census estimates. However, the results should be cross-checked with information obtained from other sources, such as the Local Council (LC) authorities. The population in each Local Council I (LC I) area should be projected separately. In the instance where UBOS and LC population figures give contradictory results, the survey must count the number of potential users. Population figures for towns should be confirmed by physically counting the houses, shops, bars, etc. in the towns. Where the numbers are large, a representative sample should be chosen.

2.1.5 Educational Institutions Demand.

Water demand in educational institutions should be based on the situation prevailing at the time of scheme design, the development plans of the Ministry of Education and Sports, Ministry of Health, other large institutional consumers such as the Uganda Police, Uganda Prisons, the UPDF and the District Local Governments, and the projected growth of the local population

2.1.6 Water for Production Demand

Irrigation

Normally, water demand considerations should not include provisions for irrigation apart from very limited garden watering which, in any case, is already included in the per capita unit water demand figures. It is however not practical that treated water is used for large scale irrigation.

Livestock

According to the Water Act of Uganda 1997 in Part I – Interpretations, “livestock unit” means a mature animal with a live weight of 500 kilograms and for the purposes of this definition—

- i. One head of cattle shall be deemed to be 0.7;
- ii. One horse shall be deemed to be 0.6;
- iii. One donkey shall be deemed to be 0.4;
- iv. One goat shall be deemed to be 0.15; and
- v. One sheep shall be deemed to be 0.15; of a livestock unit;

To cater for pigs and poultry farming, the figures below can be used for design:

- i. One Pig shall be deemed to be 0.4; and

- ii. One chicken shall be deemed to be 0.05 of a livestock unit;

Other Commercial Uses

Other demands include water sellers, such as water tenders; water for construction purposes (which may be high but transient – lasting for the length of the construction activities); water for street washing / cleaning, fountains and other municipal uses; water for recreation such as swimming pools or for water sports; etc.

2.1.7 Water Demand Patterns and Peak Factors

General

The daily water demand in a water supply scheme area will vary during the year due to seasonal climatic variations, work situations such as harvest seasons and other factors such as religious and cultural festivals

Rural Areas

In rural areas, it can be assumed that the bulk of the water used in a day is drawn between 7 a.m. and 7 p.m., but with hourly variations. Generally, two peak periods will be observed, one in the morning and the other in the evening. The same pattern can be assumed to apply for Private Connections and for Public Standpipes.

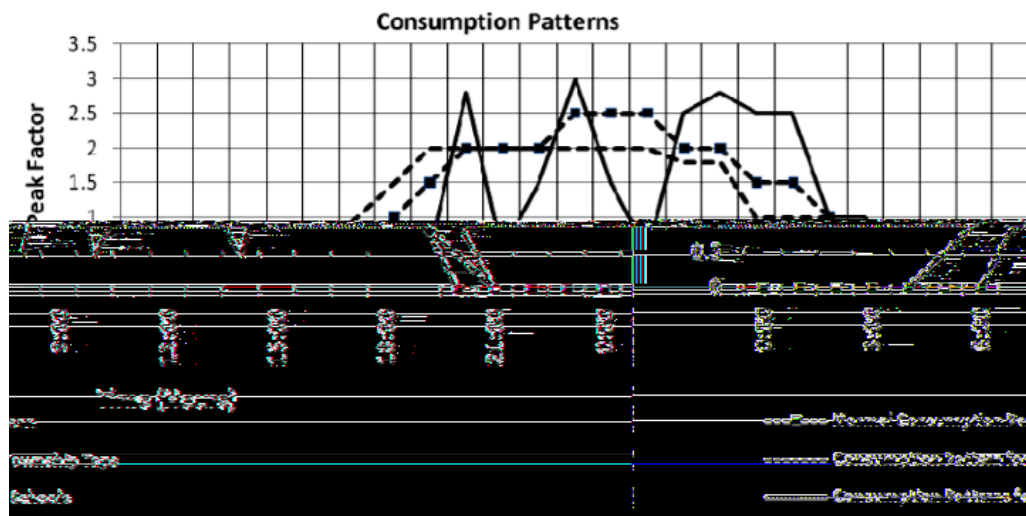
Table 2: peak hour factors

Population [Pe]	Peak Hour Factors
1,000 or more	2.0
500	2.5
200	3.0
100	3.5
50	4.5

Linear interpolation may be used to determine “Peak Hour Factors” for intermediate population figures.

Where reliable records of actual consumption patterns do exist, corresponding “Peak Hour Factors” should be calculated accordingly. Such storage facilities should be encouraged and considered when determining the design flows and capacities of the distribution mains. With EPANET, typical demand curves are given in the charts below. The patterns may be applied to supply areas or even to taps, depending on the size of the network

Typical demand patterns for various Users.



2.2 RESERVOIR

Reservoirs are those water bodies formed or modified by human activity for specific purposes, in order to provide a reliable and controllable resource. Their main uses include:

- Drinking and municipal water supply.
- Industrial and cooling water supply.
- Power generation.
- Agricultural irrigation.
- River regulation and flood control.
- Commercial and recreational fisheries.
- Body contact recreation, boating, and other aesthetic recreational uses,
- Navigation.
- Canalization
- Waste disposal (in some situations).

2.2.1 Types of reservoirs

There are three types of reservoirs; valley dammed reservoirs, bank side reservoirs, and service reservoirs

Valley dammed reservoirs are created in valleys between mountains. Usually, there is an existing lake or body of water. The mountain sides are used as the walls of the reservoir to

hold the water. A dam or artificial wall in the reservoir is built at the narrowest point to hold in the water.

To create a valley dammed reservoir, the river that will fill the reservoir must be diverted, so the ground can be cleared to lay a foundation and for the dam, a concrete lining is put in place, and dam construction can begin.

Bank side reservoirs are reservoirs that are made by diverting water from local rivers or streams to an existing reservoir. Although this can be applied to many different geographical areas, unlike the valley dammed reservoir, which requires a valley, diverting water from a river can create problems.

Service reservoirs are entirely man made. They are usually stored in concrete basins above or below ground.

Reservoirs do, nevertheless, share a number of attributes with natural lakes and some are even riverine in their overall nature. Generally, all reservoirs are subject to water quality requirements in relation to a variety of human uses. The variation in design and operation of control structures in reservoirs can provide greater flexibility and potential for human intervention than in natural lakes (and, therefore, considerable scope for management and control) with the objective of achieving a desired water quality. However, the nature of the intervention or control can complicate the development and operation of water quality monitoring programmes, as well as the interpretation of resultant data (especially as the nature of these controls may vary over time, altering the responses of the system). For reservoirs, therefore, the assessment process must take full account of the direct management influences on the water body.

2.2.2 Storage reservoir design

General

Ground storage reservoirs are normally made of reinforced concrete or concrete blocks or bricks. Elevated storage reservoirs are normally made out of galvanized pressed steel panels, and placed on steel support structures. All other factors being equal, the most economical storage reservoir shape is circular followed by square and lastly rectangular. Normally, the depth of water in a storage reservoir should not exceed 5m.

Reservoir are of the two main categories

- a) Impounding reservoir into which rivers flows naturally.

- b) Service or balancing reservoir receiving supplies that are pumped or channeled into them artificially.

Capacities

It is recommended that reservoirs are provided in standard capacities of 10, 25, 50, 100, 150, 200, 300, 500, 800 and 1200m³

Design features

The size of the inlet line is determined by the water supply and demand requirements of the community and should have a shut off valve next to the reservoir. The size of outlet is also determined by the demand requirements and should be located at least 200mm above the reservoir bottom.

Manholes and covers are installed to provide an entrance during cleaning, maintenance and repair. They should be raised higher than the roof level to prevent the entrance of contaminated surface water.

Water level indicators are used to indicate the water level inside the reservoirs. A depth gauge using a float and wire is usually used.

