

**MAKERERE**



**UNIVERSITY**

**COLLEGE OF ENGINEERING DESIGN ART AND TECHNOLOGY  
SCHOOL OF BUILT ENVIRONMENT**

**DEPARTMENT OF CONSTRUCTION ECONOMICS AND MANAGEMENT**

**DESIGN AND CONSTRUCTION OF KYABAYANJA SOLAR PIPED WATER  
SYSTEM IN MUBENDE DISTRICT**

**BY**

**NABYOLE BRENDA SEBUGGWAWO**

**2024/HD08/1640U**

**2400701640U**

**A PROJECT REPORT SUBMITTED TO THE COLLEGE OF ENGINEERING DESIGN  
ART AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR  
THE AWARD OF A POST GRADUATE DIPLOMA IN CONSTRUCTION PROJECT  
MANAGEMENT OF MAKERERE UNIVERSITY.**

## DECLARATION

This is to certify that I, **NABYOLE BRENDA SEBUGGWAWO**, am the original author of this report. All the information contained in this report is accurate and has never been submitted by any individual at any institution of higher learning for a similar or any other academic award.

Signature ..... *Brenda* ..... Date ..... *10/07/2025* .....

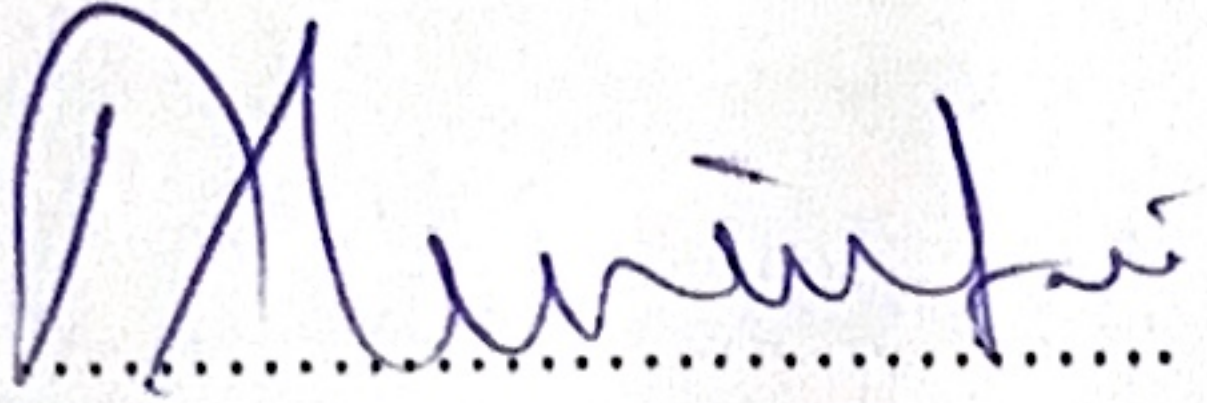
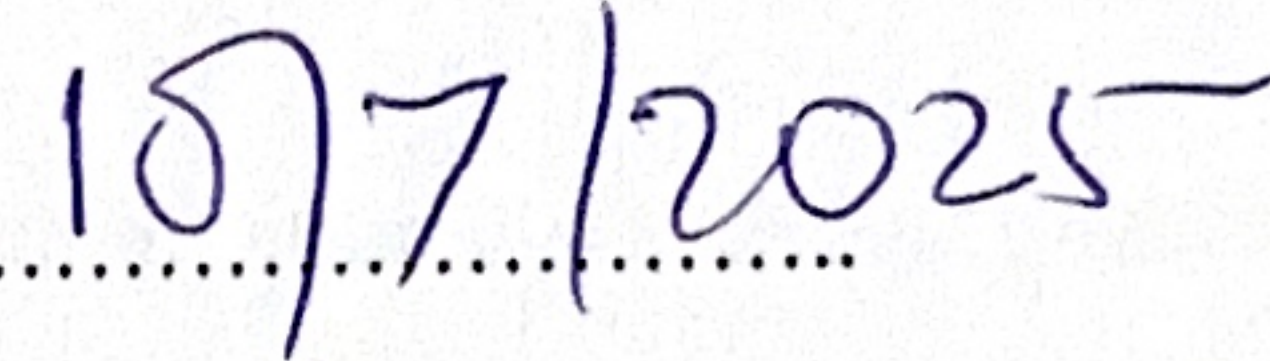
**NABYOLE BRENDA SEBUGGWAWO**

**REG NO: 2024/HD08/1640U**

**STUDENT No: 24007016404**

## APPROVAL

This work has been carried out under my supervision and is now ready for submission to the department of Construction Economics and Management, College of Engineering, Design, Art and Technology (CEDAT), Makerere University Main Campus, with my approval.

Signature.......... Date..........

**PROF. HENRY ALINAITWE**

**SUPERVISOR.**

## Digitisation and Self-Archiving Consent Agreement: Theses

Agreement between Makerere University & Students (Authors of Theses / Dissertations / Reports)

1. The author is a student of Makerere University and author of the thesis / dissertation entitled:

DESIGN AND CONSTRUCTION OF KYABAYANJA  
SOLAR PIPED WATER SYSTEM IN  
MOBENDE DISTRICT

2. The author grants to the University:

- a. The right to deposit the electronic version of the Thesis / Dissertation into Makerere University Institutional Repositories (Mak IR) or (Mak UD); and  
b. The right to store the thesis / dissertation in Mak IR / Mak UD and make it permanently available to the general public via the Internet at no cost to the general public after a grace period (if any is specified).

Choose one of the three options below (c, d, or e):

- c. The Author may opt for immediate open access to the public ..... **c**  
d. Or Restrict access indefinitely: .....  
e. Or Restrict access for the specified number of years: .....  
f. Reason for restriction: .....

3. The author warrants that to the best of the authors knowledge and belief:

- a. The thesis / dissertation is an original work;  
b. The author is the owner of all the intellectual property in the thesis / dissertation;  
or  
c. The Author is entitled to deal with the intellectual property in the thesis / dissertation by publishing it on the Internet  
d. The Author has the right, power and authority to enter into this Agreement and to grant the University the rights contained in this Agreement; and  
e. The University's use of the thesis / dissertation pursuant to this Agreement will not infringe the intellectual property rights of any third party.

4. The Author acknowledges and agrees that the University is not responsible or liable for any breach of the intellectual property rights in the thesis / dissertation, in particular any breach of copyright, as a result of the use of the thesis / dissertation pursuant to this Agreement.

5. The University acknowledges that the rights granted by the Creator in clause 2 of this Agreement, do not cause any transfer or assignment of any proprietary rights in the intellectual property in the article to the University.

Signed by the Author as confirmation that the Author has read and accepted the terms of this Agreement:

Name: NABYOLE BRENDA SEBUGGAWO

College: CEDAT School: BUILT ENVIRONMENT

(Tick) Type of Degree: (Undergraduate / PGD / Masters / PhD), Reg. No.: 2024/H008/16404

Tel No.: 0706117978 E-Mail: Nabyolebrenda@gmail.com

Signature: Brenda Date: 16/02/2026

Supervisor's endorsement: \_\_\_\_\_

## **ACKNOWLEDGEMENT**

I would like to acknowledge my supervisor, Prof. Henry Alinaitwe, for sparing his valuable time to offer me academic guidance during the course of this program,

I extend my gratitude to the team of Mubende District Local Government for the opportunity to work with them while writing the report.

I also acknowledge the government of Uganda as the key funding source which has enabled the project enhance its credibility and communal significance.

I finally thank friends and family for the extended support and encouragement.

## **ABSTRACT**

This report presents the design and construction of a solar powered piped water system in Kyabayanja village, Mubende District, aimed at addressing the community's limited access to safe and reliable water. This project harnesses solar energy to power submersible pump that draws water from a borehole into an elevated storage tank, from which it is distributed through a network of pipes to strategically located tap stands.

The design process involved estimating the community's water demand, evaluating data, sizing the solar power system, selecting appropriate pump specifications, and designing the storage and distribution infrastructure.

Construction activities included borehole drilling, installation of the solar pumping unit, tank raising, and laying of distribution and transmission pipelines. The project contributes to sustainable rural water supply by integrating renewable energy, minimizing operational costs, and promoting communal ownership. It demonstrates the feasibility and impact of solar water supply systems in rural areas of Uganda.

# TABLE OF CONTENTS

|  |            |
|--|------------|
| <b>DECLARATION</b> .....                                   | <b>i</b>   |
| <b>APPROVAL</b> .....                                      | <b>ii</b>  |
| <b>ACKNOWLEDGEMENT</b> .....                               | <b>iii</b> |
| <b>ABSTRACT</b> .....                                      | <b>iv</b>  |
| <b>LIST OF TABLES</b> .....                                | <b>ix</b>  |
| <b>LIST OF FIGURES</b> .....                               | <b>x</b>   |
| <b>ACRONYMS AND ABBREVIATIONS</b> .....                    | <b>xi</b>  |
| <b>CHAPTER ONE: INTRODUCTION</b> .....                     | <b>1</b>   |
| 1.1 Overview .....   | 1          |
| 1.2 Background .....                                       | 1          |
| 1.3 PROBLEM STATEMENT. ....                                | 2          |
| 1.4 OBJECTIVES .....                                       | 2          |
| 1.4.1 Main objectives .....                                | 2          |
| 1.4.2 Specific Objectives .....                            | 3          |
| 1.5 SCOPE OF CONSULTANCY SERVICES.....                     | 3          |
| 1.6 EXPECTED OUTPUTS. ....                                 | 4          |
| <b>CHAPTER TWO: EXISTING WATER SOURCES</b> .....           | <b>5</b>   |
| 2.1 Ownership and Location. ....                           | 5          |
| 2.2 Water Sources .....                                    | 5          |
| 2.3 Purpose and Consumer Base. ....                        | 5          |
| 2.4 Service Levels and Constraints. ....                   | 5          |
| 2.5 Technical and Economic Assessment .....                | 6          |
| <b>CHAPTER THREE: SOCIOECONOMIC STUDY</b> .....            | <b>7</b>   |
| 3.1 Distribution of the project Area. ....                 | 7          |
| 3.2 Population Distribution. ....                          | 7          |
| 3.3 Existing Water Sources And Sanitation Facilities. .... | 8          |
| 3.4 Economic activities .....                              | 8          |
| 3.5 Land Use. ....   | 9          |
| 3.6 Household Income.....                                  | 9          |
| 3.7 housing. ....  | 9          |
| 3.7 Communication and transport facilities. ....           | 10         |
| 3.8 Land tenure system.....                                | 10         |

|   |           |
|---|-----------|
| 3.9 Youth population.....   | 10        |
| Observations .....  | 11        |
| <b>CHAPTER FOUR: POPULATION PROJECTIONS AND WATER DEMAND ASSESSMENTS.....</b> | <b>12</b> |
| 4.1 Population Growth rate and Projection. ....                               | 12        |
| 4.1.1 Base Population (2024).....   | 12        |
| 4.1.2 Population Projections. ....  | 12        |
| 4.1.3 Key Observations.....   | 12        |
| 4.2 Water Demand Projections.....   | 13        |
| 4.2.1 Assessment Criteria for service levels. ....                            | 13        |
| 4.2.2 Existing NWSC Pro-poor Tariff (2023).....                               | 13        |
| 4.2.3 Proposed Tariff.....  | 13        |
| 4.2.4 Comparison Tariff (Umbrella Authority for similar schemes).....         | 13        |
| 4.2.5 NWSC Domestic Tariff.....   | 14        |
| 4.3 Level of Service Based on the Ability to Pay. ....                        | 14        |
| 4.4 Water demand. ....  | 14        |
| <b>CHAPTER FIVE: WATER RESOURCES ASSESSMENT. ....</b>                         | <b>15</b> |
| 5.1 Proposed Water Source. ....   | 15        |
| 5.2 Water Supply and Demand Analysis. ....                                    | 15        |
| <b>CHAPTER SIX: DESIGN CRITERIA.....</b>                                      | <b>17</b> |
| 6.1.1 Design Period & Horizon.....  | 17        |
| 6.1.2 Hydraulic Peak Flows. ....  | 17        |
| 6.1.3 Pipe Flow Velocities. ....  | 18        |
| 6.1.4 Operating Pressures. ....   | 18        |
| 6.1.5 Selection of Pipe Materials. ....                                       | 18        |
| 6.1.7 Storage Capacity. ....  | 18        |
| 6.1.8 System Operation Time. ....   | 19        |
| 6.1.9 Unit Water Demand. ....   | 19        |
| <b>CHAPTER SEVEN: WATER SUPPLY SYSTEM COMPONENT. ....</b>                     | <b>20</b> |
| 7.1 Transmission Main.....  | 20        |
| 7.2 Storage Tank. ....  | 21        |
| 7.3 Distribution Network.....   | 21        |
| 7.4 Disinfection. ....  | 21        |
| 7.5 Power Supply. ....  | 22        |

