Water and Sanitation Corporation (WASAC)
Republic of Rwanda

THE PROJECT FOR WATER SUPPLY MASTER PLAN FOR CITY OF KIGALI IN THE REPUBLIC OF RWANDA

FINAL REPORT (Pre-release Version)

VOLUME 4

Feasibility Study for the Project for Construction of Masaka Water Supply System

October 2021

Japan International Cooperation Agency (JICA)

Nihon Suido Consultants Co., Ltd.
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GE
JR(P)
21-086

EXCHANGE RATE (for Feasibility Study)

Average value of the telegraphic transfer middle rates at the end of each month between October 2020 and March 2021 published by the National Bank of Rwanda

USD 1 = RWF 973
JPY 1 = RWF 9.23
USD 1 = JPY 105.42

Preface

The Final Report (F/R) of the Water Supply Master Plan for City of Kigali (KWSMP) consists of the following separated volumes, namely:

- Volume 1: Executive Summary
- Volume 2: Kigali Water Supply Master Plan
- Volume 3: Feasibility Study for the Project for Expansion of Karenge Water Supply System
- Volume 4: Feasibility Study for the Project for Construction of Masaka Water Supply System

This report is the "Volume 4: Feasibility Study for the Project for Construction of Masaka Water Supply System" of the F/R

THE PROJECT FOR WATER SUPPLY MASTER PLAN
FOR
CITY OF KIGALI
FINAL REPORT
Volume 4
Feasibility Study for the Project for Construction of Masaka Water Supply System

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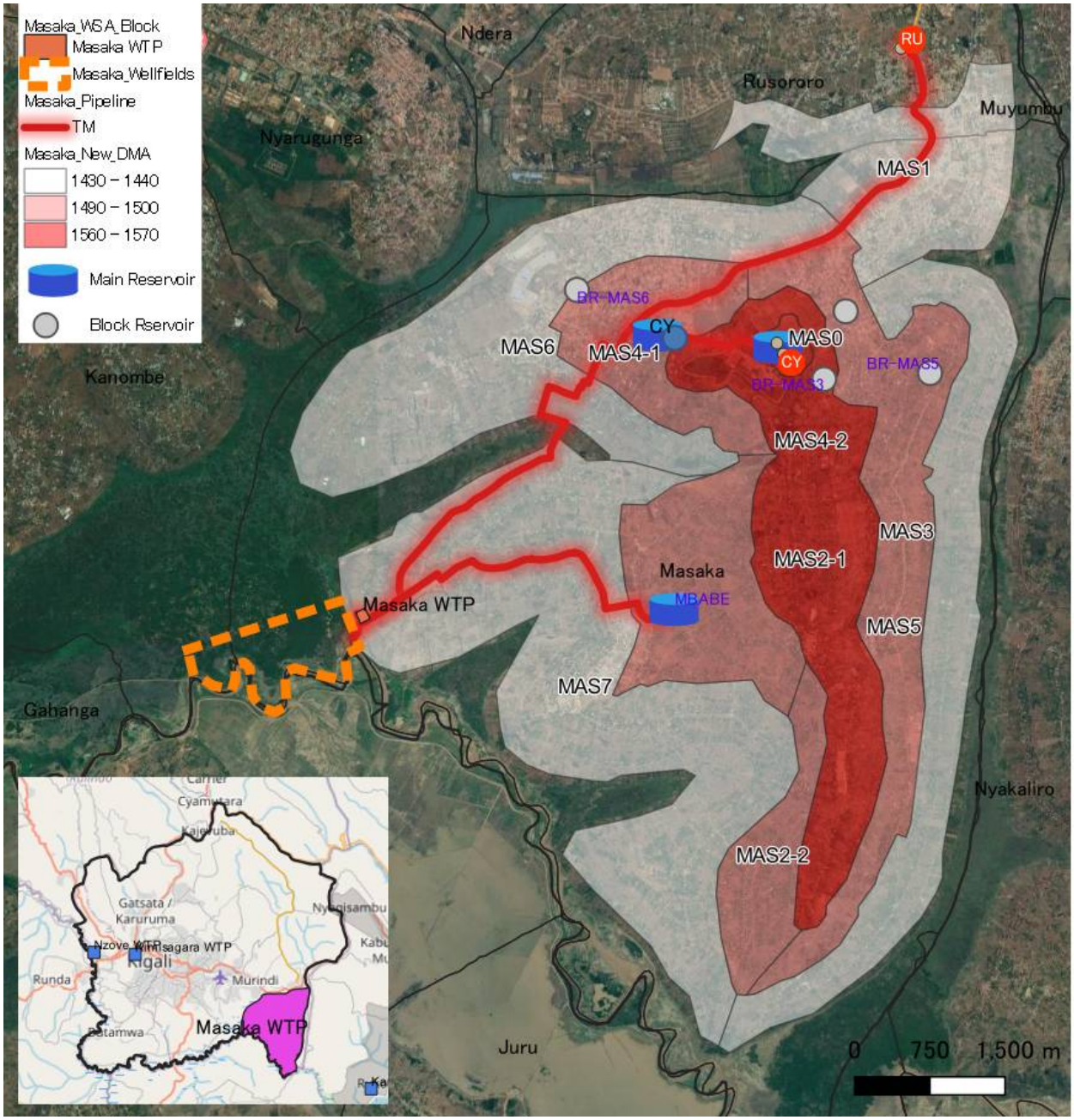
Location Map



Source: JST

Abbreviations

CoK	City of Kigali
DD	Detailed Design
DIP	Ductile Iron Pipe
EICV	Integrated Household Living Conditions Survey
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
ESIA	Environmental and. Social. Impact. Assessment.
FIRR	Financial Internal Rate of Return
F/R	Final Report
FS, F/S	Feasibility Study
FY	Fiscal Year
GOR	Government of Rwanda
JICA	Japan International Cooperation Agency
JST	JICA Study Team
KWSMP	Kigali Water Supply Master Plan
MININFRA	Ministry of Infrastructure
MINECOFIN	Ministry of Finance and Economic Planning
MINEMA	Ministry in charge of Emergency Management
M/P	Master Plan
MUSD	Million United States Dollars
ND (DN)	Nominal Diameter (Diamètre Nominal)
NPV	Net Present Value
NRW	Non-Revenue Water
NST	National Strategy for Transformation
NTU	Nephelometric Turbidity Unit
O&M (OM)	Operation and Maintenance
PVC	Polyvinyl Chloride (Pipe)
QA/QC	Quality Assurance/Quality Control
REMA	Rwanda Environment Management Authority
RURA	Rwanda Utilities Regulatory Authority
RWF	Rwanda Franc
RWB	Rwanda Water Resource Board
RWFA	Rwanda Water and Forestry Authority
SEA	Strategic Environmental Assessment
SDGs	Sustainable Development Goals
VAT	Value Added Tax
WASAC	Water and Sanitation Cooperation
WHO	World Health Organization
WTP(s)	Water Treatment Plant(s)
WSA	Water Supply Area

CHAPTER 1 INTRODUCTION

1.1 INTRODUCTION

Water supply is an essential service for the people as well as the key national target to meet basic human needs and to achieve economic development. Water and Sanitation Cooperation (WASAC), together with the Government of Rwanda, has made significant efforts to increase water coverage over the past few years and has committed to providing 100% coverage by the year 2024, thereby ensuring universal and equitable access to safe and affordable drinking water for the people aimed at achieving the goals raised by NST-1 along with Sustainable Development Goals (SDGs). The WASAC, in consultation with MININFRA, MINECOFIN and MINEMA, has established a water supply masterplan toward 2050 in order that the water infrastructure will be constructed from the aspect of long-term development in line with the Masterplan of the City of Kigali (CoK) and adjacent sectors.