Large reservoirs should be equipped with internal and external ladders and have external walkways and handrails, especially when they are elevated. They should be partitioned if the reservoirs exceed 500m³.

Data and information needed in design of capacity of a reservoir

- i. Precipitation, run off and silt records available in the region.
- ii. Erodibility of catchment upstream of reservoir for estimating sediment yield.
- iii. Area capacity curves at the proposed location.
- iv. Losses in the reservoir.
- v. Data an engineering and geological aspect.

2.3 Pipe line system

2.3.1 General design and mains

Raising mains (pipe line system) from a pumping station normally follow the ground contours, their carrying capacities dependent on hydraulic gradient. The gradient of raising main is given by the pressure and friction heads determined by the characteristics of the pump-pipeline characteristics.

2.3.2 Performance parameters for pumps

There are three principal performance parameters relatively to pump selection: flow or capacity, total delivery head and suction lift

Capacity

Required capacity measured in flow/time is determined by one of the two factors.

For direct supply pump capacity should be related to peak hourly demand.

Total head

There are three principal components to total head of importance when specifying a pump, static head, dynamic head (friction loss) and pressure head Static head (H)

The only important component of dynamic head is pipe friction, this being determined by water velocity, the higher the friction loss and its importance to match the pump to the pipe to the pipe lines

Total friction loss for a pipeline (HF)

$$=F*L/100,.....eqn(2)$$

F= Friction loss given for a particular flow in a specified pipe size (M per 100m pipe length)

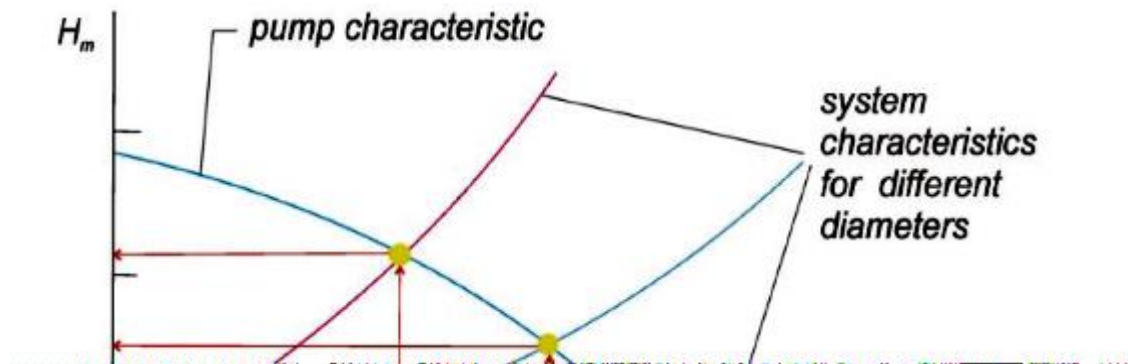
L= pipe length (m)

2.3.3 Selection of Pipeline Diameter

The best possible diameter of a pipeline system for a pumping unit depends on the system characteristic.

The various pipeline systems which could be considered as matching the pump characteristic are shown in Figure below. It must be noted that, each operational point corresponds to a particular efficiency of the pump, and the system selection largely depends on the discharge-head requirements and on pump

Figure 2: Selection of System pipeline Diameter



2.3.4 Transmission and distribution Water

2.3.5 General aspect

The purpose of transmission and distribution system of a water supply scheme is to deliver the right quantity and quality of water conveniently to the demand area. The delivery system is classified into two; the transmission main and distribution. Transmission main convey water from the source, treatment or storage facilities to the distribution system normally via storage reservoir. There may be a few service connections on the transmission main, but the purpose of this large diameter pipe is to deliver water to the distribution mains where most of the connections are.

2.3.6 METHODS OF DISTRIBUTION:

Three methods or systems are outlined below:

- (i) Gravity system
- (ii) Pumping system
- (iii) Combined gravity and pumping system

2.3.7 LAYOUT OF DISTRIBUTION NETWORKS

There are four principal methods of layout for distribution systems:

- (i) Dead end or tree system
- (ii) Gridiron system
- (iii) Circular or ring system
- (iv) Radial system

2.3.8 System Design

Introduction

A given supply area may be best served by one large scheme or by several independent smaller schemes.

The economic analysis should include both the local and foreign exchange components of the capital and operation and maintenance cost over the schemes design period.

The costs of the transmission and distribution pipelines per cubic meter of water supplied will generally increase with the size of supply area.

2.3.9 Pipeline Design

The purpose of pipeline design is to properly control frictional energy losses so as to move the desired flows through the system, by conserving energy at some points and burning it off at other points.

In the design of water distribution system, a number of software may be used including EPANET, Water CAD etc. One of the most commonly used and freely available software for the design of water distribution system is EPANET.

2.3.10 Hardy cross method

The Hardy cross method is an iterative for determining the pipe network system where input and the outputs are known and the flow inside the pipe.

The general formulae provided by Hazen – William from which head loss can be computed is;

$$V = KCR^{0.63}S^{0.54} \text{eqn3}$$

Where V is pipe flow velocity, k is a conversion factor (0.849 for SI units), C roughness coefficient R hydraulic radius and S the slope of the energy line.

$$S = h_f/L \text{eqn4}$$

Where h_f is head loss and L is pipe length. Also from continuity of flow equation

$$Q = VA \text{ where } A = \pi d^2/4 \text{eqn5}$$

Where Q is pipe flow, A is the pipe cross section area and d the pipe diameter.

The assumed flows should then be corrected using ΔQ as shown below and added to the initial guess until there is no significant change.

$$\Delta Q = -\Sigma h_f / n \Sigma h_f / Q \text{eqn6}$$

Pipe friction losses

Pipe diameter and the hydraulic pressure in a pipe are derived from the friction losses in the pipe. To calculate friction losses in ordinary transmission and distribution pipelines, it is recommended that the following empirical formulae be used:

1. s – White (Universal) formula;
2. Darcy – Weisbach formula; or
3. Hazen – Williams’s formula.

Table 3: guide to distribution velocity vs diameter

Pipe Diameter Range (mm)	Velocity Range (m/s)	Nom. Dia. (mm)	Velocity Range (l/s)
Small, DN 50 - 110	0.60 - 1.00	50	1 – 2
		65	2 – 3
		80	3 – 5
		100	5 – 8
		110	6 - 10
Medium, DN 125 - 250	1.00 - 1.50	125	10 – 18
		150	18 – 30
		200	30 – 45
		225	40 – 60
		250	50 - 80
Large, DN 300 - 500	1.20 - 2.00	300	80 – 140
		350	120 – 190
		400	150 – 250
		450	190 – 300
		500	250 - 400

2.3.11 Economic pipe Sizing

Economic pipe sizing aims at supplying the maximum number of consumers at the lowest possible cost. The positions and capacities of the reservoirs should be determined after performing appropriate analyses aimed at minimizing system costs;

- i. A pipeline traversing a given supply area, should be designed with adequate capacity to carry the Peak Hour Demand required at the supply area plus the “Maximum Day demand”.
- ii. To avoid air pockets, the numbers of pronounced high and low points should be kept to the minimum, by trying to follow the contour lines of the terrain rather than following roads and tracks. This calls for the active participation of the designer in the survey of the pipeline routes; and

- iii. In order to minimize the number of air-valves and washouts, pipeline excavation depths should be varied to avoid local high and low points.

In the design of water distribution system, a number of software may be used including EPANET, Water CAD etc. One of the most commonly used and freely available software for the design of water distribution system is EPANET.

2.4 Pipes

2.4.1 Types of materials used for pipes

The general requirements of pipes of different materials are strength, resistant to corrosion, effective capacity, maintenance, economy, availability and easy transportation to the site.