|  |           |
|--|-----------|
| <b>CHAPTER EIGHT: ENVIRONMENTAL IMPACT STUDY.....</b>                                | <b>23</b> |
| 8.1 Policy, Legal, and Administrative Framework of the Environmental Policy. ....    | 23        |
| 8.2 Potential Environmental and Social Impacts. ....                                 | 23        |
| 8.2.1 Direct Project Impacts.....  | 23        |
| 8.2.2 Indirect Impacts. ....   | 25        |
| 8.3 Observations.....  | 25        |
| <b>CHAPTER NINE: PROJECT COST ESTIMATES AND FINANCIAL ANALYSIS.....</b>              | <b>26</b> |
| 9.1 Introduction. ....   | 26        |
| 9.2 Capital Investment Cost Estimates.....   | 26        |
| 9.3 Operation & Maintenance Costs. ....  | 27        |
| 9.3.1 Annual Maintenance. ....   | 27        |
| 9.3.2 Energy Costs. ....   | 28        |
| 9.3.3 Capital Recovery Costs.....  | 28        |
| 9.4 Assumptions Used in Analysis.....  | 29        |
| 9.4.1 Design Horizon & Project Evaluation Period. ....                               | 29        |
| 9.4.2 Relevant Costs Used. ....  | 29        |
| 9.4.3 Rates Used in Analysis.....  | 29        |
| 9.4.4 Cash Flows Used in Analysis.....   | 29        |
| 9.4.5 Project Viability.....   | 30        |
| 9.5 Results of the Analyses. ....  | 30        |
| 9.5.1 Without capital cost recovery (initial investment cost).....                   | 30        |
| 9.6.2 With capital cost recovery (initial investment cost).....                      | 30        |
| <b>CHAPTER TEN: CONSTRUCTION PROCESS. ....</b>                                       | <b>32</b> |
| 10.1 Introduction.....   | 32        |
| 10.2 Phase One Construction Works (FY 2022/2023).....                                | 32        |
| 10.2.1 Borehole Equipping and Solar Pump Installation.....                           | 32        |
| 10.2.2 Transmission Pipeline (577 Metres) ....                                       | 32        |
| 10.2.3 Construction of Temporary Reservoir (10,000 Litres).....                      | 33        |
| 10.2.4 Initial Distribution Network (700 Metres).....                                | 33        |
| 10.3 Phase Two Construction Works (FY 2023/2024).....                                | 33        |
| 10.3.1 Construction of Elevated Permanent Reservoir (32,000 Litres).....             | 33        |
| 10.3.2 Extension of Distribution Network to Kijumba Trading Centre (500 Metres)..... | 34        |
| 10.3.3 Solar System Upgrade.....   | 34        |
| 10.4 Quality Assurance and Supervision .....   | 34        |

|   |           |
|---|-----------|
| 10.5 Challenges Faced During Construction.....            | 34        |
| <b>CHAPTER ELEVEN: INSTITUTIONAL AND MANAGEMENT .....</b> | <b>36</b> |
| 11.1 ARRANGEMENT .....                                    | 36        |
| 11.2 Community Based Management System Plus (CBMS+) ..... | 36        |
| 11.3 Community Based Management System (CBMS) .....       | 36        |
| 11.4 Public-Private Operation and Maintenance (PPOM)..... | 38        |
| 11.5 Supporting Legal and Regulatory Framework.....       | 39        |
| 11.6 Training of Water User Committees (WUCs).....        | 39        |
| 11.7 Quality Control.....                                 | 39        |
| 11.8 Roles of Stakeholders.....                           | 39        |
| <b>CONCLUSION AND RECOMMENDATIONS .....</b>               | <b>40</b> |
| 12.1 Key Findings from the Proposed Design .....          | 40        |
| 12.2 Recommendations .....                                | 41        |
| <b>REFERENCES.....</b>                                    | <b>42</b> |
| <b>APPENDIX.....</b>                                      | <b>43</b> |

## **LIST OF TABLES**

|  |    |
|--|----|
| Table 3-1: Population Distribution for the Project Area. ....                                      | 7  |
| Table 4-1: Domestic Population Projections for the Project Area. ....                              | 12 |
| Table 5-1: Proposed Borehole for Water Supply.....   | 15 |
| Table 6-1: Unit Water Demand proposed in the DWD Design Manual .....                               | 19 |
| Table 7-1: Transmission main design details .....  | 20 |
| Table 7-2: Pipe Sizes and Lengths to be laid in phase 1 .....                                      | 21 |
| Table 7-3: Pump Specifications. ....   | 22 |
| Table 8-1: Impact Caused by the Project Implementation and the Corresponding Mitigations.<br>..... | 24 |
| Table 9-1: Water Supply System Summary Cost Estimates .....  | 27 |
| Table 9-2: Economic Life and Annual Maintenance Cost Factors .....                                 | 28 |
| Table 9-3: Assumptions made during energy costs.....   | 28 |
| Table 9-4: Assumptions made during capital recovery estimation. ....                               | 29 |
| Table 9-5: Initial investment cost without capital cost recovery .....                             | 30 |
| Table 9-6: Initial investment cost with capital cost recovery .....                                | 31 |

# LIST OF FIGURES

|  |   |
|--|---|
| Figure 1-1: Map of the Project Area..... | 2 |
|--|---|

## **ACRONYMS AND ABBREVIATIONS**

|          |   |   |
|----------|---|---|
| BOQ      | - | Bills of Quantities                           |
| DWD      | - | Directorate of Water Development              |
| DWRM     | - | Directorate of Water Resources Management     |
| L/C/D    | - | Litres per Consumer per Day                   |
| M.a.s.l. | - | Meters above Sea Level                        |
| MDD      | - | Maximum Day Demand M <sup>3</sup> Cubic Meter |
| MWE      | - | Ministry of Water and Environment M Meter     |
| mm       | - | Millimetre                                    |
| OD       | - | Outer Diameter                                |
| PN       | - | Pressure Number                               |
| Sq. Km   | - | Square Kilometre                              |
| uPVC     | - | Un-plasticized vinyl-chloride                 |
| NWSC     | - | National Water and Sewerage Cooperation       |
| VAT      | - | Value Added Tax                               |

# **CHAPTER ONE: INTRODUCTION**

## **1.1 Overview**

Access to safe and reliable water supply remains a significant challenge in many rural parts of Uganda including Kyabayanja Village in Kiyuuni Subcounty in Mubende District. In response to this the project focuses on the design and construction of a solar powered piped water system aimed at improving water access, reducing the burden of water collection, and promoting sustainable community development. The initiative harnesses renewable solar energy to operate the system, ensuring both environmental sustainability and cost efficiency. This project aligns with Uganda's national goals of increasing rural water coverage and is intended to serve as a model for scalable, community-driven water supply solutions.

## **1.2 Background**

Kiyuuni Sub- County in Mubende District is among the water-stressed areas where access to safe and reliable water remains a significant challenge. In response to this, the Mubende District Local Government has prioritized the development of sustainable water supply solutions aimed at improving the well-being of residents in the sub-county.

In the Financial Year 2024–2025, the district allocated funds to undertake a comprehensive feasibility study and design of a motorized piped water supply system utilizing a viable borehole located in Kyabayanja. This borehole has demonstrated a commendable yield, offering a promising source for sustainable water supply.

To implement this initiative, Mubende District Local Government contracted Emsult Engineering Consultancy to carry out the feasibility study and system design. The technical analysis involved the evaluation and design of all system components, including assessment of multiple water supply options.

Hydraulic modeling of the proposed distribution network was conducted using WaterCAD software to assess system efficiency and reliability. Furthermore, the options were evaluated based on capital investment and operation and maintenance costs, using parametric cost data derived from Bills of Quantities (BOQs) and engineering cost estimates. This intervention reflects the district's ongoing commitment to improving water access through technically sound and cost-effective infrastructure development in Kiyuuni Sub- County.

## Location of the Project Area.

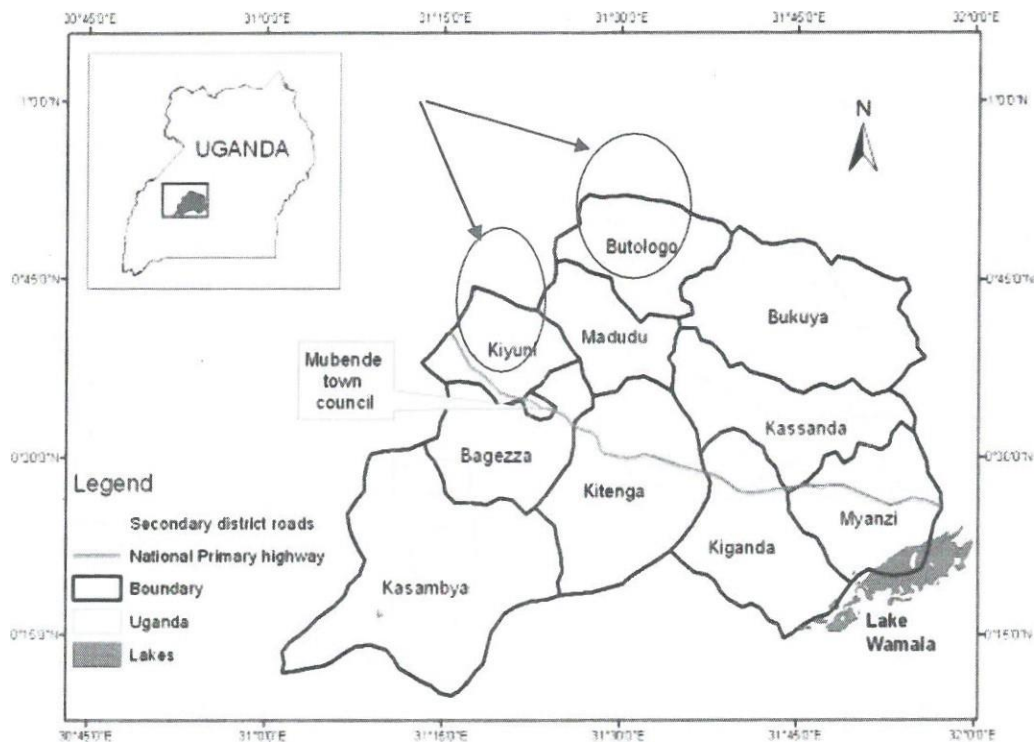


Figure 1-1: Map of the Project Area

### 1.3 PROBLEM STATEMENT.

Kyabayanja community in Mubende District faces persistent challenges related to inadequate access to safe and reliable water. The existing water sources (mainly unprotected wells and seasonal streams) are often distant, unsafe and unreliable, especially during dry seasons. This situation not only increases the risk of waterborne diseases but also places a significant burden on women and children, who are primarily responsible for fetching water.

Despite efforts by local authorities and development partners, the lack of sustainable infrastructure has hindered long term improvements in water access. There is a critical need for a cost effective, sustainable, and environmental friendly, solution to address the water supply challenges in Kyabayanja. The absence of such systems continues to affect health, productivity, and overall quality of life in the community.

### 1.4 OBJECTIVES

#### 1.4.1 Main objectives

The main objective was to design and construct a sustainable solar powered piped water supply system that improved access to safe and reliable water for the residents of Kyabayanja Village, Kiyuuni Sub County, in Mubende District.

### **1.4.2 Specific Objectives**

- i. To assess the water demand and supply needs of the Kyabayanja Community.
- ii. To conduct hydrogeological investigations to identify a viable ground water source for the system
- iii. To design a solar powered pumping system and distribution network suitable for the community's needs.
- iv. To oversee the construction and installation of the solar pumping system, storage tanks, and distribution pipelines.

### **1.5 SCOPE OF CONSULTANCY SERVICES.**

The consultancy services encompassed a detailed feasibility study involving field investigations and comprehensive analyses of technical, economic/financial, environmental, social, and management factors to assess the viability of proposed options for the water supply scheme. The study addressed the following key components:

- Evaluation of existing water resources identified for the scheme.
- Socioeconomic surveys to gauge community needs and social implications.
- Assessment of current and projected water demand.
- Feasibility analysis of proposed technical and operational solutions.
- Development of preliminary designs for water supply infrastructure in the project areas.
- Exploration of water supply management strategies.
- Environmental impact assessment to identify risks and mitigation measures.
- Preparation of cost estimates for infrastructure development.
- Financial and economic appraisal of the project's viability, including return on investment.
- Execution of detailed designs for water supply systems in the two parishes, accompanied by Tender Documents (including Bills of Quantities (BoQs), technical specifications, drawings, and instructions to bidders).