This Project for Construction of Masaka Water Treatment Plant was selected as a priority project in the Kigali Water Supply Masterplan (KWSMP), as one of the most urgent components of the water supply expansion to serve essential water to the people, especially those living in the growing east in the CoK. The Project intends to construct a new WTP sourcing groundwater along Akagera River with a capacity of 20,000 m^3/day (Phase 1) and 40,000 m^3/day (Phase 2) . The Project is urgent because the water demand is high and growing rapidly in the service area.

Table 1-1 Summary of the Expansion Stage and the Plants

Name	Total Capacity	Remarks
New Masaka Water Treatment Plant	20,000 m^3/day (Phase 1) 20,000 m^3/day (Phase 2*)	Water Sources: Groundwater

* Phase 2: Not included in this study.
Source: JST

1.2 OBJECTIVE AND SCOPES OF THE FEASIBILITY STUDY

The objectives of the study are to justify the necessity of the project and create the project for the new Masaka WTP (total 20,000 m^3/day, Phase 1). The F/S elaborated the project of the following points;

1. Background and emergency of development from the existing situation
2. Preliminary technical planning and design for the facilities
3. Environmental and social impact and necessary consideration
4. Financial and conomic evaluation

In this study, the phase 2 expansion is conceptualized in order that the land acquisition and the necessary consideration for the future expansion can be arranged at the same time as the Phase 1 expansion.

1.3 STUDY AREA

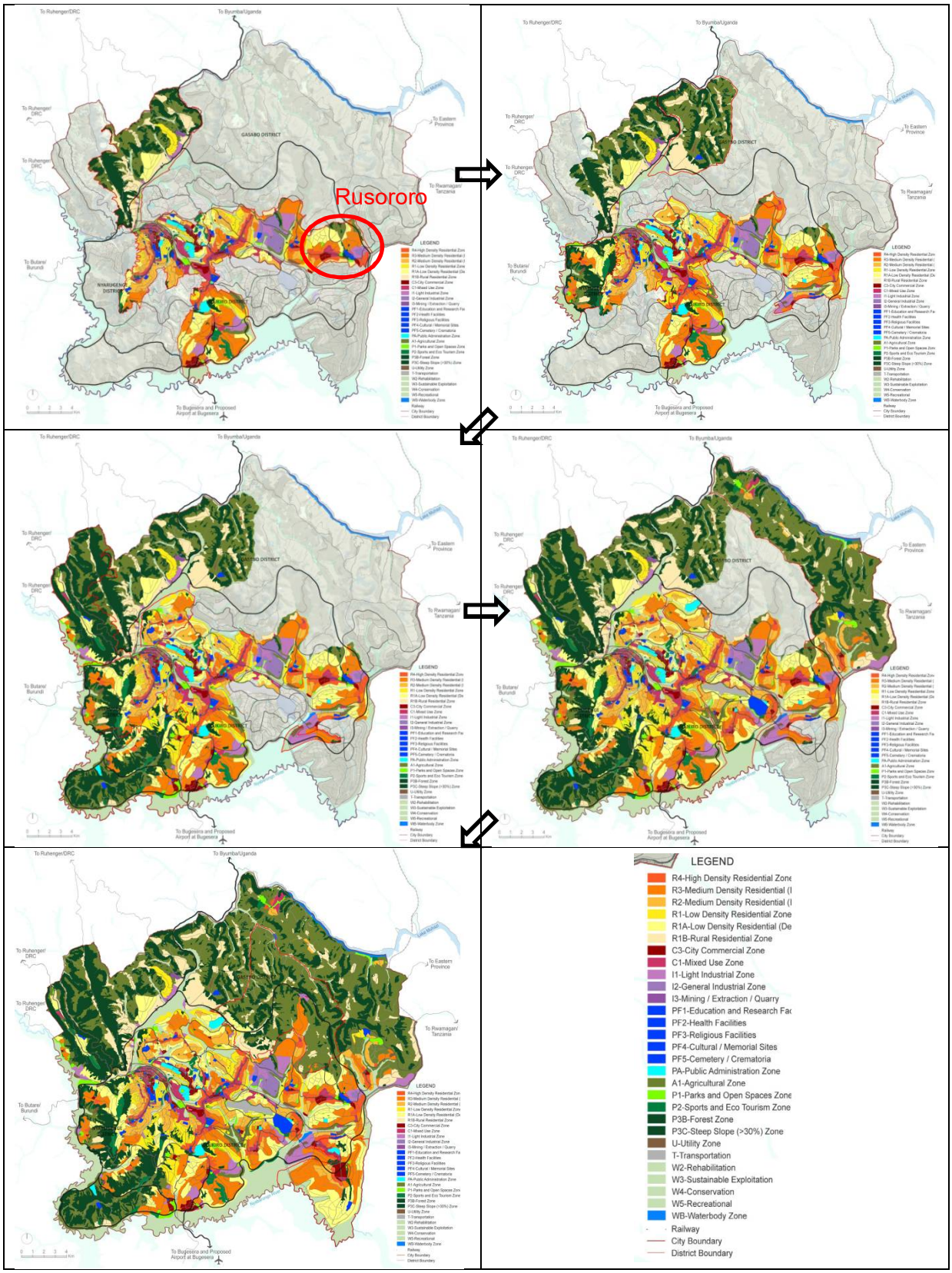
The study area consists of the Water Supply Area of the new Masaka WTP. The Water Supply Area of the Masaka WTP is the entire Masaka sector and some other areas in Rusororo before the target year of 2035. The study area is shown in Location Map.