With respect to the various pipe materials these are discussed as below:

Cast Iron pipes

- These pipes earlier cast vertically, but this type has been largely in the use by the past iron pipes, which are manufactured by the centrifugal action and now they are used universally.
- The cast iron pipes are lighter in weight, longer in length and have improved metal qualities.
- They are strong, durable, easy to join and most commonly used.
- Principal disadvantages are difficulty in transformation of large sizes, decrease in their carrying capacities with age and with quality of water transported

Wrought Iron and steel Pipes

- The wrought iron and steel pipes are stronger than cast iron and can withstand much higher pressure, but are of lighter section and hence easy to transport.
- They are however, less durable (life span upto 50 years) more liable to corrosion and there is also the difficulty of easy availability of pipe special i.e. joints, bends, etc

Concrete pipes

- Concrete pipes are very durable, heavier and can be hold in sizes upto 1800 mm in diameter
- Transportation costs are much reduced, if the pipes are cast at the construction site
- Concrete pipes have low maintenance cost and their resistance to corrosion is high.

Hume steel pipes

- These steel pipes are made from mild steel and shell lined and out coated with cement concrete or cement mortar through a centrifugal process
- They are available upto 1350 mm size and are used for trunks and distribution mains.
- They are heavy and difficult to handle.

Asbestos cement pipes

- These pipes are composed of asbestos fiber and Portland cement combined under pressure into dense homogeneous structure.
- These pipes are light in weight and can be easily cut, joined and handled and also they are smooth and resistance to corrosion.

Wood pipes

- Wood pipes are built of staves of wood held together by steel bands
- Wood is the least durable of the pipe materials and the pipe must be kept constantly full of water to prevent cracks, due to alternate wet and dry conditions.
- These pipes are now rarely employed in water works practice.

Lead pipes

- They do not find any place in conveying domestic water supply for fear of lead poisoning due to plumb solvency, where water is soft.
- They are however soft and flexible and as such used in house plumbing as overflow and flushing pipes.

Plastic pipes

- They are now finding increase in use for potable water supply in India
- These pipes have the characteristics of higher strength to weight ratio, greater environmental stability and better resistance to corrosion and bacterial contamination.
- These pipes are also resistant to a wide range of chemicals.

2.4.2 Materials Selection

Pipe materials commonly used in Uganda include ductile iron (DI), steel, galvanized steel (GS), asbestos cement (AC), un-plasticized polyvinyl chloride (uPVC) and polyethylene (PE).

DI, GS and steel pipes are strong, and they are the pipes of choice for very high operating pressures and for large size pipelines exceeding 300 mm diameter. However, the costs of fittings and valves increase rapidly with higher pipe pressure classes.

Polyethylene is very suitable for small-diameter pipelines because it can be supplied in rolls, thus reducing the numbers of the joints and bends required. Polyethylene does not deteriorate when exposed to direct sunlight.

Table 4: Pipe sizes available in Uganda

Pipe Types	Sizes (mm)
uPVC	63, 90, 110, 160, 200, 250, 315, 400
PE	20, 25, 32, 40, 50, 63, 75, 90, 110, 125, 140
GS and steel	15, 20, 25, 32, 40, 50, 65, 80, 100, 150, 200, 250, 300

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter describes the activities and methods that were used in achieving the objectives of designing a water supply system project.

3.1 Data Type and Sources

There are two types of data that were captured here: Primary and Secondary. Primary data was collected through interviews and observations during field work. Secondary data is the one that was used to obtain data from the Sub-county, GDLG through their annual reports. Other literatures and internet were employed to solve the problems.

3.2 Data Collection Techniques

3.2.1 Observation

Several Site visits to the project location were done to examine the current water and sanitation situation of the area. All the potential available water points current being used by the communities was visited.

3.2.2 Desk Study

Desk study was employed in collecting data related to Population of Muko Ikamiira parish, operation and maintenance of water supply system among others. It included thorough search through the internet, reading the available journals, Lecture notes from KIU and different university concerning the subject under study.

3.2.3 Topographic Survey

Reconnaissance and detailed survey was done using Global Positioning System (GPS).

Reconnaissance done here entails the following;

- Find out land ownerships of the various government installations within the rural growth Centre. These are health centers, sub-county administration, churches and schools within the rural growth centers, areas for commercial and residential among others.
- Coming with a rough sketch of the layout of the RGC

- Plan for appropriate survey method to be employed and also find out the probably obstacles to the survey.

The following requirements are to be identified with in a detail topographic map:

- GPS locations of several corners of Various Installations within Muko Schools, Health centers, Sub-county, administrations boundaries and for Muko as a whole.
- Waypoints along the major roads passing through and within Muko

3.2.4 Engineering Survey

To get the correct reduced levels where the pipeline will run, engineering survey was done using a dumpy level, a tape and together with a GPS. A chain age of 20m interval was used for both in surveying the Transmission and the Distribution line. The reduced levels of the various chain age points were obtained using the Rise and fall method.

3.3 System design

The Uganda Water Supply Design Manual second Edition (2000) was used in the design of the system.

3.3.1 Concept of design

The following formulae/designed concepts were employed in the design of the proposed project.

3.4 Water demand and population prediction

A design horizon of 20years used starting with 2014 as the base and ending in 2029 as the Ultimate year.

The population and demand projection for the ultimate year (2029) was used in the design process.

Population Projection, $P_n = P(1+r)^n$ ----- eqn7

Where;

P_n = population after n years, P = present population, and r = annual growth rate (%)

Present water demand required = Population (P) X Per Capita Consumption

Future water demand required = Population (P_n) X Per Capita Consumption

$$\text{Maximum Water Demand (MDD)} = \text{ADD} \times 1.3 \text{ ----- eqn8}$$

Where;

ADD = Average Day Demand obtained by the summation of all categories of demand (Domestic, Institutional, Commercial)

The Multiplier 1.3 is a peak day factor for MDD. This is given in the water supply design manual in the year 2000.

$$\text{Peak Hour Demand (PHD)} = \text{MDD} \times 2.0 \text{ -----eqn9}$$

3.5 Water Quality Analysis Test.

The water to be supplied to the community of muko was sampled from surface water as the source of water for supply and was taken to the Central Laboratory Bugolobi to determine its physio-chemical characteristics of the source. Different parameters; PH, electrical conductivity, total suspended solids, total dissolved solid, Colour, Turbidity, Hardness, magnesium chlorides were tested.

3.6 Drawings

The site layout, plan, different elevations and sections, pipe distribution system was produced using EPANET and at the sometime AUTO CAD software and topographic map was done using civil 3D.

3.7 Conducting and EI study.

It was conducted in the field to assess the impact of the proposed project on human environment issues and will be approved by NEMA.

CHAPTER FOUR

TESTING, RESULTS AND DISCUSSION

4.0 Introduction

This chapter presents all the empirical findings from the study; it includes the findings from the socio –economic survey and the project design.

4.1 General description of the Project Area

Muko is found in Rubanda district, 33km from Rubanda district headquarters and is majorly made up of three zones (A, B and C).

4.2 Topography.

The projected area is generally flat. The project Area varies between 1110 to 1085 above Mean Sea Level.

4.3 Power source.

There is electric power in the Muko parish. The power was extended from Muko main Road Town through a distance of 300m to the water source and it involved three to four electric poles to be erected up to.

4.4 Existing Infrastructure

The followings are the existing infrastructure in the project area;

4.4.1 Educational Institutions

There are some educational institutions within the project area. There are mainly primary and a secondary schools which includes Muko parents, Muko nursery school and Buhunga s s. These include the followings; market, church, Uganda police station, and private shops

4.4.2 Health Facilities.

There are only six private clinics in Muko parish.

4.4.3 Other Commercial Uses.

Other demands include water sellers, such as water tenders; water for construction purposes (which may be high but transient – lasting for the length of the construction activities); water for street washing / cleaning and also agricultural development in the area, bars, restaurants and local retail shops.