All activities were supported by systematic data collection and documentation to substantiate the Consultant's methodology and validate the study's conclusions.

## **1.6 EXPECTED OUTPUTS.**

The consultancy assignment was structured to deliver the following key outputs:

- A Feasibility Study evaluating the project's technical, economic, and operational viability.
- An Environmental Impact Assessment (EIA) outlining ecological, social, and sustainability considerations.
- A Detailed Design Report, accompanied by technical drawings, Bills of Quantities (BoQs), and Engineers' Cost Estimates for the water supply infrastructure.
- Tender Dossiers, comprising finalized BoQs, construction drawings, and proposed project schedules to facilitate the bidding and construction phases.

All outputs were developed to align with the project's objectives, ensuring compliance with technical standards and regulatory requirements.

My role on the project

I acted as the assistant water officer Mubende district and was possible for supervision while implementing the project

## **CHAPTER TWO: EXISTING WATER SOURCES**

This chapter outlines the current water supply infrastructure in Kiyuuni Sub- County, focusing on ownership, sources, service levels, and constraints.

### **2.1 Ownership and Location.**

Existing water points in Kiyuuni Sub- County are predominantly public or community managed, with no functional piped water systems. Water access relies on localized sources such as boreholes and shallow wells, primarily serving villages including Kyabayanja, and Kijumba.

### **2.2 Water Sources**

The primary water sources in Kiyuuni include; Shallow wells which are often unprotected and prone to contamination. Deep boreholes but these are also limited in number, with some non functional or requiring rehabilitation and protected springs which are mainly sparse and unevenly distributed.

### **2.3 Purpose and Consumer Base.**

Water is primarily used for domestic purposes (e.g., drinking, cooking, hygiene) by households in rural settlements. Most of the villages in the project area travel long distances to fetch water. This has a direct impact to their household income levels as this time would have been used for other productive activities. In addition, even the existing water points with in the project areas being few are usually overcrowded and this has caused routine breakdown which leaves the communities resorting back to the contaminated open water sources.

### **2.4 Service Levels and Constraints.**

Residents travel long distances (often >1 km) to collect water, with women and children spending significant time fetching water. There is also reduced water availability during dry seasons which forces reliance on contaminated stagnant pools

Kiyuuni Sub-county's water supply systems face critical challenges, there are limited functional boreholes and shallow wells fail to meet growing demand, while poorly protected sources risk contamination and waterborne diseases. Low household incomes hinder investments in water storage or sanitation, despite high community willingness to pay. Fragile maintenance frameworks leave community-managed water points prone to prolonged breakdowns, exacerbating reliance on distant or seasonal sources. These issues, coupled with inadequate sanitation infrastructure, perpetuate health risks and economic strain. Addressing

these constraints necessitates the proposed motorized piped system to ensure sustainable and equitable access.

## **2.5 Technical and Economic Assessment**

The socio-economic survey highlighted a strong community demand for improved water services, with 96.7% of households expressing willingness to pay for reliable access, though affordability remains a barrier given low average incomes (50,000–100,000 UGX/month). Health impacts are stark, as 53% of households reported illnesses linked to poor water quality (e.g., diarrhea, typhoid) in the two weeks preceding the survey. These findings underscore the economic burden of waterborne diseases and the urgent need for cost effective solutions. The proposed system aims to balance affordability with sustainable service delivery, aligning with community priorities. In conclusion, the water supply systems in the project area are fragmented and inadequate, relying on unreliable, unsafe sources. The proposed motorized piped water system aims to alleviate these challenges by providing equitable, year-round access to safe water.

## CHAPTER THREE: SOCIOECONOMIC STUDY.

The socio-economic baseline survey entails of findings derived from using key informant interviews, focus group discussions (FGDs), field observation and review of literature such as the District Development Plans, National Development Plan (NDP) and Uganda Bureau of Statistics (UBOS) statistical data to mention but a few.

### 3.1 Distribution of the project Area.

The project is located Kyabayanja in Kiyuuni Sub- County in Mubende District in Central region in Buganda Kingdom in Uganda. The project was a motorized piped water system meant to supply safe water for both domestic and commercial use to the growing population of people in the respective villages near the proposed water point. During the baseline survey its observed that the water source point can serve partly the Two (2) villages which include Kyabayanja and Kijumba in Kiyuuni Subcounty.

### 3.2 Population Distribution.

Generally, many of the districts in Uganda are facing a rapid population growth and this is the same for Mubende district. As per 2024 population census results, population has been on the increase. The total Population of Mubende District as contained in the 2024 Population and Housing Census was 521,966 with 259,035 males and 262,931 females. The Population of the district was reported to have grown by 2.4% between the period 2014-2024 and the average household size of the district was reported as 4 people per household. In the final analysis, the increasing population not only has an economic burden to the respective households that are already struggling with poor production but more so it has led to increased demand for water for domestic and farm use and often times this has affected the quality and quantity of water that is available to the communities.

**Table 3-1: Population Distribution for the Project Area.**

| Sub county | Parish     | Village    | Numbers |
|------------|------------|------------|---------|
| Kiyuuni    | Kyabayanja | Kyabayanja | 750     |
|            |            | Kijumba    | 800     |

### **3.3 Existing Water Sources And Sanitation Facilities.**

There are several water sources in Mubende district, these sources provide water for domestic, commercial and cultural use. Given the limited industries and other related commercial facilities in the location, water is majorly (87%) for domestic (District Development Plan 2020-2025). Mubende as a whole has 718 domestic water points which serve a population of 187,800 people and the entire district has 2 piped water schemes (MWE Water Supply Atlas, 2023). The same report further indicates that access to safe water stands at 38 per cent in the district. This water is got from shallow wells with about 51%, deep boreholes with about 39%, rain water harvesting tanks 0%, protected springs 6% and Public Taps 5% The baseline study captured the sanitation condition of Kyabayanja parish. It was noted that the area is still grappling with sanitation problems which range from use of dirty containers to fetch water for domestic use, contaminated water points, to open defecation due to scarcity of pit latrines. Moreover, during the dry season many of the natural water points reduce the flows which affects that quality and quantity that is available to the community and hence exposure to water diseases.

### **3.4 Economic activities**

In the project area all the major economic activity is subsistence farming which is prone to erratic weather patterns with sometimes too much rainfall and extended droughts and this implies that majority of population is vulnerable to income shocks. The majority of farmers are small holders who grow both perennial and annual crops. The perennial crops include Banana, Coffee, while the annuals include maize, Irish potatoes, sweet potatoes, beans, cassava and groundnuts. Majority (99%) of farmers are involved in the production and sale of unprocessed agricultural produce. There is 1% value addition especially in coffee. The traditional economic cash crop is coffee but, in the recent years it has been on decline due to crop diseases and poor seedlings. Some non-traditional economic crops such as maize are in high demand and they not only play their traditional role as food crops, but are currently cash crops as well. Agricultural produce is mainly for food and the surplus (if any) is sold. However, the project area is constrained by: low agricultural production and productivity; poor storage infrastructure; low value addition; limited access to agricultural financial services and critical inputs; and poor coordination and inefficient institutions for planning and implementation of development goals. Poor market access and low competitiveness for products in domestic, regional, continental and international markets; Pests and diseases affecting crop and livestock, climate change, price fluctuation of agricultural product,

political interference in daily activities and planning are still a challenge to agriculture community. Trading is also another economic activity that is being carried out. Trading is mainly in retail business. Sand mining, stones and brick laying is another economic activity that is carried out by mainly the youth. Only a very small proportion of the population is engaged in formal employment which includes teaching, nursing in the clinics and government health facility etc. (EMSULT ENGINEERS LTD, 2022)

### **3.5 Land Use.**

Land use takes various forms depending on the nature of production activity. It is notable that land use is mainly used for small scale and commercial agriculture purpose given the fertile soils, reliable rains that can support two cropping seasons in the year and availability of pastures throughout the year to support livestock production. The main crops grown include maize, Beans, Irish potatoes, sweet potatoes, Bananas, Cassava, ground nuts and coffee.

### **3.6 Household Income.**

Uganda as whole has an ambitious development aspiration of becoming a ‘‘Modern and Prosperous Country within 30 Years and Vision 2040 marked a shift from narrower focus on reducing poverty to a broader theme of achieving structural transformation. Vision 2040 targets include reaching upper middle-income status of 9,500 dollars per capita by 2040. Uganda Bureau of Statistics (UBOS) indicates that the population in Uganda now meets the threshold of \$ 850- \$900 depending on the source and year with the latest data showing a trend towards a slightly higher figure. This notwithstanding, a key informant revealed that it is near to impossible to know actual income levels in project area given the record keeping is very poor so most of the incomes is undocumented but it is estimated that the average monthly income at household level between 50,000-100,000= Ugs and only a small proportion of the population earns more than average. (UBOS, 2014)

### **3.7 housing.**

The social baseline study assessed the housing status as another land use activity in the project area. Notably, the housing structures are a mixture of both permanent and semi permanent settlements scattered within the villages. The District Development Plan 2020/2025 indicates that the number of people in semi-permanent houses is (18.6%) while makeshift is (53.6%) and permanent houses of brick and motor (12.4%)

### **3.7 Communication and transport facilities.**

In terms of telecommunications, the Sub County is served by MTN, AIRTEL. It is estimated that about 50 per cent of the youth population own a phone. These will be useful in mobilization of affected people and stakeholder engagements however; the internet connection is very scanty. In terms of transportation, the largest number of the population own bicycles for their means of transport. The poor transport system implies that movement in the project area is problematic especially in the wet season. Motorcycles commonly known as 'Boda Boda' are the major form of transport for moving people and goods given that they can move on bad roads. However, the major form of water transport to the household from the different sources is by walking. A small proportion of the population can afford to transport water on lorries/cars. This water is fetched in plastic Jerry cans. Children and women are the major collectors of water at the household level.

### **3.8 Land tenure system.**

The Land Act (1995) is the primary law that governs land in Uganda. This constitution allows for an individual to own land under that land tenure system which include Customary, freehold or leasehold which impacts land management and development potential. It therefore implies that the land tenure system is an important ingredient for development in Uganda as it influences access to the distribution of water to the respective end users. Under the Customary land tenure system, the District Development Plan 2020/2025 takes note that most of the land in the respective parishes is held under customary tenure system. The clan leaders are tasked with allocation of land for various uses to members of the community. Under this arrangement, land is passed from one generation to another generation and is owned under prevailing customs, traditions or tribal norms. The motorized piped water project was mainly to traverse customary owned land.

### **3.9 Youth population.**

There is high youth unemployment which is about 72.3% (District Development Plan 2020/2025) given that there is limited industrialization or value addition to the agro-input. Most of them lack appropriate skills to join the workforce. This signifies a limited savings and a high dependence burden on the households in the project area.

## Observations

- The communities of Kiyuuni are enthusiastic about the improved water and sanitation system. With the expectations that the new water supply system will improve the current water related problem, the community is keen and enthusiastic to having a new water supply system.
- A hygiene education campaign will be necessary to raise community awareness on the importance of safe water and sanitation. The involvement of key stakeholders such as institutions, local community organizations, landlords, tenants, will be vital to involve in the hygiene education campaigns.
- Throughout the socio-economic household survey process, the Consultant noted a general lack of knowledge among communities regarding the capital and O&M cost requirements for obtaining on-plot sanitation option. Property owners often rely on local masons/contractors and some of these have provided misleading information most especially in this area where the water table is very high. As part of the hygiene education campaign this information should be provided to communities.

# CHAPTER FOUR: POPULATION PROJECTIONS AND WATER DEMAND ASSESSMENTS.

## 4.1 Population Growth rate and Projection.

Based on the 2024 Uganda Bureau of Statistics (UBOS) census, Mubende District recorded a population growth rate of 2.4%, for its rural settlements. This aligns with national trends and has been adopted for projecting future domestic and institutional populations in the beneficiary villages of Kifumbira, and Kijumba.

### 4.1.1 Base Population (2024)

The Kiyuuni Sub County leadership provided the following baseline population figures for the beneficiary villages for the proposed water supply scheme:

- Kyabayanja : 714 inhabitants
- Kijumba : 700 inhabitants

### 4.1.2 Population Projections.

Using the UBOS-approved growth rate of 2.4%, the Domestic population for the villages is projected as per the Table 4-1:

**Table 4-1: Domestic Population Projections for the Project Area.**

| Village      | 2024        | Base year (2025) | Initial year (2030) | Future Year (2040) | Ultimate Year (2050) |
|--------------|-------------|------------------|---------------------|--------------------|----------------------|
| Kyabayanja   | 750         | 768              | 865                 | 1096               | 1390                 |
| Kijumba      | 800         | 819              | 922                 | 1169               | 1482                 |
| <b>Total</b> | <b>1550</b> | <b>1587</b>      | <b>1787</b>         | <b>2265</b>        | <b>2872</b>          |

### 4.1.3 Key Observations.

- The adopted 2.4% rate is reflective of the UBOS’s authoritative 2024 data and aligns with Mubende District’s rural demographic trends.
- Institutional population growth rates for schools, health centers, and religious institutions will be assumed to grow at the same rates as the domestic population increase of 2.4% annually.
- Projections extend to 2050 to ensure infrastructure (e.g., water demand calculations, pipeline capacity) meets long-term needs.