1.4 BACKGROUNDS AND ISSUES OF STUDY AREA

1.4.1 The rapid development of the Study area

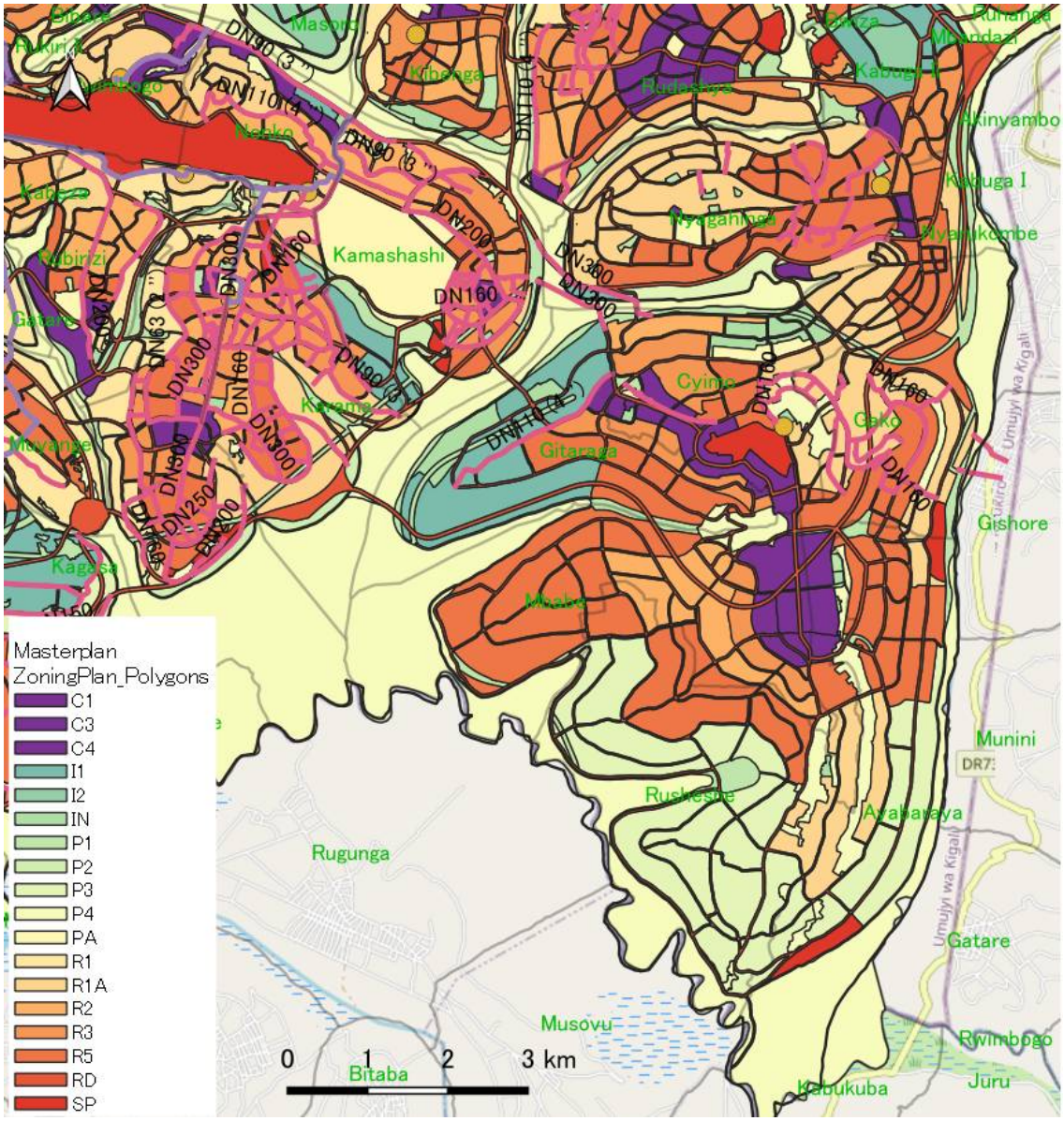
Population projection in the CoK is based on the High Growth Scenario of the City Masterplan (2019). The CoK M/P also presents a phased development plan that is divided into five phases (Phase 1: 2019 – 2024, Phase 2: 2025 – 2031, Phase 3: 2032 – 2038, Phase 4: 2039 – 2045, Phase 5: 2046 – 2050), and indicating priority areas for development (**Figure 1-1**).

As shown in the abovementioned figures, the Masterplan Report of the CoK M/P pointed out that the trend of development and growth in the CoK would be moving towards the eastern and southern parts of the city. Masaka and Rusororo sector are the areas that the earliest development is expected (Phase1). Adjacent sectors, including the Gahengeri, Muyumbu and Nyalaliro sectors, are also expected to be developed along with the CoK's development. The Masterplan (sectoral development plan) for those sectors is as shown in **Figure 1-2**.



Source: Masterplan Report (2019 Edition) of CoK M/P

Figure 1-1 Transition of Development Phase with Land Use Details



Source: JST

Figure 1-2 Masaka WTP and adjacent sectors' development

1.4.2 Water Supply Coverage

The current water supply coverage in the target area is very low compared to the adjacent regions of the CoK as well as the urban areas in the Rwamagana districts. The low water supply coverage is mainly due to the lack of water sources in the surrounding area. Water supply coverage by the WASAC is quite low in this area; existing water supply connections in the Target Areas are counted only 6,000 as of 2019. Other populations may get water from "other improved sources" such as protected/unprotected springs and private wells. The EICV V (2018) shows that the water supply coverage by the piped water supply into dwellings is 34.0% in the CoK and only 4.7% in the Eastern province. Given that we take "Total improved"

populations as the water supply coverage, the population with access to safe water supply (at least Basic) is **127,000** in the Target Area.

Table 1-2 Water Supply Coverage of Target Area

	Piped into dwelling/yard	**Public standpipe**	Total improved
Kigali City	34.0	46.3	80%

Source: EICV V (2018)

1.4.3 Non Revenue Water (NRW) and Leakage Ratio

The water supply capacity includes the actual water demand by the customers and of the leakages.
The target for the ineffective water percentage was assumed as in **Table 1-3.**

- The leakage ratio was set as the same value as the target NRW ratio defined in the KWSMP. This is because most of the reasons for NRW consists of the leakages in the CoK.
- The NRW target is ambitious compared to the current status of the NRW (38.8 % in CoK), but it is achievable for the newly expanded Project in this area. The value of 23% (in 2035) to 25% (in 2025) is conservative given that the water supply systems are new.

Table 1-3 Target Ineffective Water Percentage in the MasakaWater Supply System

Year	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Leakage percentage (NRW percentage)	25%	24%	24%	24%	24%	24%	23%	23%	23%	23%	23%