Table 5: Commercial facilities in the project area

Category	Number
Shop with dwellings	12
Shop without Dwellings	26
Bar small.	3
Restaurant	2
Grinding mills	1
Market	1
Uganda police	1
Private clinics	4
Schools	3
Farms	5

Source: Socio-Economic Household Survey

4.6 Baseline Conditions

4.6.1 Financial and Economic Analysis

The purpose of the financial and economic analysis was to assess the financial and economic viability of the proposed project, i.e., if the proposed project is financially and economically attractive or not from the entity's viewpoint.

Guidelines for the Economic Analysis of Water Supply Projects:

- i. Defining the project objectives and economic rationale.
- ii. Demand analysis and forecasting effective demand for project outputs. This is based on either secondary information sources or socioeconomic and other surveys in the project area.
- iii. Establishing the gap between future demand and supply from existing facilities after ensuring their optimum use.
- iv. Identifying project alternatives to meet the above gap in terms of technology, process, scale and location through a least-cost and/or cost effectiveness analysis using economic prices for all inputs.

- v. Identifying benefits, both quantifiable and non-quantifiable, and determining whether economic benefits exceed economic costs.
- vi. Assessing whether the project's net benefits will be sustainable throughout the life of the project through cost-recovery, tariff and subsidy (if any) based on financial (liquidity) analysis and financial benefit-cost analysis.
- vii. Testing for risks associated with the project through sensitivity and risk analyses.
- viii. Identifying and assessing distributional effects of the project and poverty reduction impact.

4.6.2 Water Usage

From the survey data information tells us that the natives of Muko that majority (90%) of the population uses water mainly for domestic purposes, business and trade takes 6% while brewing and others take equal percentage at 2%. Majority of the respondents asked think safe water is more Important than other thing else like, electricity, housing etc. On average when asked, the majority of the house hold respondents say they normally use 40 to 60 liters of Water per household. Majority of the source(s) of water used here is borehole followed by protected springs and others (like unprotected sources, example, streams and ponds.).

4.6.3 Walking Distance

According to water supply design manual year 2000, the walking distance to the water point source should not exceed 1.5km, and according to the survey carried at Muko parish majority 80 percent walk a distance of more than 1.5km and only 20 percent lies in range of 1km to 1.5km.

4.6.4 Time Duration for collecting Water

According to field survey, 50% of the respondents takes at most 60minutes to collect water, and the remaining percentage takes above 60 minutes to collect water.

Table 6: Time duration for collecting water

At most 60 minutes	50%
At least 60 minutes	50%

Source: Field Survey

4.6.5 Household income and Expenditure

The monthly income and expenditure of the respondents was captured to ascertain whether they will be in position to pay for the operation and maintenance of the water supply system once it is put in place. Most natives of Muko parish majority 98 percent practice agriculture and only 2 percent earns salary ranging from 100,000 to 400,000/= per month.

4.6.6 Willingness and ability to pay for water.

Due to low level of affordability as a result of prolong exposure to in assurgency, it was found that, based on service level one for rural areas a tariff of 50/= per 20liter jerry can would be feasible for the community to pay. This would means a collection of 8,193,000/= per month excluding tax and standard fees. Which was possible to meet the operation and maintenance cost and allows generation of funds to enable periodic replacement of the system mechanical and electrical components whose life span does not exceed 10years.

4.6.7 Water Quality

A sample of the water supplied to the consumers was sampled from existing borehole tested for micro-biology and physic-chemical quality. Sixteen parameters in total were tested at NWSC Central laboratory- Bugolobi as shown in appendix H.

4.7 Population Projection

4.7.1 Base Data

The Base year for the population projection was taken as year 2014; this being the year when the Socio-Economic Household Survey (SEHS) was carried out. The future population was obtained by projecting the base population got from the SEHS and it was 2739

4.7.2 Population growth rate.

A growth rate of 2.98% (according to population growth rate of 2012) was used to project the current population. This growth rate was adopted from UBOS following the housing and population census of the year 2012. On this basis, it is expected that the commercial and institutional activity will grow at the same growth rate as the domestic population.

The population on average shows mainly long term residents who have lived in the area since the 1990s and early 2000s. The household size on average is 6 persons. The domestic Population projection is as shown below.

Table 7: Domestic population Projection

R=2.98 percent n = 10

DOMESTIC POPULATION (DP)

Domestic growth rate			=	2.98%	
		CURRENT POPULATION/BASE YE AR	INITIAL YEAR	FUTURE YEAR	ULTIMATE YEAR
Location	HH. No.	2014	2017	2027	2037
zone A	70	610	666	794	1147
zone B	68	540	590	704	940
zone C	44	350	382	456	644
TOTAL	282	1500	1638	1954	2739

SOURCE: Water supply design manual

4.8 Water Demand.

4.8.1 Domestic Demand

This is the water demand by the people in their environment.

4.8.1.1 Level of Service

Muko is still considered as rural area, Three Service levels were used in projecting the domestic demand. Under these service levels, three Income classifications were applied as noted below

Low income, single household with yard tap, Low income, multiple households with yard tap and Low income, using kiosks or public tap.

The demand per consumer category related to the level of service being provided. Uganda Water Supply Design manual second edition (2013), in table 2-2.

According to SEHS, the proposed level of service for the design for Muko is as noted below.

Low income, Single household with yard tap = 3%

Low income, Multiple households with yard tap = 2%

Low income, Using kiosks or public tap = 95%
ts in the design.

4.8.3 Maximum Day Demand

The Maximum Day Demand was got by multiply the Average Day Demand by a PDF of 1.3. The Average Day Demand was got by adding all the demand categories together, that is, Domestic, Institutional, Commercial and Industrial and losses or the unaccounted for water. AMDD of 187.23m³/d was got. This is the demand that was used to design the Pump, the transmission line and the balancing storage reservoir.

4.8.4 Peak Hour Demand

The PHF got by multiplying the MDD with a PHF of 2.0. This PHF was got through interpolation based on the population from the PHF given in the Uganda Design Manual in a year 2000 in table 2-9. A PHD of 374.46m³/d was got and this is the demand that was used to design the distribution network. For projection, look at the appendixes.

PHD=374.46m³/d

4.8.5 Water source

The existing borehole in Muko was selected as the source of water supply for the designed project

4.8.6 Pipe Flow Velocities Pipe

Flow velocity in the transmission line was kept constant at 0.7m/s while in the Distribution networks, it varies considerably from 0.4m/s to as low as 0.2m/s.

This was done to keep the residual pressure at the remotest end to at least above 7m heads of water.

4.8.7 Operating Pressure

The operating pressure in the transmission line should be kept below 1.5MPa (pressure class D) and UPVC materials were used. In the distribution network, it varies as noted in the subsequent sub-sections.

4.8.8 Values and washout

The Air Relief Valve position was determined in relation to the HGL. Air relief valve was provided at a distance of 865m while washout was provided at a distance of 1300m

4.8.9 System Operating Time

The system was operated to pump in the morning and in the evening hours.

4.8.10 Pump design

Pumping hours = 6hrs in the morning and 6hrs in the evening

Pump capacity = 3.5m³/hr

Pumping head

Total pumping head = static + dynamic head + pressure head

Pressure head was neglected since the fire hydrant is not required, further when delivering to the open outlet, pressure at the delivery points is zero.

Static head

Reduced levels of the tank =1000m

Reduced levels of the well =985m

The recommended depth of installation of pump was 23m this inclusive of the pumping level

Sh =15m according to Uganda water design manual the friction factor of GI =2.9

$$=2.9*23/100 =0.667$$

$$\text{Total pumping head} =15 + 40.82 +0.667 =60\text{m}$$

Pump capacity depends on the head and discharge that were determined from available data of existing borehole in design

$$Q=3.5\text{m}^3/\text{h} \text{ and head of } 60\text{m}$$

4.8.11 Power Requirement.

A power requirement of 1kw was provided to drive the pump.