## **4.2 Water Demand Projections.**

### **4.2.1 Assessment Criteria for service levels.**

The expenditure on water supply is calculated from the water tariff and the household size. This together with the income distribution curve gives the levels of service segmentation for the served population. In assessing the consumers in the various levels of service, the Ability to pay water rates as well as the demand for the service has been considered. The limit of expenditure for water is 5% of the household income. In this assessment, four water tariffs have been considered as follows:

- Existing Pro-poor Water Tariff in NWSC areas (2017) of Ushs 1,250, (25sh/20litre jerrycan)
- Umbrella Authority Tariff of Ushs 3,528 (71sh/20litre jerrycan)
- A NWSC domestic tariff of Ushs 4,400 (88sh/20litre jerrycan)
- A proposed tariff of Ushs 5,150 (103sh/20litre jerrycan) to cater for inflation
- The tariffs have been calculated as detailed indicated in the next sections.

### **4.2.2 Existing NWSC Pro-poor Tariff (2023).**

A comparative water tariff of USh 1,250 per m<sup>3</sup> (USh 25/- per 20 litres) normally charged in the case for the rural population where a pre-paid metering system is placed as a pro-poor tariff and this has been used in the comparative analysis. It is inclusive of 18% VAT. Therefore, while computing the monthly bill 18% VAT was excluded.

### **4.2.3 Proposed Tariff.**

A proposed water tariff of USh 5,150 per m<sup>3</sup> (USh 103/- per 20 litres) has been proposed. It is inclusive of 18% VAT. Therefore, while computing the monthly bill 18% VAT was excluded.

### **4.2.4 Comparison Tariff (Umbrella Authority for similar schemes).**

A comparative water tariff of USh 3,528 per m<sup>3</sup> (USh 71/- per 20 litres) was proposed. It is also inclusive of 18% VAT.

#### **4.2.5 NWSC Domestic Tariff.**

The analysis has also considered the NWSC domestic tariff. USh 4,400 per m<sup>3</sup> (USh 88/- per 20 litres) has been proposed. It is also inclusive of 18% VAT.

#### **4.3 Level of Service Based on the Ability to Pay.**

The level of service that was provided depended on both the ability to pay as well as the demand for the service. In this situation, the limit of expenditure for water is 5% of the household income. In order to determine the demand based on Ability to pay, the following conditions should be fulfilled:

- i) The population should be able to pay the connection costs to get a house connection.
- ii) The population should be able to pay the monthly water bills, commensurate with their level of service. The survey results indicated that the average household size in the Project Area was about 4.4 persons per household. Based on internationally accepted guidelines, it is assumed that about 5% of the monthly household income would be spent on payment for water. Thus the money available to be spent on payment for water has been calculated using the declared income from the socio-economic survey as a basis for computation.

#### **4.4 Water demand.**

The water demand computation was made on the basis of the ability to pay (5% income); with the demand based on the unit consumption rate, the levels of service and the served population figures. The water demand was calculated at the water tariffs of USh 25, 71 and 100 and 103 per 20 litres for comparative purposes.

## CHAPTER FIVE: WATER RESOURCES ASSESSMENT.

This chapter evaluates alternative water sources, recommends the most viable option, and estimates the capacity and population coverage potential for the proposed water supply system.

### 5.1 Proposed Water Source.

One (1) borehole has been identified as a viable water source to serve the project area, considering 16 hours of pumping per day.

**Table 5-1: Proposed Borehole for Water Supply.**

| Owned by   | BH No.   | Driller's Yield (m <sup>3</sup> /hr) | Testing Yield (m <sup>3</sup> /hr) |
|--|----------|--------------------------------------|------------------------------------|
| Government<br>(Mubende District<br>Local Government) | DWD83564 | 4                                    | 3.4                                |

Source: *Pump Testing Report.*

The borehole in Kyabayanja served the villages of Kyabayanja and Kijumba, with water demand projections. Water quality tests confirmed compliance with national potable water standards, making the source suitable for drinking and domestic use. The drilling and test pump reports form the basis for the design of a Motorized Piped Water System in the target area.

### 5.2 Water Supply and Demand Analysis.

The projected water demand for Kyabayanja and Kijumba villages, based on a tariff of Ushs 103/- per 20 liters is summarized below:

**Table 5-2: Summary of the project area water demand.**

| Village      | 2025 | 2030 | 2032 | 2037 | 2040 | 2050 |
|--------------|------|------|------|------|------|------|
| Kyabayanja   | 64   | 72   | 76   | 85   | 91   | 116  |
| Kijumba      | 41   | 46   | 48   | 54   | 58   | 74   |
| Total Demand | 105  | 118  | 124  | 139  | 149  | 190  |

The existing borehole (DWD83564) in Kyabayanja Parish has a yield of 3.4 m<sup>3</sup>/hr, supplying 54.4 m<sup>3</sup>/day at 16-hour pumping. This meets:

- 52% of 2025 demand but only 29% by 2050.
- If the water resources are used to supply Kifumbira Village Alone, it can fully serve Kyabayanja's demand until 2032 (48 m<sup>3</sup>/day vs. 54.4 m<sup>3</sup>/day supply).

## **CHAPTER SIX: DESIGN CRITERIA.**

### Design Criteria – Water Supply.

This section is concerned with the establishment of design parameters and standards, for water supply system, to be used in the design of the project interventions. (Ministry of Water and Environment, 2013)

#### **6.1.1 Design Period & Horizon.**

The DWD Water Supply Design Manual (2013) gives the following timeline for the determination of the design Horizon:

- 1) Initial Year- Year of Commissioning Water Supply System taken to be 5 years after commencement of Feasibility Studies.
- 2) Ultimate Year- 20 years Design Horizon from Initial Year.

The Design Horizon for Motorized Piped Water System in Kiyuuni Sub County in several villages was taken to be 20 years. Basing on the 2013 DWD Design Manual, the Initial Year is usually taken to be 5 years after commencement of Feasibility Studies. Therefore, the Current (base) year 2025. Hence the Initial Year was taken as 2030, and 2050 as the Ultimate Year.

#### **6.1.2 Hydraulic Peak Flows.**

The Average Day Demand which depicts the daily water consumption by domestic and non domestic consumers is subject to seasonal climatic variations, harvest seasons, and other factors such as transient population, and religious and cultural festivals. To allow for increased demands during these seasons, a maximum day peak factor of 1.3 is proposed.

Application of this factor to the Average Day Demand gives us the Maximum Day Demand which will be used to design the capacities of the transmission mains, pumping stations, and reservoirs.

Hourly fluctuations in demand vary depending on water usage. These fluctuations are catered for by peak hour factors which tend to be high for small rural communities and lower for larger communities. Distribution mains have to be designed with adequate capacity to meet the peak hour demands of the consumers being supplied. To accommodate the peak hourly flow in the major distribution mains from the reservoir(s) to the system a peak hour factor of 2.0 is proposed.

### **6.1.3 Pipe Flow Velocities.**

In order to limit hydraulic forces on bends in the distribution networks and to limit water hammer effects, it is proposed that the maximum flow velocities should not exceed 0.75 – 2.5 m/s. For water pumping mains the flow velocities at the optimum pipe diameter shall apply. Head losses in the main pipelines will be limited to maximum of 10 m/km.

### **6.1.4 Operating Pressures.**

In line with the MWE Water Manual 2013, the pressures in the distribution system will, as far as possible, be kept below PN 6 (60m of Water Head) and above PN 1 (10m of Water Head).

### **6.1.5 Selection of Pipe Materials.**

Choice of material for the laying of pipes was based on commonly used pipe material sizes in the country as follows:

- Large diameter (>250mm ND) – Ductile Iron or Steel
- Medium size diameter (90 – 250mm ND) – uPVC
- Small size diameter (< 90mm OD) – HDPE

### **6.1.7 Storage Capacity.**

Storage reservoirs are designed to fulfil the following functions:

a) To provide for fluctuations in consumer demand during the day (e.g. the peak hour flow), without having to design the treatment plant and pumping mains to match this peak flow. It thus provides a balance between the demand rate of transmission (at maximum day demand) and consumption rate (peak hour flow). This is the balancing storage. Additionally, the storage reservoir provides for a fairly constant residual pressure and flow to the consumers.

b) The storage reservoir also provides a reserve capacity for fire-fighting, power interruptions, and allows time for system repairs and essential maintenance upstream of the storage to be made without interrupting flow to the consumers. This is the Emergency Storage. It was proposed to size the storage at 30% of the maximum day's demand inclusive of emergency storage.

### 6.1.8 System Operation Time.

The distribution system is assumed to operate 24 hours per day. The pumping stations will however operate for a maximum of 16 hours/day.

### 6.1.9 Unit Water Demand.

Reference has been made to the 2013 DWD Design Manual in the estimation of the adopted Unit Water Demand. Table 6-1 gives the Unit Water Demand proposed in the DWD Design Manual and these were adopted in water demand analysis.

**Table 6-1: Unit Water Demand proposed in the DWD Design Manual**

| Type of water use or User | DWD Design Manual l/c/d | Adopted Rate l/c/d |
|---------------------------|-------------------------|--------------------|
| <b>DOMESTIC</b>           |                         |                    |
| Public stand taps         | 20l/c/d                 | 20l/c/d            |
| Yard taps                 | 40l/c/d                 | 40l/c/d            |
| House connections         | 100l/c/d                | 100l/c/d           |
| <b>INSTITUTIONAL</b>      |                         |                    |
| School – Day              | 10l/c/d                 | 5l/c/d             |
| Boarders                  | 50l/c/d                 | 20l/c/d            |
| Churches                  | 5l/c/d                  | 5l/c/d             |
| Mosques                   | N/A                     | 20l/c/d            |
| <b>HEALTH CARE</b>        |                         |                    |
| Out patients              | 10l/c/d                 | 10l/c/d            |
| In patients               | 100l/c/d                | 70l/c/d            |
| Non residential staffs    | N/A                     | 5l/c/d             |

## CHAPTER SEVEN: WATER SUPPLY SYSTEM COMPONENT.

For the proposed water supply system, the existing borehole will be equipped for water supply using solar energy to power the pumps with a standby diesel generator. The details for the components required have also been described in the sections below.

### 7.1 Transmission Main.

The transmission main will be OD 75 mm; PN16 of 577m long and will be laid from the existing borehole in Kyabayanja (Kiyuuni S/c) to the tank.

**Table 7-1: Transmission main design details**

|                                     |                       |         |
|-------------------------------------|-----------------------|---------|
| Flow                                | Q(m <sup>3</sup> /hr) | 3.4     |
|                                     | Q(m <sup>3</sup> /s)  | 0.00094 |
| Length of pipeline                  | L(m)                  | 576.92  |
| Coefficient of Friction             | Chw                   | 140     |
| ID                                  | D(m)                  | 0.06    |
| Flow velocity                       | V(m/s)                | 0.32    |
| Friction loss                       | Hf(m/km)              | 2.26    |
| Head loss                           | (m)                   | 1.30    |
| 10% losses on fittings              | (m)                   | 0.13    |
| Draw Down                           | DD(m)                 | 51.15   |
| Pump installation de[yh             | GE(m)                 | 67.6    |
| Static water level                  | (m0                   | 11.44   |
| Ground elevtion diff btntank and BH | (m)                   | 62.3    |
| Tank inlet above ground             | (m)                   | 10      |
| Residual head                       | (m)                   |         |
| Total pumping head                  | (m)                   | 152.3   |
| Wqter hammer                        | (m)                   | 9.39    |
| Pipe details                        | <b>OD75mmPN16</b>     |         |
| Combined pump motor efficiency      |                       | 0.6     |
| Power Requirement                   | (watts)               | 2359.06 |
| Power requirements                  | (kW)                  | 2.36    |
| Generator Capacity                  | (kVA)                 | 7.08    |

## 7.2 Storage Tank.

Based on the initial water availability, a storage tank of 32m<sup>3</sup> capacity on a 6m high stand will be erected at a high ground of elevation 1199.8masl from which water would gravitate to the supply area.

## 7.3 Distribution Network.

Hydraulic Analysis using Water CAD Software was carried out for the Distribution Network to determine the Optimum Pipe Sizes.