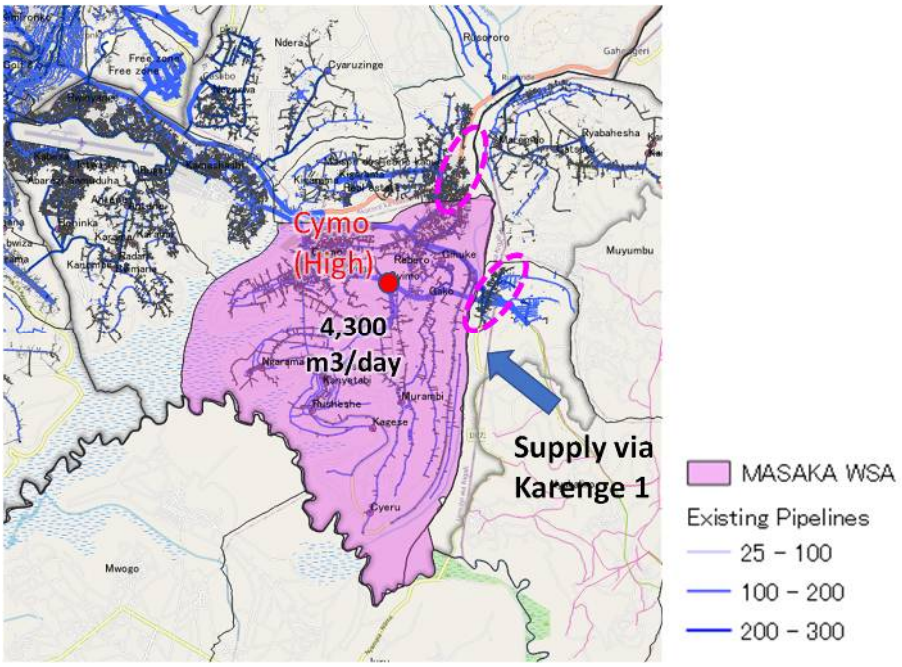
Source: JST

CHAPTER 2 DESIGN CONDITIONS

2.1 WATER SUPPLY AREA AND EXISTING COVERAGE

Water Supply Area (WSA) for new Masaka WTP and the existing water supply systems are illustrated in **Figure 2-1**. The area includes entire Masaka sector which is geographically separated from the adjacent sectors. The existing customers in this area are approximately 6,000, from which the water consumption is estimated to be approximately 4,300 m^3/day.

The status-quo of the access to safe water is approximately 80% according to the city statistics of EICV-V. However, the actual water supply coverage may be lower than the figure indicated in the statistics because the specific coverage information in the Masaka sector is not available. The estimate covered population by individual connections are 26,000, which consists only 35% of the total population in the Masaka sector (75,000, year 2021) (**Table 2-1**).



Source: JST

Figure 2-1 Water Supply Area of New Masaka WTP and Existing Water Supply

Table 2-1 Existing Number of Customers and Consumption

Area	Number of Customer	Estimated Existing Demand (m^3/day)*	Estimated Existing Consumption with leakages(m^3/day)**
In Masaka Sector	6,045	2,592	4,180
Neighboring Area (Nyakaliro, Rusororo)	1,200	515	830

Note: *Assumed industrial demand is 21.8% of total demand ** Assumed Leakage Ratio is 38%. 88 lpcd as per existing water consumption in Kanombe branch. Source: JST

2.2 EXISTING FACILITIES

Figure 2-2 shows the existing clear water transmission and distribution pipelines in the Masaka WSA. The target WSA is an existing water supply systems from Karenge WTP via a DIP 300mm pipelines named Karenge 1. The water from Karenge WTP is transmitted only 3 to 5 days a week due to the limitation of available water; the other pipeline from Karenge WTP (Karenge 2) has been prioritized for the use of Free Trade Zone in Ndera.The Karenge 1 pipeline was constructed in the 1980's[1] and getting aged at some section of the pipelines. The pipeline causes some leakages especially at the Nyakaliro site (e.g. air valves and the pipe installed in marshy areas). The major distribution pipelines is connected to the existing Cyimo (High) reservoir located on top of the Masaka hill. The distribution pipelines also extend to a lower part of Nyakaliro sector and the Rusororo sector for approx. 600 customers each by ND110 pipes.

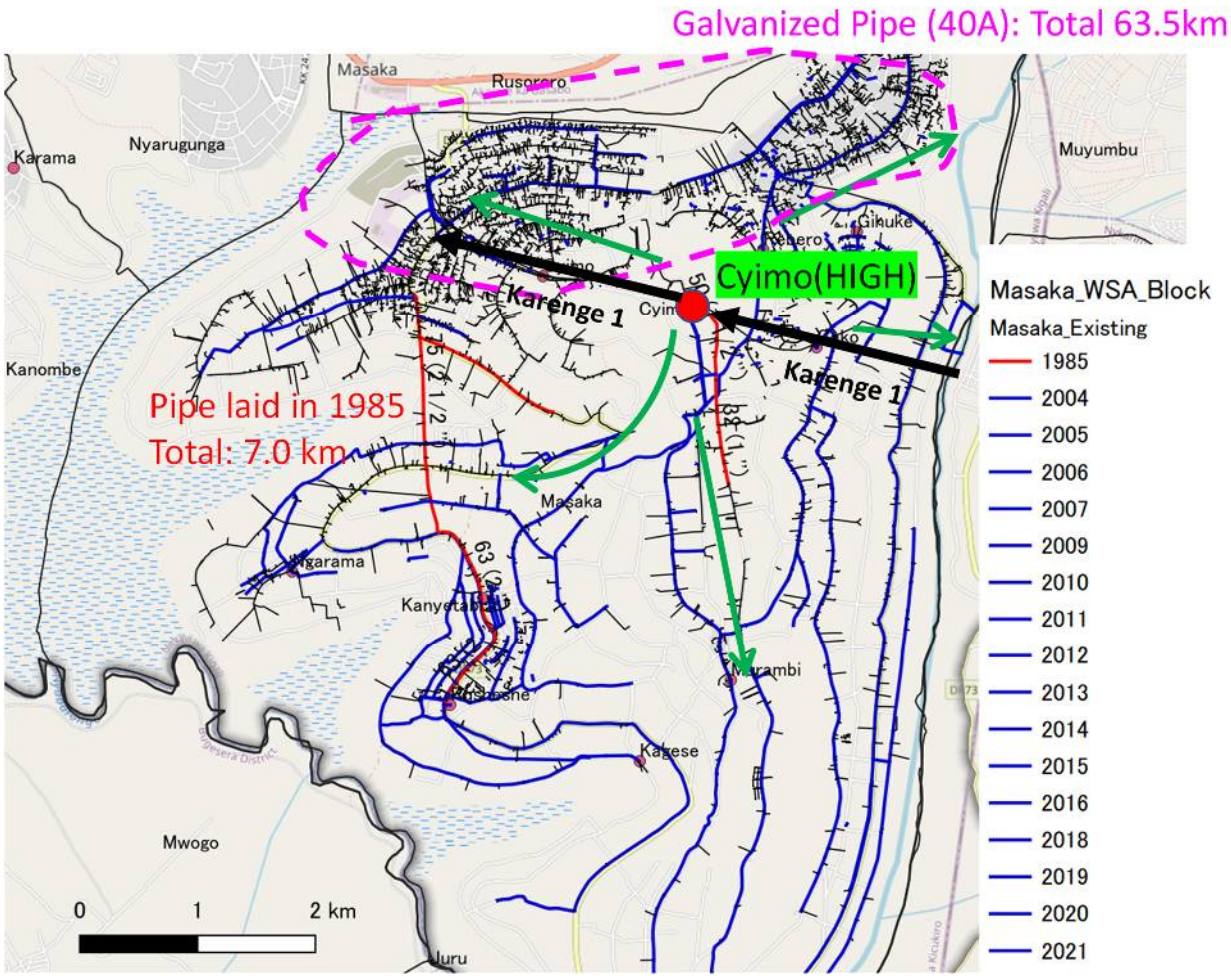
Table 2-2 shows the characteristics and the lengths of existing pipelines in the Masaka WSA. The total length of the existing pipelines in this area is 352 km, of which 78% is not more than 63mm small distribution pipelines and customer connections. Year of installation is unknown for most of the pipelines (70%) while they look relatively new since most of the known pipelines are constructed after the year 2004. Among them, there is a section with 7 km of pipeline constructed in the year 1985, which seems not in use anymore.