4.8.12 Balancing Storage tank

The tank reservoir capacity was designed based on a schedule of demand pattern according to water supply design manual year 2000 .The MWE design manual recommends that the reservoir capacity be taken as 30% of Maximum Daily Demand

Therefore the capacity of storage tank = $(30/100)*187.23 = 56.2\text{m}^3$, thus the designed tank capacity = 100m^3 from the recommended standard capacities available in Uganda.

The shape of the tank considered was cylindrical.

Tank sizing

Volume of a cylindrical tank = area x height

Area = πr^2 where r = radius of cylinder = $d/2$ from Uganda water design manual recommends that the height of the reservoir should not exceed 5m , So 3m height was considered in sizing of tank

$$H = 3.0 + \text{Free board (0.5m was considered)} = 3.5\text{m}$$

Therefore the dimensions of the designed tank are,

$$D = 6.74\text{m}, h = 3.5\text{m} \quad V = 100\text{m}^3.$$

4.8.13 Friction losses

Using the Darcy-weisbach equation in getting the friction loss in the distribution network, total head losses of 269m of the distribution network and including all losses of stand taps in their locations depending on their pipe length, fittings, valve shown in table 9.

4.8.14 Design Horizon

Design horizon of 20 years (ending in 2039); starting with 2017 as the base year was taken.

4.8.15 Materials and Pipe Diameters

For the intake, the pump is considered to be installed at 35m in the borehole. This was considered to be GI rising pipe from the water up to the pump on the surface in the pump house. From the pump house was considered to be PVC pipe and HDP Pipes of class 4.

4.8.16 Intake

The intake is an existing borehole yielding 3.5m³/h. Base on the projection, was enough to satisfy the demand. The test pumping results of the borehole yield is attached to the appendix.

4.9 SANITATION

From the SEHS, it was found that 82.9% of the respondents are using 9% private VIP latrines, 4.5% other means while another 4.5% are have none. Diarrhea and Typhoid are the major water and sanitation related diseases that are seriously affecting the community standing at 35%anrespectively according to the SEHS.

4.10 ENVIRONMENTAL IMPACT ASSESSMENT

4.10.1 Introduction

Legal requirement and policy in Uganda, dictates that EIA be carried out for projects that are likely to have significant environment effects so as its adverse effect is mitigated and maximizing the positive effects.

Section 23 of the National Environmental Statute (1995) provides that the operator of a project shall take all reasonable measures to mitigate any undesirable effects not contemplated during the implementation of the project. The third schedule of the National Environmental Statute (1995) lists water projects as activities that require EIA.

4.10.2 Impact related to the construction activities

Loss of Vegetable covers

The construction of the proposed project had an adverse effect on the environment which resulted into loss of trees and other land cover of ecological importance. The Water pipelines however shall be laid along the road reserve resulting into minimum loss of trees and vegetation covers.

Spoil Materials

In the course of construction of the project, there will be significant excavation of the ground and the excavated material will need to be disposed of. Improper disposal may have an adverse effect on the environment and the community. The materials have to be disposed of in proper landfills or use in landscaping within the construction site. When laying pipes, earth shall be displaced in the process spoil shall be generated and the earth is exposed to the surface leading to increasing the risk of erosion.

Loss or Damage to the land

There shall be no relocation or resettlement of the people as a result of the project work. Some loss of cultivation land may occur. No building is going to be destroyed

The owners of the crops and land are eligible for compensation as per the existing law in the area.

Permanent Severance of land and change in Land rights

The land act of 1997 empowers bonafide occupants with all the rights of ownership. Where pipe are to be laid especially where the land is privately owned, right of access for maintenance purposes was required and this affected the rights of the original owner forever. An “easement” as provided in the water statue of 1995 was provided to grant access to grant access to the pipeline at any time.

Temporary limitation to access

As a result of laying the pipes during construction, temporary inconveniences shall be caused to the population at road crossings, footpath crossings and frontages to the buildings. This shall be minimized by proper timing of works to cause minimum inconveniences to the population.

Material for Construction and Disposal

Constructional materials such as sand, boulders, aggregates etc. shall have to be used for various works especially constructing the pump house. If poor handle they can be dangerous and unsightly. The contractor shall apply the best engineering practices to make sure that the materials are properly kept.

4.10.3 Proposed mitigation measures

The mitigation plan addresses the negative impacts generated during the implementation of the project. The mitigation measures include the following

Provision of adequate safety procedures and supervision of works, including the provision of appropriate training for the workforce, especially when undertaking potentially hazardous activities.

Minimization of the amount of land taken by construction activities and adequate mitigation of the effects on the owner, or user of the land that has to be taken.

Restriction of working time to day light hours to minimize rate of accidents, disruption due to noise and impact of dust generation.

Advance warning of works was made to farmers, and compensation payable for loss of crops if any are destroyed.

Ensuring that contractors complete all reinstatement work to a high standard before approval is given.

Trenches were excavated, pipes laid and backfilled within one day at road crossings and access routes to minimize disruption

4.10.4 Social Economic Impact

The positive socio-economic impacts of the project shall include:

Creation of new jobs during the construction and operation of the water supply system.

Improved availability of the water both in the project area and the sub county as a whole.
Reducing drastically the time wasted in moving distant places, standing in long queues etc. because water will be available at the doorsteps of the community.

Improved service delivery at the health center because of constant availability of potable water

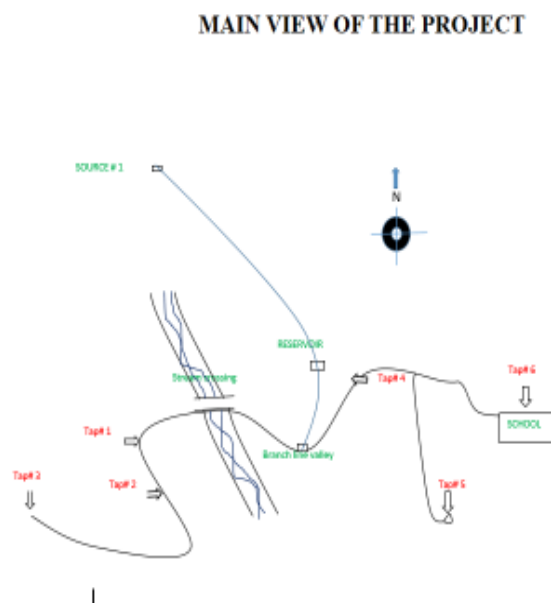


Table 8: Topographical survey data showing transmission and distribution mains

ELEVATION (METRES)	MANLINE PIPE LENGTH (METRES)			
950	0+000		Reservoir	
930	0+200		Tap 1	
910	0+400		Break Tank	
860	0+600			
850	0+800			
840	0+1000			
820	0+1200			
800	0+1400		Washout	
810	0+1600			
820	0+1800			
830	0+2000			
835	0+2200			
840	0+2400		Air Valve	
826	0+2600			
780	0+2800			
750	0+3000			
745	0+3200		Break Tank	
730	0+3400			
725	0+3600		Tap 5	
720	0+3800		Tap 6	