The undulating nature of the ground (Topography) and Residual Heads dictated the design (size of Pipes in relation to the velocity of flow in the Pipes). Table below gives the sizes and length of pipelines. The schematic layouts of the Distribution Network including junction and pipe details. The distribution network has been sized for the entire proposed project area but only the pipes serving phase 1 areas will be laid in the initial phase as government seeks to find alternative water sources to augment the supply to be able to serve the entire project area.

**Table 7-2: Pipe Sizes and Lengths to be laid in phase 1**

| Pipe Size/Type      | Length (m)   |
|---------------------|--------------|
| OD 125mm uPVC, PN10 | 233          |
| OD 110mm uPVC, PN10 | 320          |
| OD 90mm uPVC, PN10  | 400          |
| OD 75mm HDPE, PN10  | 1,070        |
| <b>Total</b>        | <b>2,023</b> |

It would require the installation of the following components during phase 2 of the project

- i. Siting new production wells with total yield of about 10m<sup>3</sup>/hr.
- ii. Construction of new borehole pumping house(s)
- iii. Installation of submersible pump(s)
- iv. Installation of solar and diesel generator(s) on the borehole(s)

## 7.4 Disinfection.

The design allowed for a chemical house, from where chlorine solution will be prepared and fed into a dosatron which will feed it to the water as it is being pumped into the storage tank.

## 7.5 Power Supply.

Solar panels were installed at the borehole to provide energy for running the pump. A stand by diesel generator will also be put in place to ensure constant power supply. The pumps specifications as shown in table below. The costs for these two power sources have been provided for with in the BOQs.

**Table 7-3: Pump Specifications.**

| Bore Hole Name | Head(m) | Discharge (m3/hr) |
|----------------|---------|-------------------|
| No. DWD83567   | 153     | 3.4               |

## **CHAPTER EIGHT: ENVIRONMENTAL IMPACT STUDY.**

In this Chapter, the Environmental Impact Assessment for the Construction of the Proposed Water Supply system in Kiyuuni Sub County in Mubende district is discussed. This includes the transmission lines, distribution lines and the storage reservoir.

The objective of the EI Assessment was to identify significant socio and environmental impacts the proposed works are likely to have on the societies and recommend mitigation or adaptive measures in line with the potential impacts.

### **8.1 Policy, Legal, and Administrative Framework of the Environmental Policy.**

The Environmental Policy of the Government of Uganda (GoU) aims at enhancing the health, and quality of life of the people in Uganda; the integration of good environmental practice and behaviour into developmental policies, plans and activities.

In addition, government policy aims at the conservation and restoration of the environment, raising public awareness, and ensuring individual and community participation in environmental and developmental activities. In this study, every opportunity has been taken to fulfil these policy objectives particularly with respect to stakeholder consultation and in environmental monitoring.

### **8.2 Potential Environmental and Social Impacts.**

Potential Environmental/Social Impacts will arise both from the construction and installation of the Water Supply system, and after construction due to the water system itself. In either case there is likely to be both direct and indirect impacts. Most of these impacts would become insignificant if reasonable low-cost mitigation measures are implemented.

The following environmental aspects were taken into consideration and where necessary, mitigation measures suggested to safeguard the environment.

#### **8.2.1 Direct Project Impacts.**

Disturbances will occur during the construction work for the project. The construction may cause the following concerns as shown in Table 8-1.

**Table 8-1: Impact Caused by the Project Implementation and the Corresponding Mitigations.**

| <b>Impact</b>   | <b>Mitigation</b>   | <b>Status</b> |
|---|---|---------------|
| Land acquisition for tank sites, pump houses, etc.                | Working hand in hand with District and local authorities to harmonise the situation   | Done          |
|   | Compensate the people affected  | Done          |
|   | Where possible, buy land for the construction of water supply components  | Done          |
| Crop destruction during construction                              | Ensure that pipe lines run within the road reserves   | Done          |
|   | Compensation based on government rates  | Done          |
| Water flooding roads and people's compound from public stand taps | Provision of drain channels   | Done          |
|   | Avoid locating public stand pipes near tarmac roads and near private properties   | Done          |
| Effluent disposal from water treatment plant                      | Proper disposal of the effluent that mainly contains heavy metals by collecting it in a suitable allocated area and provision of sludge drying beds | Done          |
| Damaging roads during pipe laying                                 | Ensuring proper road reinstatement as per UNRA guidelines   | Done          |
| Degradation of physical land                                      | Reinstatement of sites after construction   | Done          |
| Spread of diseases  | Sensitisation of the workers and the community about STD's  | Done          |
| Traffic management during construction                            | Provide alternative safe traffic routes and or diversions as per Uganda police traffic procedures   | Done          |

### **8.2.2 Indirect Impacts.**

Most of the indirect impacts are beneficial to the community. There may be a few negative ones which will require attention. It was indicated in the survey that availability of water would generate additional businesses some of which may be unplanned such as bars/drinking places without adequate sanitation. It is therefore proposed that the community is sensitized on proper hygienic conditions in which to operate.

Jobs were created during and after the Implementation of the project hence empowering the locals economically.

### **8.3 Observations.**

The EI Scoping showed that the potential negative environmental impacts are minimal. The described mitigation measures given, followed by good and appropriate environmental practices are adequate to preserve the local environment. The Distribution mains was largely run within the road reserves. However, for instances where people's plantations have encroached on the road reserves and in order to maintain good relationship with the community, the people whose crops were destroyed during the course of pipe laying will also be compensated.

# **CHAPTER NINE: PROJECT COST ESTIMATES AND FINANCIAL ANALYSIS**

## **9.1 Introduction.**

The water supply scheme has been analysed to determine their financial viability. The purpose of the financial analysis is to determine the viability or sustainability of the scheme without the need for future injection of funds or resources from the government. This means that the scheme should be able to absorb all its operational, maintenance and replacement costs.

The project would be considered viable if their annual cash inflows exceed their annual cash outflows. In other words, their net cash flows should be positive. (i.e., revenues collected from the sale of water should exceed the cost of supplying that water to the consumers).

NPV (Net Present Value) calculations for the cash flows at 5%, 10%, 15% and 20% rates of return were undertaken. The tariffs that resulted in both positive net cash flows and positive NPVs were considered appropriate.

The scheme has two options that were further analysed on the assumption that capital costs were recoverable and thereafter not recoverable. In so doing, a total of four options were analysed.

## **9.2 Capital Investment Cost Estimates.**

The capital investment costs for the works have been estimated and presented in Table 9-1 below for the water supply system.

**Table 9-1: Water Supply System Summary Cost Estimates**

| Item                            | Amount (UShs)        |
|---------------------------------|----------------------|
| Preliminaries                   | 89,700,000           |
| Day Works                       | 21,595,000           |
| Pump Station                    | 77,366,600           |
| Transmission mains              | 47,950,000           |
| Distribution Lines              | 233,742,548          |
| Intensificstion Lines           | 36,835,000           |
| Storege Reservoir               | 305,353,610          |
| Mechanical and Electrical works | 205,961,000          |
| Publoc Stand Posts              | 47,895,211           |
| <b>SUB TOTAL</b>                | <b>1,066,398,969</b> |
|                                 |                      |
| CONTIGENCY SUM                  | 53,319,948           |
|                                 |                      |
| <b>SUB TOTAL</b>                | <b>1,119,718,917</b> |
|                                 |                      |
| Allow for VAT (18%)             | 201,549,405          |
|                                 |                      |
| <b>TOTAL PROJECT COST</b>       | <b>1,321,268,322</b> |

### 9.3 Operation & Maintenance Costs.

In order to have sustainable schemes, a break-even tariff which ensures that the operation and maintenance costs are met is vital.

During operation of the scheme, expenses will be made on; maintenance and replacements, office running, communication, transport and staff salaries and fuel for the generator.

#### 9.3.1 Annual Maintenance.

The annual replacement costs were calculated based on the economic life of the system components and even depreciation of assets over the economic life. The annual maintenance costs were estimated as a percentage of the capital costs. Table 10-2 gives the economic life and annual maintenance factors based on the water supply design manual (of MWE) 2013.

**Table 9-2: Economic Life and Annual Maintenance Cost Factors**

| Item                 | Economic life (years) | Cost Factor (%) 30 Pump Houses |
|----------------------|-----------------------|--------------------------------|
| Pumping Mains        | 30                    | 1                              |
| Pump Houses          | 30                    | 1                              |
| Reservoirs           | 20                    | 2                              |
| Distribution Network | 30                    | 1                              |
| Public stand posts   | 20                    | 2                              |
| Electromechanical    | 10                    | 5                              |

**9.3.2 Energy Costs.**

An average monthly charge is UGX 5000 as per the average cost of fuel on the market were considered. Other assumptions made during the estimation of the annual energy costs are given in the table below.

**Table 9-3: Assumptions made during energy costs**

|                                  |       |
|----------------------------------|-------|
| Pump efficiency                  | 0.6   |
| Pumping head                     | 131.5 |
| Energy contribution by Solar     | 0.33  |
| Energy contribution by Generator | 0.67  |
| Generator fuel efficiency        | 0.3   |
| Generator fuel cost in UGX/L     | 5000  |

The costs assume that pumping of borehole is done 16hrs a day.

**9.3.3 Capital Recovery Costs.**

In calculating the capital recovery costs, it was assumed that the recovery is spread over the component life span. Hence the capital costs were divided by the economic life of each system component. The table 9-4 below gives the assumptions made during the computations of the capital recovery costs.

**Table 9-4: Assumptions made during capital recovery estimation.**

|  |        |
|--|--------|
| Uganda interest rate from BOU                                    | 0.1    |
| Inflation rate   | 0.042  |
| Real Interest rate   | 0.056  |
| Service life of M&E components                                   | 10     |
| Service life of civil components                                 | 20     |
| Ratio of residual to initial capital amounts for M&E components  | 0.1    |
| Capital recovery factor - initial capital investment (M&E works) | 0.093  |
| Capital recovery factor - residual value (M&E works)             | 13.687 |

**9.4 Assumptions Used in Analysis.**

In undertaking the financial analysis, the following assumptions were presumed:

**9.4.1 Design Horizon & Project Evaluation Period.**

Base year for the analysis is 2025. According to the design, the project is expected to become operational in the year 2030. The project has been evaluated up to the period 2050. Phase 1 of the project is to run for 7 years from the base year, beyond which more water resources from additional boreholes would be added to augment supply for the two villages.

**9.4.2 Relevant Costs Used.**

In analysing the costs, the engineer's estimate of annual maintenance and replacement costs based on a percentage of the capital costs were included. Operational costs such as staff salaries, office running costs, and recurring costs (i.e., energy, communication and transportation) were also included.

**9.4.3 Rates Used in Analysis.**

An annual increase of 3% was assumed for the above costs throughout the project evaluation period. However, rates of 5%, 10%, 15% and 20% were used to discount the project's cash flows. A contingency cost of 10% was also included in the financial calculations.

**9.4.4 Cash Flows Used in Analysis.**

In calculating the optimal rate of water, 3 different cash flows were calculated. (See Appendix for details). These were:

1. CF1. Cash flows based on the quantity of water pumped annually
2. CF2. Cash flows based on the quantity of water expected to be sold annually (i.e. Engineer's Estimate of 90%) (10% loss)

2. CF3. Cash flows based on 80% of the quantity of water expected to be sold annually (assumed a 20% loss of all water pumped)

#### **9.4.5 Project Viability.**

The project's viability was assessed using the Net Present Value (i.e., NPV) of its cash flows. A cost per cubic meter of water was calculated annually for the project evaluation period. This was done to illustrate the minimum rate at which the water should be sold for the project to remain viable.

### **9.5 Results of the Analyses.**

#### **9.5.1 Without capital cost recovery (initial investment cost).**

The system involves using solar energy and standby diesel generator to pump water from the borehole. This project was initially analysed on the assumption that the capital costs (i.e., the initial investment) were not recoverable. For the scheme to be viable it must be able to absorb all of the operational and maintenance costs incurred in delivering the water to the consumer. Given the quantity of water expected to be sold annually (based on the Engineer's Estimate of 80%), the lowest price at which the water can be sold is Ushs 16,056/m<sup>3</sup>. While this price results in positive NPVs for discount rates 5% to 20% for the duration of the project evaluation period, it results in negative cash flows for some of the analysed years. It is therefore recommended that Ush 21,906/m<sup>3</sup> be the minimum tariff for the water. At this rate, both NPVs and annual CFs are positive. Project IRR = 9%.