The Karenge 1 is an old pipeline (installed in 1985) but can be utilized if there are no leakages. However, it is not recorded how much water is leaking within the transmission line because there is no flow meter in the pipeline. Major pipe materials are PVC and HDPE. However, more than 63.5 km of the pipelines are the Galvanized Steel Pipe (GSP) with 40A diameter. According to the WASAC's experiences, a number of leakage cases have been taking place at GSPs with small diameter throughout the CoK. The pipes concentrated on the lower part of the northern area of WSA, where existing city development is concentrated. Therefore, at least this 63.5 km of GSP needs to berehabilitated in line with the new expansion of the water supply systems.

[1] Not identified the exact year of installation.

Source: JST

Photo (Left) Karenge 1 pipe at Nyakaliro-Masaka boundary (Right) Leakage of Karenge 1 or Karenge 2 observed at a airvalve chamber



Source: JST

Figure 2-2 Existing Water Transmission and Distribution Facilities in the Masaka Water Supply Area

Table 2-2 Existing Pipeline in the Masaka Water Supply Area

Diamter	Length, km
25-32	56.6
40-63	219.1
75-90	50.7
100-125	10.5
160	0.4
200	3.4
300	10.9
Unknown	0.5
total	352.1

Year of Pipe Laying	Length, km
1985	**7.0**
2004-2016	75.6
2018-	19.9
Unknown	249.6
total	352.1

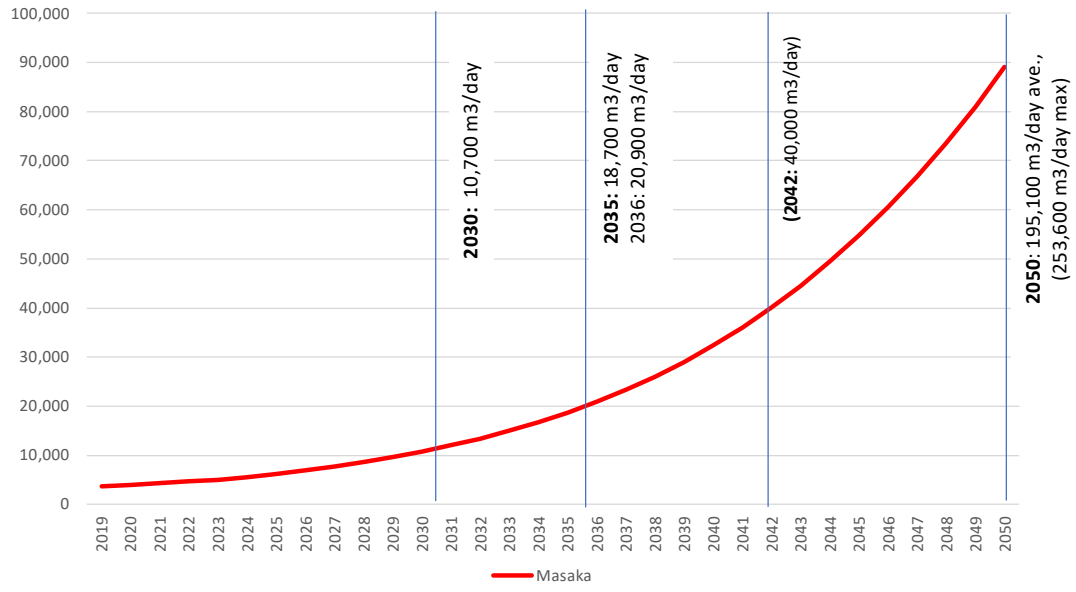
Pipe Materias	Length, km
DI (Ductile Iron)	3.7
Galvanized Pipe	**71.6**
IP (Iron Pipe-Acier Bitume)	1.2
Polyethylene (HDPE)	66.0
Polypropylene (PPR)	0.5
PVC	166.5
Unkown	42.7
total	352.1

Source: JST

2.3 WATER DEMAND PROJECTION

The projected water demand in the WSA is shown in **Figure 2-3**. The total daily average water demand will reach 10,700 m^3/day in the year 2030, and 18,700 in the year 2035. The demand will then doubled to 40,000 m^3/day in the year 2042, and will reach 195,100 m^3/day in the year 2050 ultimately. Note that there is an uncertainty in the timing of the demand increase affected by the actual urban development.

The target population for the Project is estimated 169,000 in the year 2035, which means additional 143,000 people will gain access to water by this Project. It should be noted that the planned 20,000 m^3/day capacity will be fulfilled in the year 2035, while the WTP can be completed in 2026 at the earliest as shown in Chapter 6. This means water should be transmitted to outside area meanwhile the demand grow to reach at the WTP capacity, in order that the production capacity is utilized without loss.



Source: JST

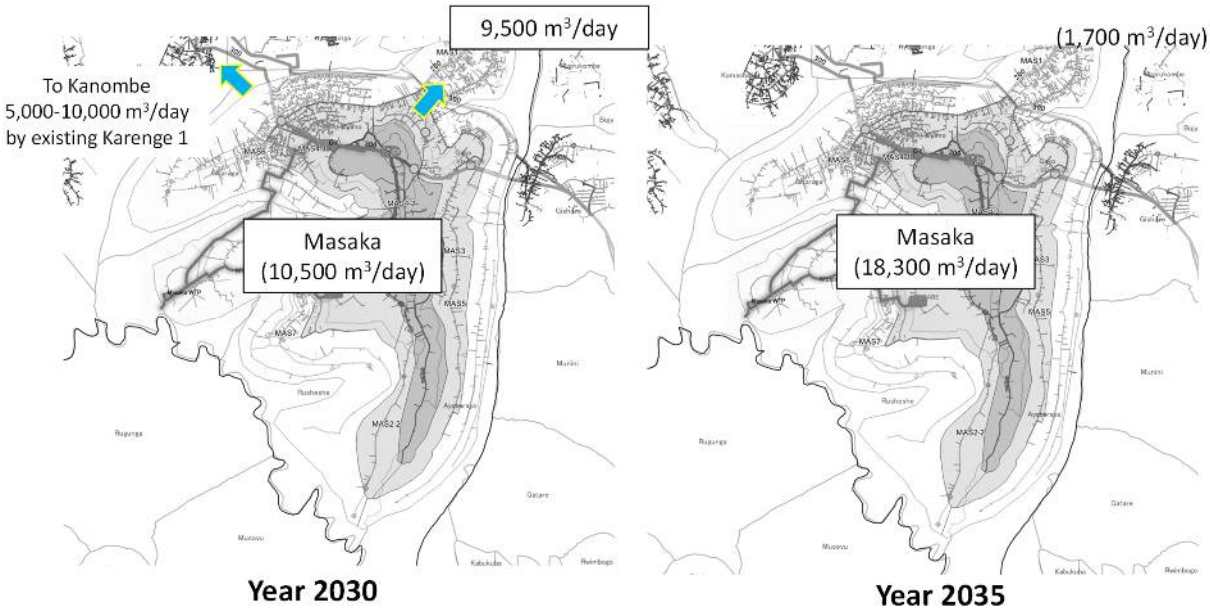
Figure 2-3 Water Demand Projection in the WSA (Masaka sector)