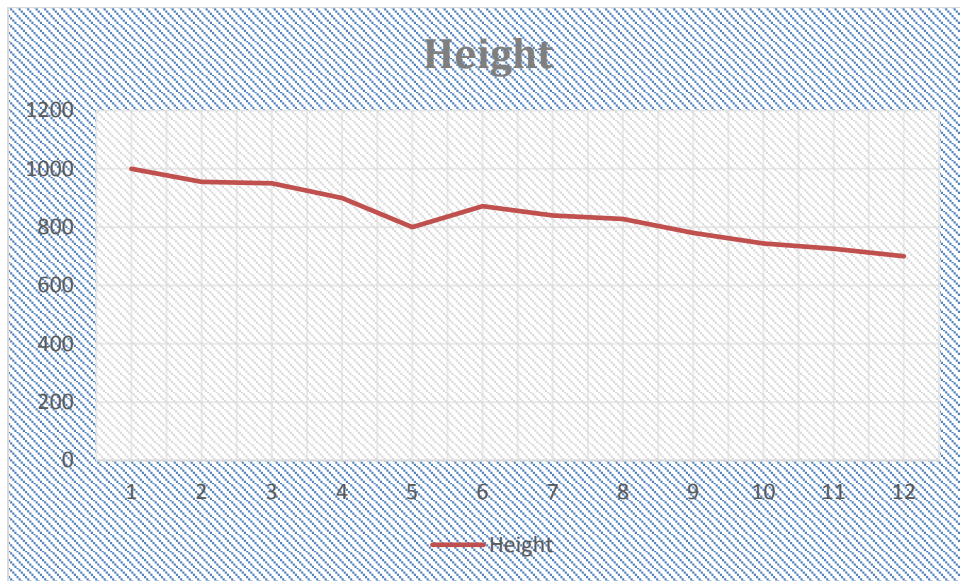


Figure 3: Profile showing distributions lines from the reservoir to the last point

DESCRIPTION

From the break-pressure tank to the source is 100 meters of elevation. It was possible to use Class IV in this section, but it was actually less expensive to install another break-pressure tank and use Class III pipe. Thus, another break-pressure tank was required 60 meters lower than the source. This would put it just downstream from Tap 1 (for the sake of convenience, the break- Pressure tank was located 5 meters lower than the tap, which was placed at ML-400. This was break pressure tank 1 (BT 1), and the next one downstream was a break pressure tank 2 (BT 2)

A third break pressure tank was 60m lower than BT 2 which put it at an elevation of 840m, between taps 2 and 3

The next break pressure tank BT 4 was 60 m lower than BT3, which put it at an elevation of 780m, between Taps 3 and 4

From BT 4, there is 80m of vertical distance to the last tap, which required either another break pressure tank or class IV pipe.

In this case, a 20mm HDP pipe was used to reach the last tap, and such pipe is provided only in class IV.

So the four break pressure tanks were located as follows:

BT 1 ML 400, elevation 950m

BT 2 ML 600, elevation 900m

BT 3 ML 2240, elevation 840m

BT 4 ML 2540, elevation 780m

And class IV pipe was designed, reach by reach, beginning at the source.

First Reach (Source Tap 1)

Design flow 1.35 LPs) (flow for 6 taps)

Pipe length: $380 - 0 = 380$ m

1000m (Elev of HGL @ source)

-955m (elevation of Tap 1)

-15m (desired residual head at Tap 1)

30 m Desired frictional Headloss

$$\frac{\text{Desired headloss}}{\text{Pipe length}} = \frac{30}{380} \times 100\% = 7.89\% \text{ (Desired frictional headloss factor)}$$

From the HDP Frictional headloss Table for a flow of 1.35LPs, its seen that the headloss factor of 32mm HDP pipe is too high (18.15%) while that of 50mm HDP pipe is too low (2.08%). Thus, a combination of both of the pipe sizes is need to produce exactly the desired head loss.

Then from the calculations the length needed

Let the length of a 50mm HDP by y and the 32mm HDP be x

$$x + y = 380 \quad \text{and} \quad 0.1815x + 0.0208y = 30 \quad \text{Solving these two equations}$$

243m of 50mm HDP at 2.08% creates 5m of headloss

137m of 32mm HDP at 18.15% creates 25m of Headloss

30m Total head loss

Elevation of HGL at Tap 1 = 970m

Second Reach (Tap 1 and BT 1)

Design flow = $(1.35 - 0.225) = 1.125$ LPs (flow for 5 taps)

Pipe length: $400 - 380 = 20$ m

970m (Elev of HGL @ Tap 1)

-950m (elevation of BT 1)

-10m (desired residual head at BT 1)

10 m Desired frictional Headloss

$$\frac{\text{Desired headloss}}{\text{Pipe length}} = \frac{10}{20} \times 100\% = 50\% \text{ (Desired frictional headloss factor)}$$

From head loss table, it is seen that no factor is given for this flow for 20mm HDP pipe (because the flow velocity would be too high), therefore there is no choice but to use 32mm HDP pipe:

20m of 32mm HDP at 12.6% creates 3 m of head loss

Actual residual head = 17m from $(20 - 3)$ (acceptable)

Therefore BT 1 must be constructed with a globe valve at its discharge, adjusted to allow exactly 1.125 Laps flow. For convenience sake, a gate valve can be installed on the outlet of the tank, permitting the downstream pipeline to be shut down cutting off the flow for tap 1

The HGL is now at the surface level of the water in the tank, at 950m elevation.

Third Reach (BT 1 and BT 2)

Design flow = 1.125 LPs (flow for 5 taps)

Pipe length: $600 - 400 = 200$ m

Since there are no tap stands along this reach, there is no reason why the pipe must flow full. Select the smallest size that will allow the design flow through.

950m (Elev of HGL @ BT 1)

-900m (elevation of BT 2)

0m (desired residual head at BT 2)

50 m Maximum allowable Headloss

$$\frac{\text{Desired headloss}}{\text{Pipe length}} = \frac{50}{200} \times 100\% = 25\% \text{ (Maximum allowable frictional factor)}$$

32mm HDP is the smallest pipe size that has a frictional factional factor less than 25%, so this is the pipe size to be used. Since there is no need to maintain pressure in the pipeline, the pipe is allowed to discharge freely into BT 2. Gravity will drain the line faster than it will fill, so it would not flow full.

Fourth reach (BT 2 and Tap 2)

Design flow = 1.125 LPs (flow for 5 taps)

Pipe length: 1980 – 600 = 1380m (Including 850m of class IV)

900m (Elev of HGL @ BT 2)

-872m (elevation of Tap 2)

-7m (minimum desired residual head at Tap 2)

21 m Maximum desired Headloss

$$\frac{\text{Desired headloss}}{\text{Pipe length}} = \frac{21}{1380} \times 100\% = 1.52\% \text{ (Desired frictional headloss factor)}$$

This reach will require 530 m of class III pipe and 850m of class IV pipe. Once again, combination pipe sizes are required. Class III 50mm HDP pipe will be used for the entire class III length:

530m of 50mm HDP at 1.40% create 7m of headloss. (Therefore only 14m of allowable headloss left)

The proper combination of class IV pipe is

567m of 50mm HDP at 2.12% creates 12m of headloss

283m of 63mm HDP at 0.70% creates 2m of headloss

14m of total headloss

Thus, the pipe arrangement for the entire reach is:

270m of class III 50mm HDP pipe

567m of class IV 50mm HDP pipe

283m of class IV 63mm HDP pipe

260m of class III 50mm HDP pipe

Elevation of HGL at tap 2 = 879m

A washout is located at the bottom of the U – profile, since it is a major low point in the system, and there is no reservoir tank to allow sedimentation to occur. The presence of a washout does not affect the hydraulic profile of the system (except when the washout is opened).

Fifth reach (Tap 2 and BT 3)

Design flow = 0.90 LPs (flow for 4 taps)

Pipe length: 2240 – 1980 = 260m

879m (Elev of HGL @ Tap 2)

-840m (elevation of BT 3)

-10m (desired residual head at BT 3)

29 m desired Headloss

$$\frac{\text{Desired headloss}}{\text{Pipelength}} = \frac{29}{260} \times 100\% = 11.2\% \text{ (Desired frictional headloss factor)}$$

The only pipe size which gives a close frictional factor is 32mm HDP:

260m of 32mm HDP at 8.9% creates 23m of headloss

Actual residual head = 16m (acceptable)

BT 3 must have a globe valve at its discharge so that the exact desired flow of 0.9 LPs comes through. A gate valve may be installed on the outlet to cut off downstream flow without effecting the upstream taps.