**Table 9-5: Initial investment cost without capital cost recovery**

| <b>21906/m<sup>3</sup></b> | <b><u>NPV of CF1</u></b> | <b><u>NPV of CF2 (90%)</u></b> | <b><u>NPV of CF3 (80%)</u></b> |
|----------------------------|--------------------------|--------------------------------|--------------------------------|
| <b>NPV@5%</b>              | <b>3,221,992,779</b>     | <b>2,275,329,374</b>           | <b>1,328,665,970</b>           |
| <b>NPV@10%</b>             | <b>1,989,452,672</b>     | <b>1,486,365,719</b>           | <b>983,278,765</b>             |
| <b>NPV@15%</b>             | <b>1,327,477,923</b>     | <b>1,033,236,736</b>           | <b>738,995,549</b>             |
| <b>NPV@20%</b>             | <b>941,488,949</b>       | <b>754,338,218</b>             | <b>567,187,488</b>             |

#### **9.6.2 With capital cost recovery (initial investment cost).**

The project was also analysed on the assumption that the capital costs (i.e. the initial investment) would be recoverable. In this case, the appropriate price at which the water can be sold is Ushs 24,787/m<sup>3</sup>. This increase is expected because of the increased costs due to capital recovery. Project IRR = 7%.

**Table 9-6: Initial investment cost with capital cost recovery**

| <b>2,4787/m<sup>3</sup></b> | <b><u>NPV of CF1</u></b> | <b><u>NPV of CF2 (90%)</u></b> | <b><u>NPV of CF3 (80%)</u></b> |
|-----------------------------|--------------------------|--------------------------------|--------------------------------|
| <b>NPV@5%</b>               | <b>2,860,428,039</b>     | <b>1,789,262,796</b>           | <b>718,097,553</b>             |
| <b>NPV@10%</b>              | <b>1,730,234,376</b>     | <b>1,160,983,198</b>           | <b>591,732,019</b>             |
| <b>NPV@15%</b>              | <b>1,136,603,983</b>     | <b>803,665,231</b>             | <b>470,726,479</b>             |
| <b>NPV@20%</b>              | <b>797,068,765</b>       | <b>585,304,629</b>             | <b>373,540,494</b>             |

# CHAPTER TEN: CONSTRUCTION PROCESS.

## 10.1 Introduction

The construction phase of the Kyabayanja Solar Piped Water Supply System was implemented in two progressive phases during the Financial Years **2022/2023 (Phase One)** and **2023/2024 (Phase Two)**. The goal was to provide safe, reliable, and sustainable water to the people of Kyabayanja and the neighbouring Kijumba Trading Centre. The construction activities encompassed the establishment of water abstraction and storage infrastructure, installation of solar pumping equipment, construction of transmission and distribution pipelines, and development of water points.

This chapter provides a comprehensive account of the civil, mechanical, and electro-mechanical works executed under each phase, including specifications, quantities, and implementation methods.

## 10.2 Phase One Construction Works (FY 2022/2023)

### 10.2.1 Borehole Equipping and Solar Pump Installation

A previously drilled borehole, DWD83567 was equipped with a **solar-powered submersible pump** suitable for medium head and moderate discharge rates. The solar pump was selected based on static water level, yield tests, and energy efficiency.

- **Pump Type:** DC submersible pump (capacity ~1.5 – 2.0 kW)
- **Solar Array:** Installed capacity of ~2.0 kW, comprising mono-crystalline panels on a fixed metallic frame
- **Pump Controller:** MPPT (Maximum Power Point Tracking) with dry-run and overload protection
- **Cabling:** Submersible flat cables with adequate insulation and UV resistance

### 10.2.2 Transmission Pipeline (577 Metres)

Water was transmitted from the borehole to the temporary reservoir via an **800-metre-long transmission main**.

- **Pipeline Material:** HDPE PN10, 63 mm diameter
- **Trenching:** Excavation to 0.75–1.0 m depth with backfilling and compaction
- **Fittings:** Air release valves, isolating valves, and thrust blocks at bends
- **Anchoring:** Provided at vertical rises to resist hydraulic surges

### 10.2.3 Construction of Temporary Reservoir (10,000 Litres)

A **10,000-litre plastic tank** was mounted on a reinforced concrete platform to serve as an interim storage reservoir for Kyabayanja village.

- **Platform:** 1.5 m high RC base with reinforced columns and a ring beam
- **Tank Type:** UV-resistant HDPE tank with inlet, outlet, washout, and overflow provisions
- **Drainage and fencing:** Provided to protect the area and prevent pooling

### 10.2.4 Initial Distribution Network (700 Metres)

Water was distributed from the temporary reservoir to the community using a **700-metre distribution line**.

- **Pipeline:** HDPE PN8, 50 mm and 32 mm diameters
- **Service Connections:** Three public tap stands constructed with drainage aprons
- **Installation:** Pipe-laying at a depth of 0.6–0.8 m, with marker posts at road crossings

## 10.3 Phase Two Construction Works (FY 2023/2024)

Phase Two aimed to upgrade the system into a permanent facility with increased storage, service area coverage, and system resilience.

### 10.3.1 Construction of Elevated Permanent Reservoir (32,000 Litres)

A **32 m<sup>3</sup> (32,000 litres)** elevated steel reservoir was constructed to replace the temporary setup and ensure better pressure management for extended distribution.

- **Tank Design:** Cylindrical, welded mild steel with anti-rust treatment and internal epoxy coating
- **Elevated Tower:** 10-metre high structural steel tower anchored on a reinforced concrete base with tie beams
- **Access and Safety:** Includes a ladder with cage, inspection platform, and safety rails
- **Overflow, Inlet, Outlet, and Washout:** All fitted with proper gate valves and screens

### **10.3.2 Extension of Distribution Network to Kijumba Trading Centre (500 Metres)**

A **500-metre-long pipeline extension** was laid to supply water to **Kijumba Trading Centre**, expanding the system's reach.

- **Pipeline Material:** HDPE PN10, 63 mm and 50 mm diameters
- **Public Standpoints:** Two tap stands constructed at key locations within the trading centre
- **Fittings:** Included gate valves, washouts at low points, and air valves at high points to prevent air locking

### **10.3.3 Solar System Upgrade**

To accommodate the increased head and flow requirements, the solar pumping system was expanded.

- **Additional Panels:** Installed an additional 1.5 kW of PV modules, raising total to ~3.5 kW
- **Wiring and Junction Box:** All cables routed through UV-protected trunking with weatherproof terminal enclosures
- **Security:** Solar array fenced and protected with tamper-proof anchorage

## **10.4 Quality Assurance and Supervision**

Construction supervision was carried out by the District Water Office with support from technical staff and the contractor's site engineers. Quality assurance measures included:

- Verification of materials on delivery against specifications
- Daily site inspections and photographic documentation
- Pressure testing of pipelines (transmission and distribution) to ensure leak-free joints
- Adherence to Occupational Health and Safety (OHS) protocols during excavation, tank erection, and solar mounting

## **10.5 Challenges Faced During Construction**

- **Unfavourable weather** during trenching and backfilling led to delays in some pipeline sections

- **Delays in procurement** of steel tank components caused rescheduling of tower construction
- **Community requests** for additional tap stands beyond the design scope created pressure for variation.

The two-phase construction process was successfully completed, delivering a fully functional solar-powered piped water system. With a robust transmission and distribution network, elevated storage, and renewable energy-powered pumping, the system now reliably serves Kyabayanja village and Kijumba Trading Centre. The phased implementation ensured early community access to water while gradually building toward long-term sustainability and improved service delivery.

# **CHAPTER ELEVEN: INSTITUTIONAL AND MANAGEMENT**

## **11.1 ARRANGEMENT**

This chapter presents a basis for the Operation and Maintenance (O&M) framework of the proposed water supply systems. First, it is pertinent to point out early enough that the Consultant concurs that the desired O&M systems for the scheme should emerge out of an effective participatory process involving all key stakeholders (Communities, Sub-county and District Leaders and DWD); and secondly, the system should include capacity strengthening mechanisms for the user communities as well as their respective local governments.

Usually, inappropriate O&M systems for water facilities are the cause of inadequate revenue collection from water users and poor quality of improved water services. However, as already noted in the earlier chapters of this report, the people are willing in principle to contribute towards O&M of the proposed facilities. The consultant has made concrete recommendations regarding the most suitable O&M arrangement. Below we present the major arguments in the discussion of a sustainable O&M framework for the proposed water supply systems.

## **11.2 Community Based Management System Plus (CBMS+)**

CBMS+ is an approach where by a community formally outsources the O&M function to an entity which might be a PSO or NGO, NWSC, the UA, or the HPMA with the requisite training, skills and experience. The entity is here referred to as the Area Service Provider (ASP) that operates on a contract management arrangement. CBMS+ is characterized by the following features:

- All users pay for water on a monthly basis or per volume (both households and institutions).
- Area Service Provider contracted to Operate and Maintain all the protected water facilities in areas which are not under the jurisdiction of other water authorities.
- Sub County Water Supply and Sanitation Board and District Water Supply and Sanitation Board.
- Strengthened back up support mechanisms.
- District & Regional Water Authorities.

## **11.3 Community Based Management System (CBMS)**

This system is premised on the widely held belief that community-based management solutions are the most appropriate, as long as the community organisation is representative,

accountable, and has the capacity to implement its tasks, and there is an adequate tariff and cost recovery mechanism in place to pay for the costs of supplying the service.

For effective CBMS, it is essential for communities to make informed choices about the costs to be incurred, as the estimated tariff must take into account maintenance costs as well. Years of experience also show that community-based management committees need access to technical assistance on a continuous basis. This assistance can be provided by local government, a central government agency, or the private sector. In Uganda, the CBMS is characterised by three tiers, including the Community, Sub- County and District. It has been in existence for about 25 years, but until most recently much of the O&M work was left to the Community without any financial contribution from the District or Sub- County. For this particular assignment, we advocate for a 4-tier system which includes:

| Institution      | Role  |
|------------------|---|
| The Town Council | <ul style="list-style-type: none"> <li>• Contribute their resources (in time and money) necessary to cover standard operation and maintenance costs</li> <li>• • Act as owners of the facility; with primary responsibility for ensuring service provision and operations and maintenance; as well as setting and collection of user fees to ensure continuous financial self-sufficiency of service delivery and operations and maintenance</li> </ul> |
| The Sub County   | <ul style="list-style-type: none"> <li>• Monitor the usage of the facility as well as provide the much-needed extension services</li> <li>• Budget for and contribute a percentage of the finances to supplement contributions by the community</li> <li>• • Provide support to communities in planning, and training</li> </ul>  |
| The District     | <ul style="list-style-type: none"> <li>• Budget for back up support and provide supervision</li> <li>• Avail finances to help cover major repairs or repairs whose cost implication is beyond the capacity of the communities and the Sub- County Local Governments</li> <li>• Provide support to communities in planning, and training</li> </ul>  |
| DWD              | <ul style="list-style-type: none"> <li>• Ensuring that the facility leads to the overall attainment of its water supply purpose</li> <li>• • Facilitate capacity building and learning -adviser, facilitator, and trainer to local governments and communities</li> </ul>   |

Due to various limitations, the community of within the project areas on their own may not be able to sustainably undertake O&M of the water supply facility. The prevalence of poverty in the community expected to benefit from the project has been highlighted. The implication here is that the tariffs may not be sufficient to cover the O&M costs of the water facilities in the short run.

It is for this reason that stakeholders encourage the Local Governments (at District and Sub-County levels) to subsidise the cost of O&M so that people are allowed time to gradually realise the benefits from the facility and eventually be able to service the costs sustainably in future.

#### **11.4 Public-Private Operation and Maintenance (PPOM).**

This is where the community owns the water facility but contracts a private operator to provide a range of support services, which could include equipment and spare parts supply, operations and maintenance, organizational support, and training. However, it is important that these are done under accountable and transparent procurement procedures, and according to national standards and regulations.

Involvement of private operators therefore, is expected to ensure the advantage of flexibility and timely decision making as well as cost effectiveness.

| Institution  | Role   |
|--|--|
| User Communities (through their Water User Groups) | <ul style="list-style-type: none"> <li>• Own the facility and finance the O&amp;M through regular contributions by the benefiting households.</li> <li>• An elected (voluntary) committee representing the user community oversees all operations.</li> <li>• The elected committee collects user charges to cover standard operation and maintenance services.</li> </ul> |
| The Private Sector (Operator)                      | <ul style="list-style-type: none"> <li>• Provide routine maintenance and major repair services, ensuring functionality of the water facility.</li> <li>• A full-time employee of the private entity who may be a resident in the parish may be positioned at the facility and is responsible for routine operations.</li> </ul>  |

### **11.5 Supporting Legal and Regulatory Framework.**

Currently, Water User Communities and Water User Committees operate on the basis of Government's good will, without enabling legal instruments. The Minister in charge of Water should put in place a statutory instrument to ensure an enabling environment for WUCs to carry out their responsibilities in harmony with national legislation. Such instruments are a motivating factor for user committees and are already operational in some African countries.