Table 2-3 Covered Population, Coverage and Water Demand

Item	2021	2026	2030	2035
Population in the Supply Area, nos.	74,935	95,802	121,616	169,220
Estimated/Target Total Covered Population, nos.	26,428	95,800	121,600	169,200
Water Supply Coverage*, m^3/day	80%	100%	100%	100%
Total Demand w/ NRW, m^3/day	4,334	6,900	10,700	18,700
Remaining water supply amount allottable to other area, m^3/day		13,100	9,300	1,300

*Including public taps

Source: JST



Source: JST

Figure 2-4 Transition of water demand and allotment to other areas in the intermittent year (2030)

CHAPTER 3 WATER SOURCES AND INTAKE

3.1 COMPARISONS AND SELECTION OF WATER SOURCES

Various water sources that are being used by WASAC's WTPs are shown in **Table 3-1**. In addition to the WTPs, there are some pumping stations that use independent water sources such as springs and wells. The water from such sources is generally connected to water tanks located at the pumping stations and it is chemically treated at the site before its use.

Both water from boreholes along the river and water taken directly from Akagera River can be considered as water sources for the Masaka WTP. As described above, the maximum turbidity of the Nyabarongo (Akagera) River becomes over 10,000 NTU which results in suspension of intake. Water Treatment cost becomes high because of the high turbidity.

Therefore, it is recommended to use water from boreholes as being done in Kanzenze WTP in order to avoid high turbidity and to avoid the risk of possible contamination of the river water.

Table 3-1 Water Sources Used by WASAC (WTPs)

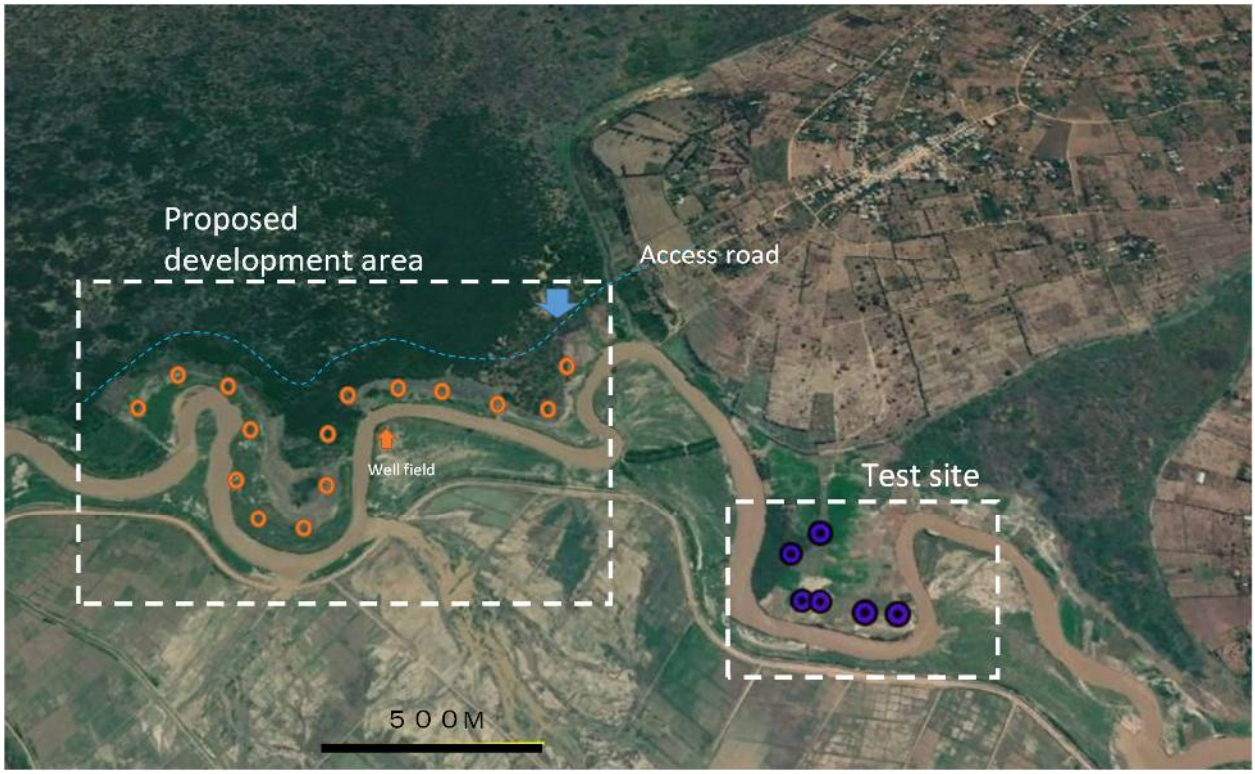
WTP	Water Source	Quantity	Quality	Problems/challenges
Nzove 1WTP	 Groundwater (river bed water)	Thirty-one boreholes drilled in 2006. At the moment, 9 boreholes do not work. Current capacity for 22 boreholes is around 25,000 m^3/d.	It is relatively low turbidity compared to the Nyabarongo River. Sometimes high concentrations of ammonia, iron (Fe) and manganese (Mn) are detected.	Maintenance of boreholes
Nzove 2 and New Nzove 1 WTPs	 River (Nyabarongo)	Nyabarongo river can secure a considerable amount of water.	Sometimes the maximum turbidity of the Nyabarongo River was over 10,000 NTU which results in intake stop.	Water Treatment cost is high because of high turbidity. .
Kimisagara WTP	 River (Yanze)	Yanze is a small river and cannot produce much water compare to the Nyabarongo river.	It has better quality than the Nyabarongo River since the environment around the river has been protected.	Presence of sand, mud, stones and gravels at Yanze intake leads to the clogging of raw water transmission pipelines.
Karenge WTP	 Lake (Mugesera)	No specific issues in terms of quantity	Water quality varies depending on the time, but turbidity increases in the rainy season. Eutrophic conditions due to high level of total-nitrogen, total-phosphorus, and pH.	The lake is located in the eastern part of the CoK and is quite far from the town. The Karenge WTP is built near the lake. Algae is always the problem during treatment.