Elevation of HGL at 3 = 840m

Sixth reach (Tap 3 and BT 3)

Design flow = 0.90 LPs (flow for 5 taps)

Pipe length: 2330 – 2240 = 90m

840m (Elev of HGL @ BT 3)

-828m (elevation of Tap 3)

-7m (minimum desired residual head at Tap 3)

5 m Maximum Allowable desired Headloss

$$\frac{\text{Desired headloss}}{\text{Pipelength}} = \frac{5}{90} \times 100\% = 5.56\% \text{ (Desired frictional headloss factor)}$$

For this flow, 50mm HDP pipe must be used;

90m of 50mm HDP at 0.99% creates 1 m of Head loss

Actual residual head = 11m (acceptable)

Elevation of HGL at tap 3 = 839m

Seventh reach (tap 3 and BT 4)

Design flow = 0.675 LPs (flow for 3 taps)

Pipe length: 2540 – 2330 = 210m

839m (Elev of HGL @ Tap 3)

-780m (elevation of BT 4)

-10m (desired residual head at BT 4)

49 m desired Headloss

$$\frac{\text{Desired headloss}}{\text{Pipelength}} = \frac{49}{210} \times 100\% = 23.33\% \text{ (Desired frictional headloss factor)}$$

Again there is no choice but to use 32 mm HDP

210m of 32mm HDP at 5.3% creates 11m of headloss

Actual residual head = 48m (acceptable)

This residual head is getting close to the maximum allowable limit of 56m. High residual heads wear and tear on control valves, reducing their lifetimes and requiring more frequent replacement.

Elevation of HGL at BT 4 = 780m

Eighth reach (BT 4 and Tap 4)

Design flow = 0.675 LPs

Pipe length: 3740 – 2540 = 200m

780m (Elev of HGL @ BT 4)

-744m (elevation of Tap 4)

-15m (desired residual head at Tap 4)

21 m Maximum desired Headloss

$$\frac{\text{Desired headloss}}{\text{Pipe length}} = \frac{21}{200} \times 100\% = 10.5\% \text{ (Desired frictional headloss factor)}$$

Again, there is no choice but for 32mm HDP

200m of 32mm HDP at 5.3% creates 11m of headloss

Elevation of HGL at tap 4 = 769m

Ninth Reach (Tap 4 and Tap 5)

Design flow = 0.45 LPs

Pipe length: 2860 – 2740 = 120m (Including 850m of class IV)

769m (Elev of HGL @ Tap 4)

-726m (elevation of Tap 5)

-15m (minimum desired residual head at Tap 5)

28 m desired Headloss

$$\frac{\text{Desired headloss}}{\text{Pipe length}} = \frac{28}{120} \times 100\% = 23.33\% \text{ (Desired frictional headloss factor)}$$

A combination of 32mm HDP and 20mm HDP pipe sizes are used

67m of 20mm HDP at 40% creates 27m of headloss

53m of 32mm HDP at 2.56% creates 1m of headloss

Actual residual head 15m

Elevation of HGL at tap 5 = 741m

Tenth Reach (Tap 5 and Tap 6)

Design flow = 0.225 LPs

Pipe length: 3280 – 2860 = 420m

741m (Elev of HGL @ Tap 5)

-700m (elevation of Tap 6)

-15m (desired residual head at Tap 6)

26 m desired Headloss

$$\frac{\text{Desired headloss}}{\text{Pipe length}} = \frac{26}{420} \times 100\% = 6.2\% \text{ (Desired frictional headloss factor)}$$

A combination of 32mm HDP and 20mm HDP is needed

218mm of 32mm HDP at 0.78% creates 2m of headloss

202m of 20mm HDP at 12.0% creates 24m of headloss

Actual residual head = 15m

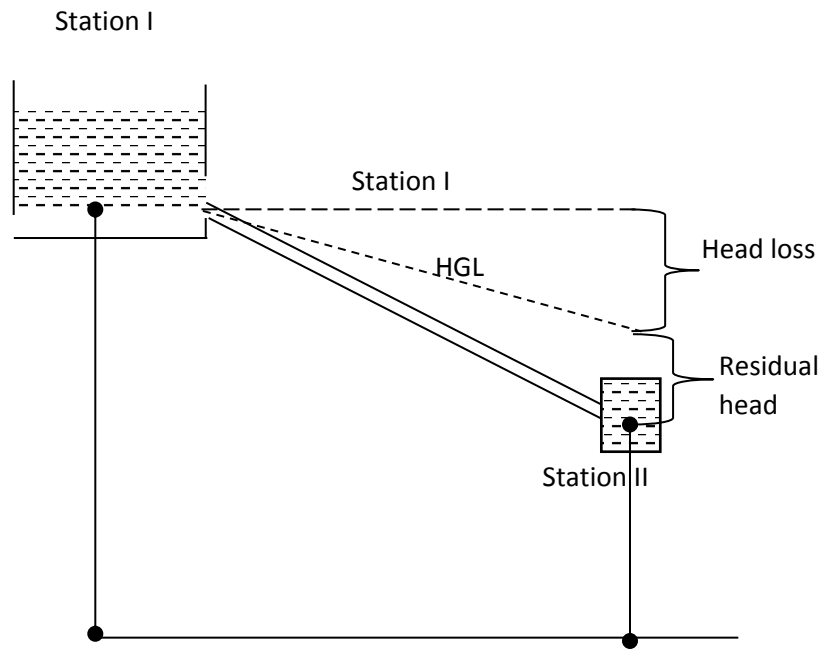


Table 9: Headlosses

Distance	Height	Remarks
0	1000	Source (reservoir)
380	955	Tap 1
400	950	Break Tank 1
600	900	Break Tank 2
1300	800	Washout
1938	872	Tap 2
2240	840	Break tank 3
2330	828	Tap 3
2540	780	Break tank 4
2740	744	Tap 4
2860	726	Tap 5
3280	700	Tap 6