### **11.6 Training of Water User Committees (WUCs).**

The participation of communities should evolve around Water User Committees (WUCs) that are elected by the communities and trained by the District to effectively undertake specific roles.

The WUC structures should also assist the Local Government in implementation of extension services (to supplement the capacity at the Sub-counties which may be inadequate).

There is therefore need to interact with the existing Water Source Committees and identify their training needs- for example: How have they performed? and, what challenges have they met?

What could be the most likely challenges and roles for WUCs? Specific areas of institutional support would include, among others: establishing a reporting system; and, establishing administrative and basic financing systems including operating a savings account.

### **11.7 Quality Control.**

A number of quality issues should be addressed including but not limited to: policing a no-go zone around the facility.

### **11.8 Roles of Stakeholders.**

There should be a clear definition of mandates and responsibilities among the different stakeholders including DWD, District and Sub- County leaders or staff, Parish chiefs, user communities and private sector players in the O&M of facilities

## CONCLUSION AND RECOMMENDATIONS

The detailed design for the motorized piped water supply system in Kiyuuni Sub- County, Mubende District, represents a critical intervention to address the persistent water scarcity and sanitation challenges faced by the communities of Kyabayanja and Kijumba. This report consolidates technical, financial, environmental, and socio- economic analyses to present a sustainable and scalable solution aligned with national standards and community needs.

### 12.1 Key Findings from the Proposed Design

| Project target area       | How it was addressed during execution   |
|---------------------------|---|
| time                      | The project was executed in two phases across FY2022/23 and 2023/24 most activities were completed within the planned time frame with minor delays during procurement |
| cost                      | The project adhered to the approved budget there was no significant cost over run   |
| Quality                   | Quality assurance was assured through supervision by qualified district engineers, testing of materials, and compliance with MWE standards                            |
| Scope                     | The project scope included an 800meter transmission line, a 32,000ltr permanent resevoir and 1,200m on distribution pipeline. The full scope was achieved as designed |
| safety                    | Health and safety measures were enforced at all sights and there were no major accidents reported during construction   |
| Stake holder involvement  | Continuous engagement of the district water offices, local leaders and the community was ensured  |
| Risk management           | Potential risks such as poor soils and weather delays were anticipated and mitigated through proper site investigation and flexible planning                          |
| Sustainability            | Solar technology ensures long term savings  |
| Environmental impact      | An EIA was followed during construction   |
| Monitoring and evaluation | The previous team conducted regular site meetings   |

## **12.2 Recommendations**

- To avoid delays experienced during the initial stages, future projects should prioritize early procurement and streamline contractor engagement timelines.
- Continuous sensitization and training of water user comities should be emphasized to ensure community ownership and proper operation and maintenance of the system
- Ongoing supervision by qualified technical staff and use of certified materials should be upheld in future projects to ensure durability and compliance with sector standards

## **REFERENCES**

EMSULT ENGINEERS LTD. (2022). Feasibility report for the construction of the Kyabayanja solar piped water system.

Ministry of Water and Environment . ((2013)). Ministry of Water and Environment Water Supply Design Manual.

Ministry of Water and Environment. (2013). Ministry of Water and Environment Water Supply Design Manual,.

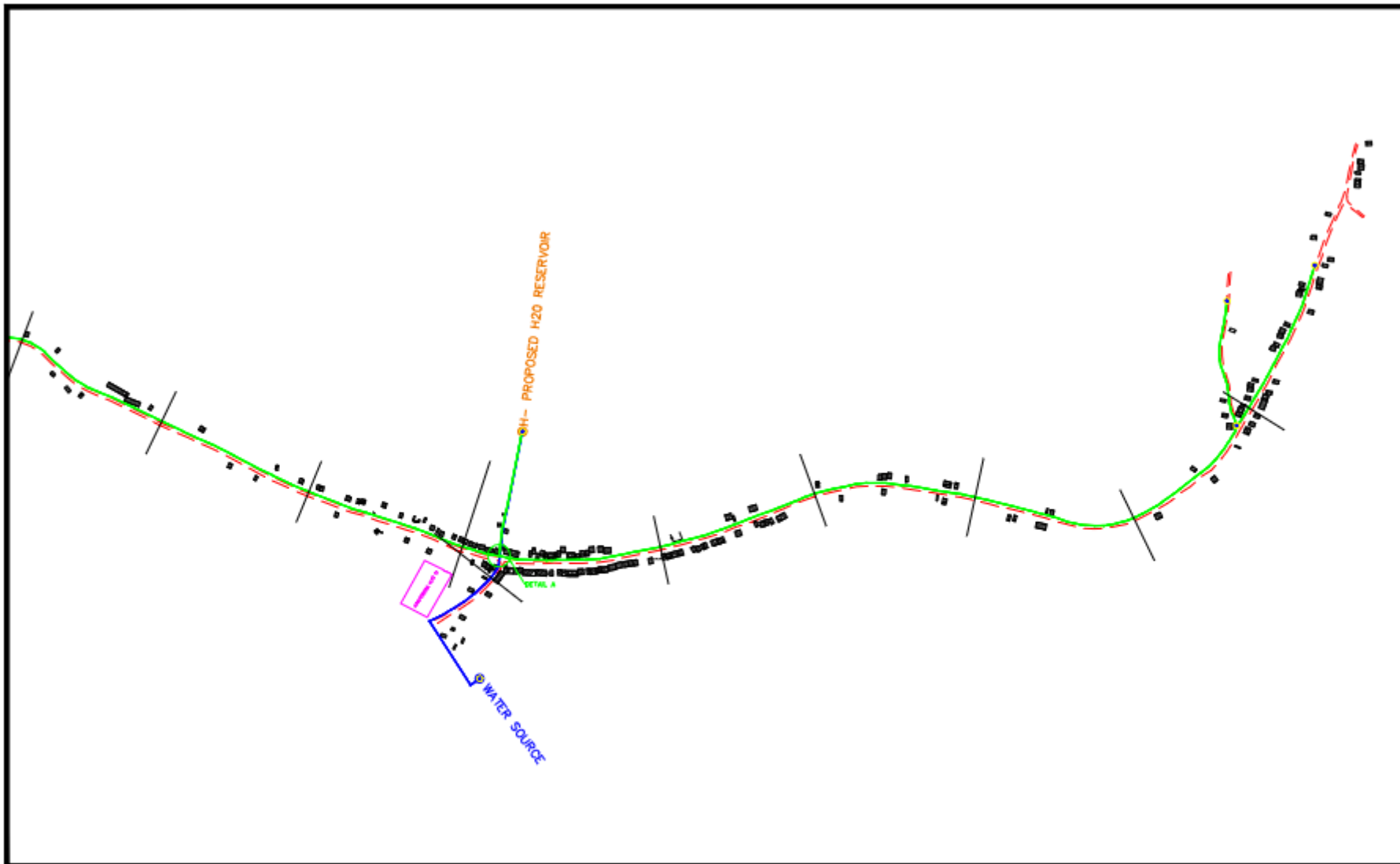
UBOS. (2014). Uganda National Population and Housing Census Report.

# APPENDIX

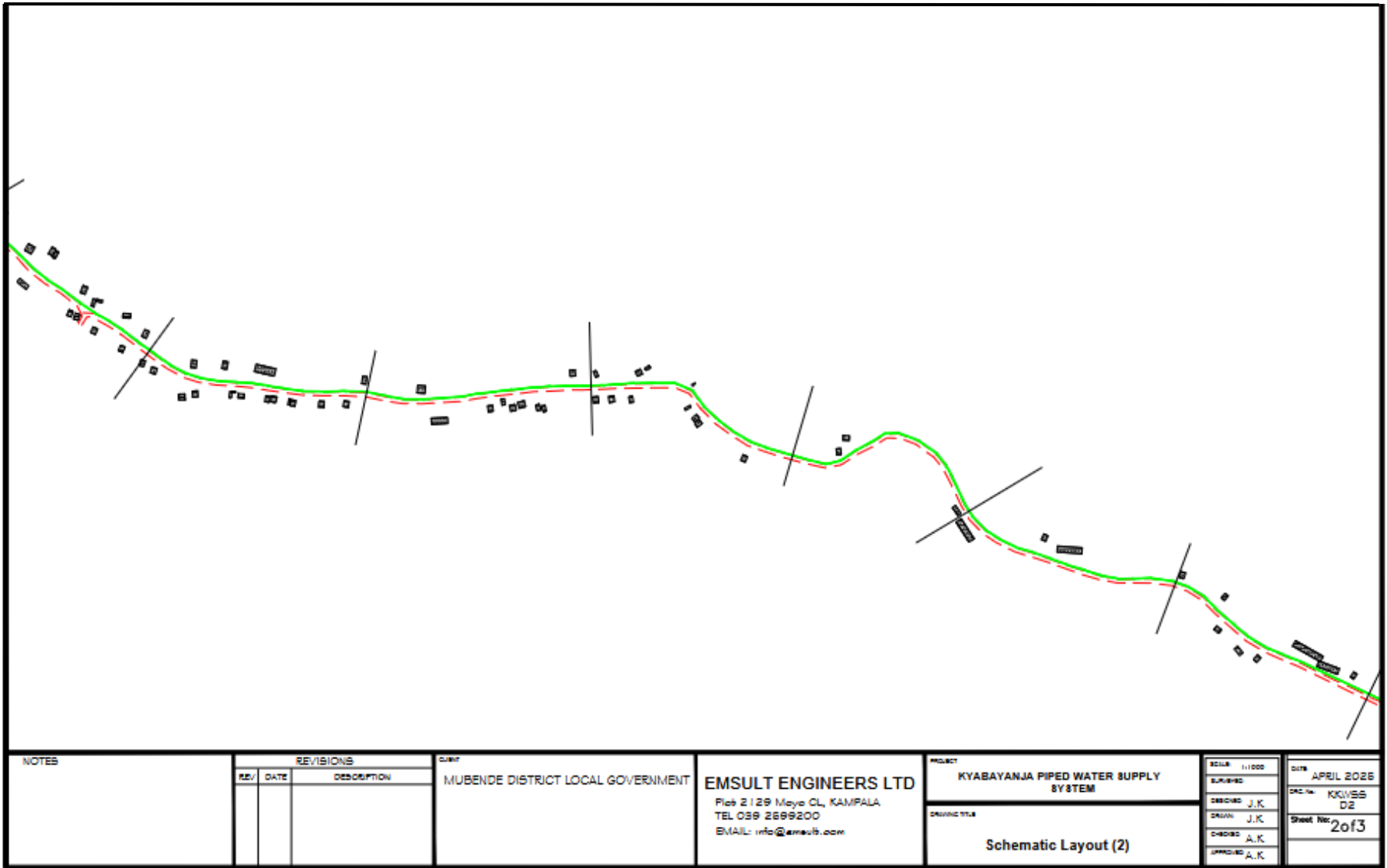
| <b>PROPOSED CONSTRUCTION OF KYABAYANJA WATER SUPPLY SYSTEM</b> |                                 |             |                         |
|--|---------------------------------|-------------|-------------------------|
| <b>IN MUBENDE DISTRICT LOCAL GOVERNMENT</b>                    |                                 |             |                         |
| <b>BILLS OF QUANTITIES</b>                                     |                                 |             |                         |
| <b>MAIN SUMMARY</b>  |                                 |             |                         |
| <b>BILL No</b>   | <b>BILL</b>                     | <b>PAGE</b> | <b>AMOUNT (USHS)</b>    |
| 1  | PRELIMINARIES                   | 1/2         | 89,700,000.00           |
| 2  | DAY WORKS                       | 2/1         | 21,595,000.00           |
| 3  | PUMP STATION                    | 3/1         | 77,366,600.00           |
| 4  | TRANSMISSION MAINS              | 4/3         | 47,950,000.00           |
| 5  | DISTRIBUTION LINES              | 5/4         | 233,742,548.00          |
| 6  | INTENSIFICATION LINES           | 6/2         | 36,835,000.00           |
| 7  | STORAGE RESERVOIR               | 7/1         | 305,353,610.00          |
| 8  | MECHANICAL AND ELECTRICAL WORKS | 8/5         | 205,961,000.00          |
| 9  | PUBLIC STAND POSTS              | 9/2         | 47,895,211.00           |
|  | <b>SUB TOTAL</b>                | <b>USHS</b> | <b>1,066,398,969.00</b> |
|  | CONTINGENCY SUM (5%)            | (5%)        | 53,319,948.45           |
|  | <b>SUB TOTAL</b>                | <b>USHS</b> | <b>1,119,718,917.45</b> |
|  | Allow for VAT @ 18%             | (18%)       | 201,549,405.14          |
|  | <b>TOTAL PROJECT COST</b>       | <b>USHS</b> | <b>1,321,268,322.59</b> |