WTP	Water Source	Quantity	Quality	Problems/challenges
Kanzenze WTP		Analysis of 12 pumping test data on Nyabarongo flood plain shows that it is possible to withdraw 1,200 - 1,400 m^3/day per borehole.	Turbidity is lower than that of rivers (<100 NTU), iron, manganese and ammonia are as high as river water. From the pumping test results, the turbidity tends to rise as the pumping time increases.	Although turbidity is lower than that of rivers, water quality is not good compared to deep groundwater because it is river bed water. In the floodplain of the Nyabarongo River there are places where the clay layer is thickly deposited, and there is not a good aquifer.

Source: JST

3.2 GROUNDWATER INVESTIGATION AT MASAKA AREA

In order to understand the aquifer property at flood plain of Akagera River around Masaka area, core drilling and water well drilling were carried out. Due to limitation of the accessibility and problem of land compensation, the test site was not the proposed wellfield area.



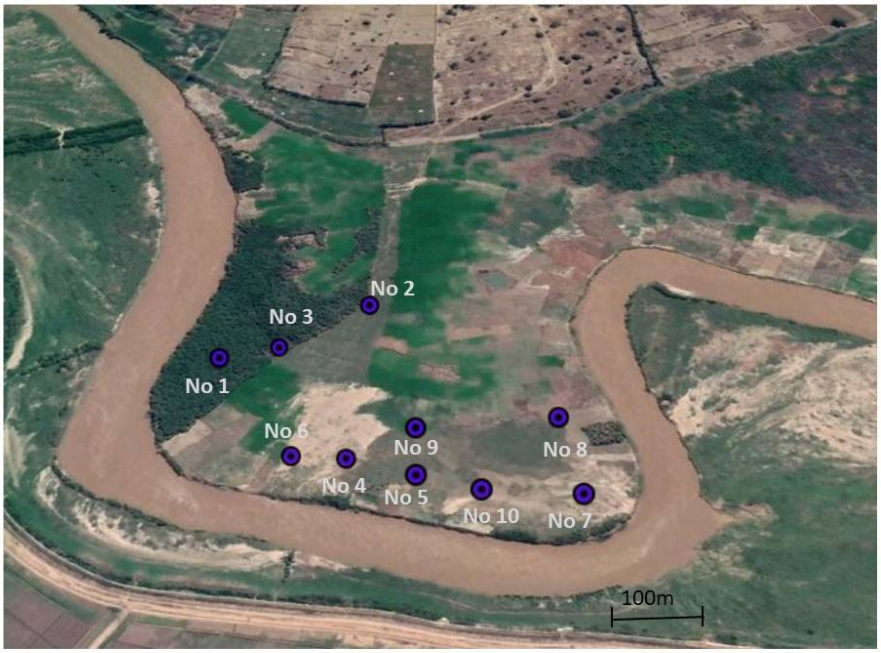
Source: JST

Figure 3-1 Proposed Wellfield Site and Test Site

3.2.1 Core drilling at test site

(1) Purpose of Core Drilling

Purpose of core drilling is to estimate aquifer profile along Akagera River at Masaka area. 10 core drilling works were conducted at test site. Core samples of each borehole were taken to 30m. **Figure 3-2** show the drilling spots.



Source: JST

Figure 3-2 Location of Core Drilling at Test Site

Rotary and wire line system was used as drilling method. From the surface (natural ground) core drilling by PQ size (85mm inside diameter) in unconsolidated formation up to the final depth. When the soil is not stable, the installation of a temporary steel casing to prevent collapsing of surface soil was necessarily used. After the core samples were taken, those boreholes were used for groundwater level monitoring.

(2) Lithological data by core drilling at test site

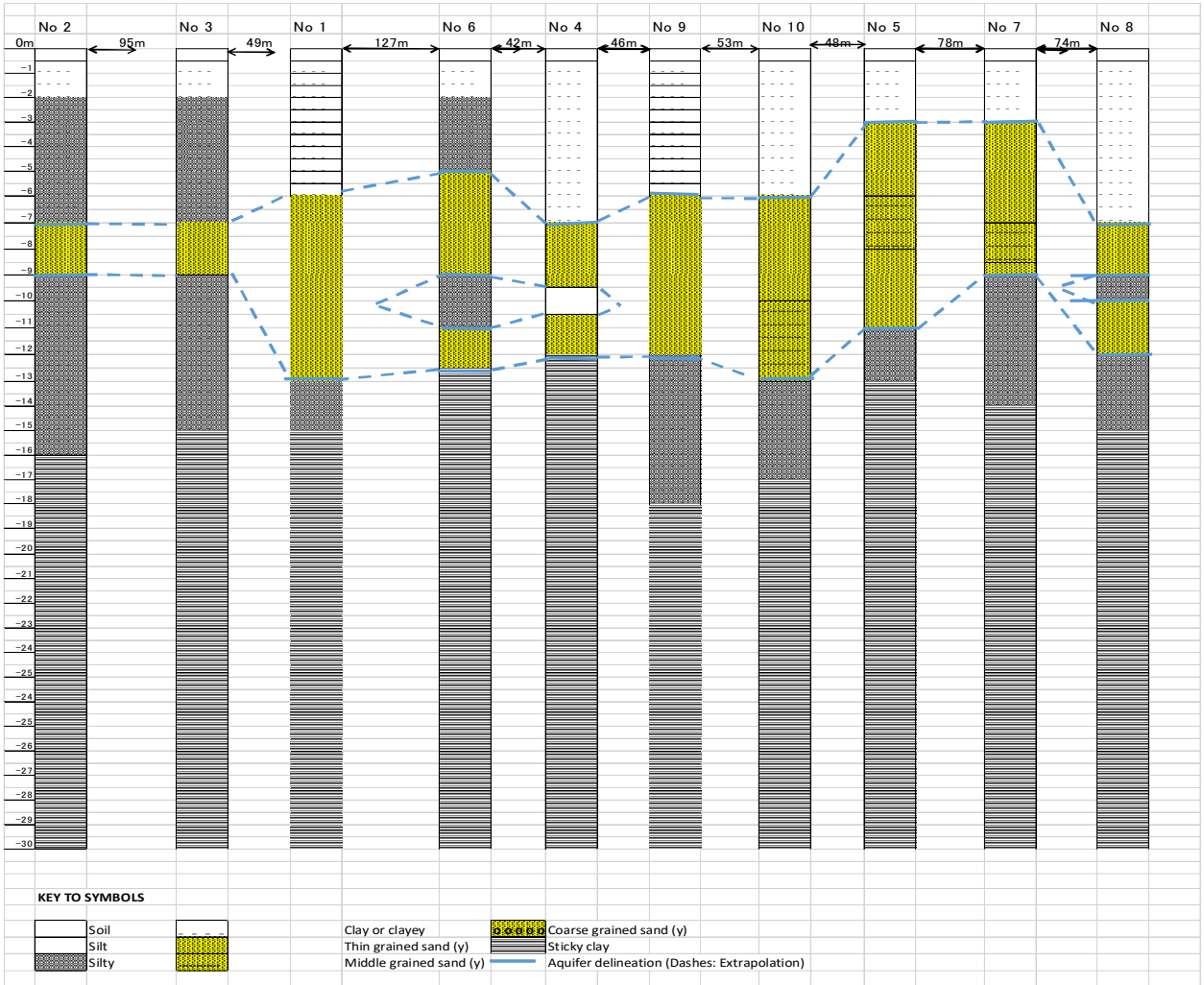
The core samples shows that the study area is in sedimentary formation consisting of different layers, mainly clayey soil with thick layers of mainly fine sand at 7 to 11 m depths. There are one or two sand layers and have the thickness of 2 to 10m. Grain size of sand is fine to coarse sand. Data also shows the depth to sticky clay layer at the bottom of aquifer. Depth of clay layer at the bottom of aquifer of each borehole is shown in **Table 3-2** .