Water source

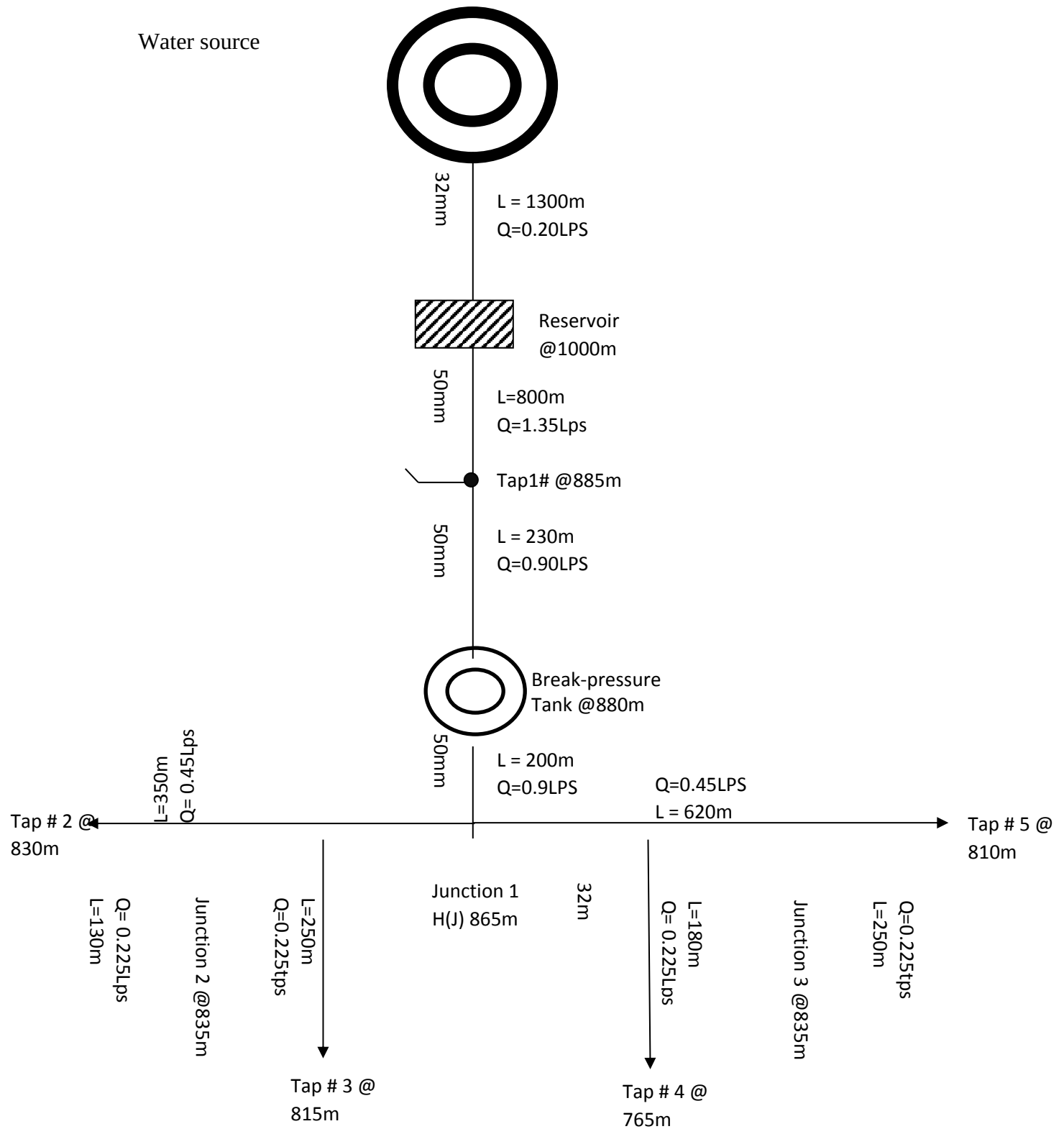


Table 10: shows the calculated values that were used in transmission mains.

	Reach													F – N	R - G	
	Station I	Station II	Flow (LPs)	Pipe Length (m)	HGL @ Station I	Elevation of Station II	Desired residual head	Desired Frictional Headloss	Frictional headloss factor	Pipe sizes (mm)	HDP Class	Actual frictional headloss factor	Head loss	HGL @ Station II	Actual residual head of Station II	Remarks
Reach	Intake	Reservoir	0.2	1300										1000		Water pumped into reservoir
1	Reservoir	Tap 1	1.35	380	1000	955	15	30	7.89	50		2.08	5			Combination of 32mm and 20 mm HDP
2	Tap 1	BT 1	1.125	20	970	950	10	10	50.00	32		12.6	3	967	17	Acceptable Headloss
3	BT 1	BT 2	1.125	200	950	900	0	50	25.00	32		25	50	878		
4	BT 2	Tap 2	1.125	1380	900	872	7	21	1.52	50	IV	2.12	12	886	14	
										63	IV	0.7	2			
5	Tap 2	BT 3	0.9	260	879	840	10	29	11.15	32	III	8.9	23	840		
6	BT 3	Tap3	0.9	90	840	828	7	5	5.56	50	III	0.99	1	839	11	Ok
7	Tap 3	BT 4	0.675	210	839	780	10	49	23.33	32	III	5.3	11	780		Combination of 32mm and 20 mm HDP
8	BT 4	Tap 4	0.675	200	780	744	15	21	10.50	32	III	5.3	11	769	25	
9	Tap 4	Tap 5	0.45	120	769	726	15	28	23.33	32	III	2.56	1			Need Frictional diffuser
										20	III	40	27	741	15	Acceptable Head loss
10	Tap 5	Tap 6	0.225	420	741	700	15	26	6.19	32	III	0.78	2	715	15	Acceptable head loss
										20	III	12	24			
				4580												

DETAILS OF PIPE AND FITTINGS OF A TAP

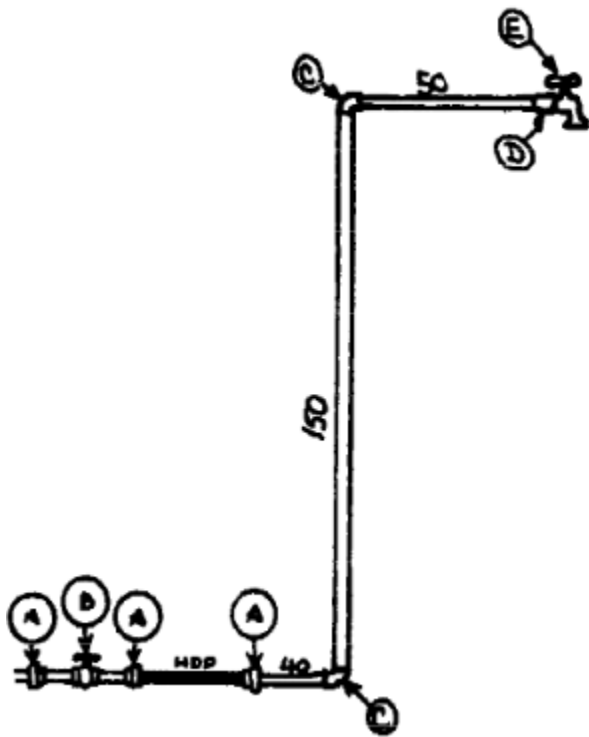


Figure 5: Details of pipes and fittings of tap

Item	Total quantity
A 1/2", 20mm GI/HDP Brass union (3 per tap stand)	12
1/2", GI NIPPLE (2per tap stand)	8
B , Globe valve	4
1/2", GI pipe @ 40cm*	160cm
C , GI elbows (2 per tap stand)	8
1/2", GI pipe @ 150cm*	600cm
1/2", GI pipe @ 50cm*	200cm
D , GI socket	4
E , Brass Favcet	4
(*all GI pipe threaded @ both ends)	
TAPSTANDS #1-#4	

CHAPTER FIVE

RECOMMENDATIONS AND CONCLUSION

5.1 Conclusion

The problem to be solved here was water shortage encountered by the people of Muko Ikamiiro parish due to lack of a reliable water supply system that forced people to fetch water from open water sources like ponds, wells which were susceptible to contamination from runoff, animal droppings since the water was always shared with the animals, long distances moved by the people in their trial to access safe drinking water.

To overcome the above problem, certain specific objectives were to be met first these included; to determine the water demand for the community, to characterize and determine the quality of the available water sources, to design an effective water supply system.

All these objectives were met step by step through series of activities as stated in the previous chapters until the last point of providing the cost estimates.

Its highly hoped that when the design is implemented, the community of Muko Ikamiiro parish shall not again face the above said problems and shall contribute significantly to the rapid development of Ikamiiro Parish Rubanda district until 2034.

5.2 Challenges

- Inadequate access to data which in the end incorporated the use of other methods to come up with the required data.
- Time consuming as it takes a lot of time to figure out the errors made within the software.
- Inadequate knowledge on the use of the software.

5.3 Recommendations

In order to achieve successful implementation of this design, a number of further inputs may need to be made for the project to fully benefit the community and the scheme to function optimally for its sustainability.

We recommend the following;

- The local council authorities and the community should fully be involved in the implementation of the design alongside the contractors. This is to instill ownership of the scheme in the community minds and provide community members with the skills for the upcoming tasks.

- Further studies still need to be carried out on the detailed design especially structural components of the system.
- Private operators are to be hired to operate and maintain the system on a regular basis.
- Sanitation, operation and maintenance plan to be studied and agreed upon by the local council body in charge.

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- 5 Bamberger, M and Hewitt, E (1986). Monitoring and Evaluating Urban Development Programs.
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APPENDIX II: PROPOSED BUDGET FOR THE PROJECT

NO.	ITEM	AMOUNT (UGX)
1	Transport and accommodation	200,000
2	Tests	350,000
3	Data collection	100,000
4	Binding and photocopy	100,000
5	Consulting	200,000
7	Miscellaneous	200,000
	TOTAL	1,150,000=