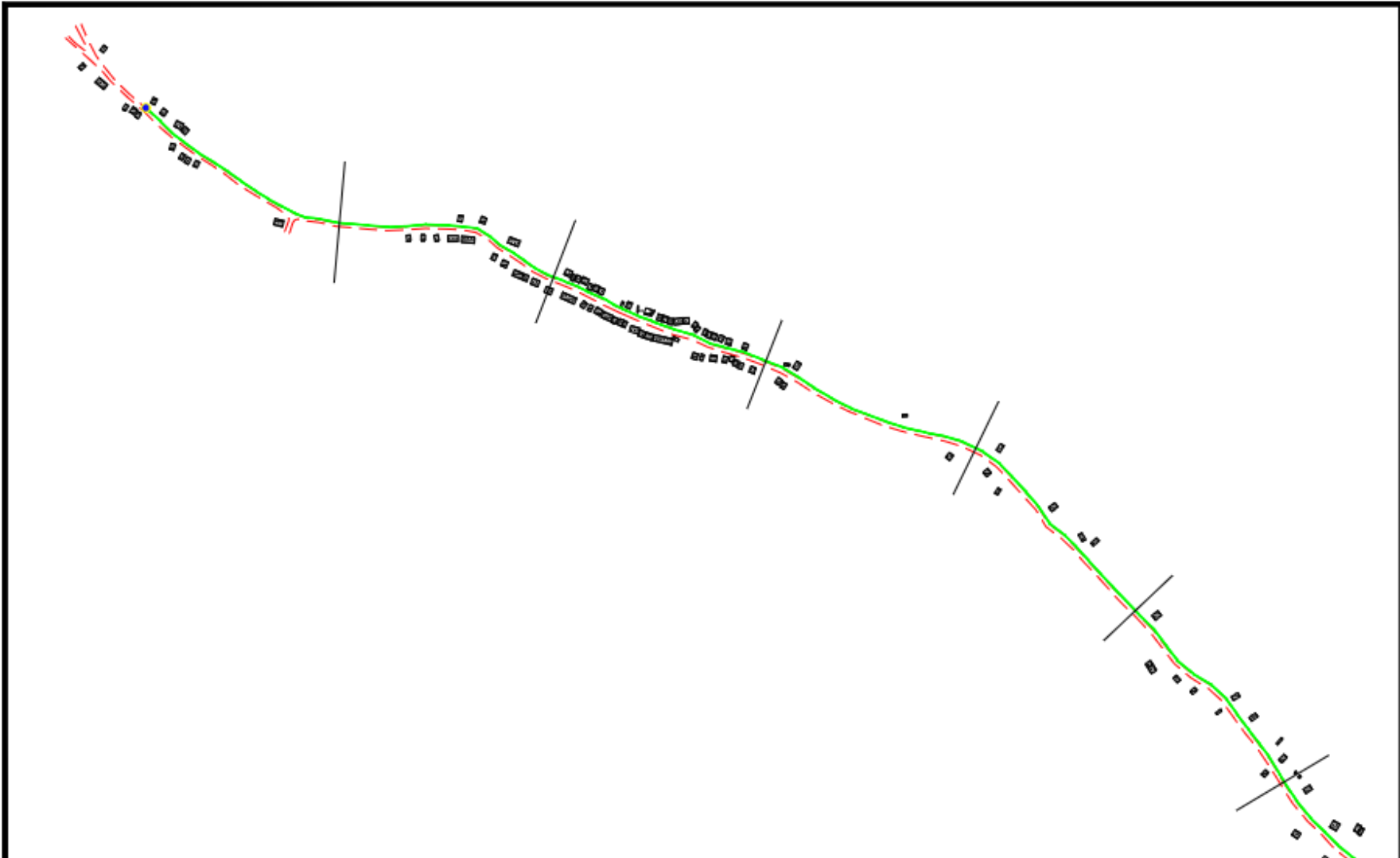
|                               | Demand Category                        | Unit                   | Base Year | Future Population |      |      |      |      | Unit demand (ltrs/d) | Water Demand |      |      |      |      |      |
|-------------------------------|--|------------------------|-----------|-------------------|------|------|------|------|----------------------|--------------|------|------|------|------|------|
|                               |  |                        | 2025      | 2030              | 2032 | 2037 | 2040 | 2050 |                      | 2025         | 2030 | 2032 | 2037 | 2040 | 2050 |
| <b>Village</b>                |  |                        |           |                   |      |      |      |      |                      |              |      |      |      |      |      |
| Kyabayanja                    | Kyabayanja P/S                         | No                     | 500       | 563               | 590  | 665  | 714  | 905  | 10                   | 5.0          | 5.6  | 5.9  | 6.6  | 7.1  | 9.0  |
|                               |  | No                     | 0         | 0                 | 0    | 0    | 0    | 0    | 50                   | 0.0          | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
|                               | Green Valley P/S                       | No                     | 400       | 450               | 472  | 532  | 571  | 724  | 10                   | 4.0          | 4.5  | 4.7  | 5.3  | 5.7  | 7.2  |
|                               |  | No                     | 0         | 0                 | 0    | 0    | 0    | 0    | 50                   | 0.0          | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
|                               | Hill view Nursery school               | No                     | 150       | 169               | 177  | 199  | 214  | 271  | 10                   | 1.5          | 1.7  | 1.8  | 2.0  | 2.1  | 2.7  |
|                               |  | No                     | 0         | 0                 | 0    | 0    | 0    | 0    | 50                   | 0.0          | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
|                               | Victory P/S SDA                        | No                     | 500       | 563               | 590  | 665  | 714  | 905  | 10                   | 5.0          | 5.6  | 5.9  | 6.6  | 7.1  | 9.0  |
|                               |  | No                     | 0         | 0                 | 0    | 0    | 0    | 0    | 50                   | 0.0          | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
| Rise & shine Kanyogoga P/S    | No                                     | 300                    | 338       | 354               | 399  | 428  | 543  | 10   | 3.0                  | 3.4          | 3.5  | 4.0  | 4.3  | 5.4  |      |
|                               | No                                     | 0                      | 0         | 0                 | 0    | 0    | 0    | 50   | 0.0                  | 0.0          | 0.0  | 0.0  | 0.0  | 0.0  |      |
| Kijumba                       | Kijumba P/S                            | No                     | 160       | 180               | 189  | 213  | 228  | 289  | 10                   | 1.6          | 1.8  | 1.9  | 2.1  | 2.3  | 2.9  |
|                               |  | No                     | 0         | 0                 | 0    | 0    | 0    | 0    | 50                   | 0.0          | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
| <b>Health Institutions</b>    |  |                        |           |                   |      |      |      |      |                      |              |      |      |      |      |      |
| Kyabayanja                    | Government Health Centre II Kyabayanja | In-patients(Beds)      | 0         | 0                 | 0    | 0    | 0    | 0    | 70                   | 0.0          | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
|                               |  | Out-patients (Beds)    | 0         | 0                 | 0    | 0    | 0    | 0    | 10                   | 0.0          | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
|                               |  | Non Resident Staff(No) | 0         | 0                 | 0    | 0    | 0    | 0    | 10                   | 0.0          | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
| <b>Religious Institutions</b> |  |                        |           |                   |      |      |      |      |                      |              |      |      |      |      |      |
| Kyabayanja                    | Jesus is lord Christian fellowship     | N0                     | 80        | 90                | 94   | 106  | 114  | 145  | 5                    | 0.4          | 0.5  | 0.5  | 0.5  | 0.6  | 0.7  |
|                               | St. paul Anglican kyabayanja           | N0                     | 360       | 405               | 425  | 479  | 514  | 651  | 5                    | 1.8          | 2.0  | 2.1  | 2.4  | 2.6  | 3.3  |
|                               | Kyabayanja Apostle church              | N0                     | 300       | 338               | 354  | 399  | 428  | 543  | 5                    | 1.5          | 1.7  | 1.8  | 2.0  | 2.1  | 2.7  |
|                               | Kijengere community church             | N0                     | 200       | 225               | 236  | 266  | 285  | 362  | 5                    | 1.0          | 1.1  | 1.2  | 1.3  | 1.4  | 1.8  |
|                               | Apostles church kyabayanja             | N0                     | 200       | 225               | 236  | 266  | 285  | 362  | 5                    | 1.0          | 1.1  | 1.2  | 1.3  | 1.4  | 1.8  |
|                               | Kyabayanja Masgidi Nuhu                | N0                     | 200       | 225               | 236  | 266  | 285  | 362  | 5                    | 1.0          | 1.1  | 1.2  | 1.3  | 1.4  | 1.8  |
| Kijumba                       | Kijumba Masgidi Nuhu                   | N0                     | 200       | 225               | 236  | 266  | 285  | 362  | 5                    | 1.0          | 1.1  | 1.2  | 1.3  | 1.4  | 1.8  |
|                               | Kijumba miracle centre                 | N1                     | 200       | 225               | 236  | 266  | 285  | 362  | 5                    | 1.0          | 1.1  | 1.2  | 1.3  | 1.4  | 1.8  |
|                               | Kijumba Pentecostal church             | N2                     | 200       | 225               | 236  | 266  | 285  | 362  | 5                    | 1.0          | 1.1  | 1.2  | 1.3  | 1.4  | 1.8  |
|                               | Kijumba church of uganda               | N3                     | 500       | 563               | 590  | 665  | 714  | 905  | 5                    | 2.5          | 2.8  | 3.0  | 3.3  | 3.6  | 4.5  |
|                               | Kijumba catholic church                | N4                     | 410       | 462               | 484  | 545  | 585  | 742  | 5                    | 2.1          | 2.3  | 2.4  | 2.7  | 2.9  | 3.7  |



|       |           |      |  |   |               |                  |
|-------|-----------|------|--|---|---------------|------------------|
| NOTES | REVISIONS |      | CLIENT<br>MUBENDE DISTRICT LOCAL GOVERNMENT  | PROJECT<br>KYABAYANJA PIPED WATER SUPPLY SYSTEM | SCALE 1:1000  | DATE APRIL 2026  |
|       | REV.      | DATE |  |   | DESCRIPTION   | DRAWN J.K.       |
|       |           |      |  | DESIGNED J.K.                                   | APPROVED A.K. | SHEET No. 1 of 3 |
|       |           |      | <b>EMSULT ENGINEERS LTD</b><br>Plot 2129 Mayo CL, KAMPALA<br>TEL 039 2699200<br>EMAIL: info@emsult.com | DRAWING TITLE<br><b>Schematic Layout (1)</b>    |               |                  |



|       |           |      |   |  |  |               |                       |
|-------|-----------|------|---|--|--|---------------|-----------------------|
| NOTES | REVISIONS |      | CLIENT<br>MUBENDE DISTRICT LOCAL GOVERNMENT | <b>EMSULT ENGINEERS LTD</b><br>Plot 2   29 Maya CL, KAMPALA<br>TEL 039 2699200<br>EMAIL: info@emsult.com | PROJECT<br><b>KYABAYANJA PIPED WATER SUPPLY SYSTEM</b><br><br>DRAWING TITLE<br><b>Schematic Layout (2)</b> | SCALE 1:1000  | DATE APRIL 2025       |
|       | REV.      | DATE |   |  |  | DESCRIPTION   | DRAWN J.K.            |
|       |           |      |   |  |  | DRAWN J.K.    | DATE 02               |
|       |           |      |   |  |  | CHKD BY A.K.  | Sheet No: <b>2of3</b> |
|       |           |      |   |  |  | APPROVED A.K. |                       |



|       |           |      |   |   |  |  |
|-------|-----------|------|---|---|--|--|
| NOTES | REVISIONS |      | CLIENT<br>MUBENDE DISTRICT LOCAL GOVERNMENT   | PROJECT<br>KYABAYANJA PIPED WATER SUPPLY SYSTEM | SCALE<br>1:1000  | DATE<br>APRIL 2026                             |
|       | REV.      | DATE |   |   |  |  |
|       |           |      | EMSULT ENGINEERS LTD<br>Plot 2129 Moyo CL, KAMPALA<br>TEL 039 2699200<br>EMAIL: info@emsult.com | DRAWING TITLE<br><b>Schematic Layout (3)</b>    | DESIGNED<br>J.K.<br>DRAWN<br>J.K.<br>CHECKED<br>A.K.<br>APPROVED<br>A.K. | DRG. No.<br>KKWES<br>D2<br>Sheet No.<br>3 of 3 |



**Solar panels installed on the borehole.**



**Raised Reservoir tank of 32,000l**



**People fetching water from one of the public stand taps.**