Table 3-2 Depth of Clay Layer at the Bottom of Aquifer and Aquifer thickness

Borehole	Depth of clay layer (BGL) (m)	Total aqfuier thickness(m)
No 2	16m	2m

Borehole	Depth of clay layer (BGL) (m)	Total aqfuier thickness(m)
No 3	15m	2m
No 1	15m	7m
No 6	12.6m	5.5m
No 4	12m	4m
No 9	18m	6m
No 10	17m	7m
No 5	13m	8m
No 7	14m	6m
No 8	15m	4m

Source: JST



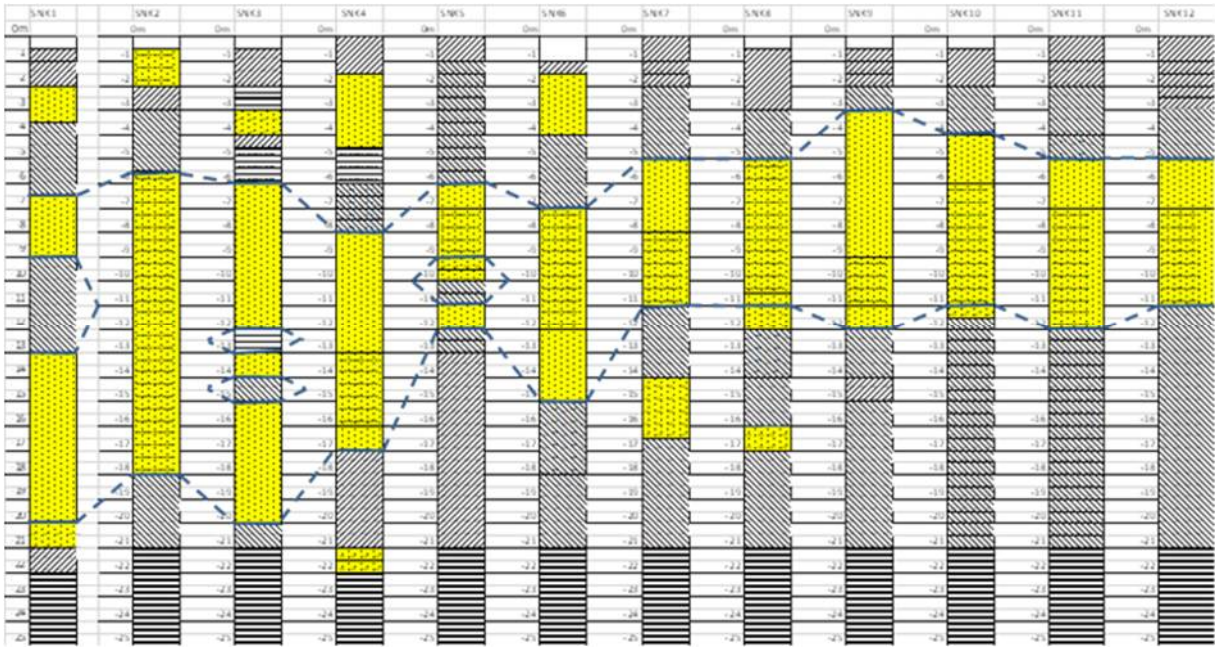
Source: JST

Figure 3-3 Thickness of Aquifer distribution by core data (yellow color indicate aquifer)

(3) Lithological Data at Kanzenze Wellfield

The core drilling was also carried out at Kanzenze wellfield previously about 10km upstream of the investigation site. The core drilling result in the Kanzenze shows the aquifer thickness is from 5 m to 10 m.

This heterogeneity of thickness and distribution cause the variation of borehole yield.



Source: Report prepared by Foraky Africa and WE Consultant (Nyabarongo Aquifer Test Pumping)

Figure 3-4 Thickness of Aquifer distribution at Kanzenze boreholes (yellow color indicate aquifer)

3.2.2 Water well drilling at test site

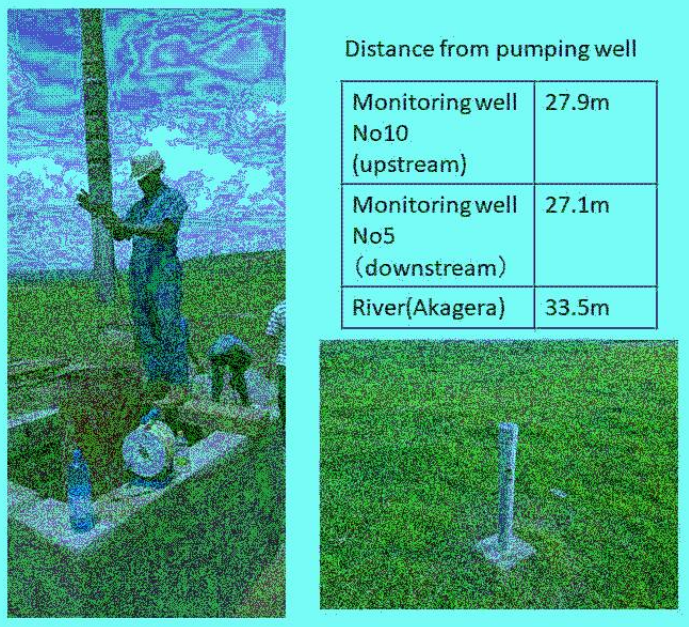
After the analysis of lithological data by core drilling, drilling point for water well was decided. Drilling was carried out by mud drilling method which is suitable in consolidated formation like weathered formation like sedimentary formations; silt, clay, sand and gravels. Collapsing weathered formations were adopted using installation of temporary casings to stabilize depth. 540 mm and 450 mm diameter of drill bit was used throughout the clayey formation and 480 mm bit diameter throughout the sedimentary formation to the final depth. Temporary steel casings were used to avoid the collapsing hole and installation of permanent PVC casings. After the drilling, 315mm PVC were installed with screened PVC installed adjacent to aquifer zones. A bottom plug made of PVC was capped at the bottom of the casing. Development of the well by flashing / surging from top to bottom of the well and along the screen zones was done to clean water free from drilling cuttings, silt and other impurities.

3.2.3 Pumping test of water well at test site

After the completion of well, pumping test was conducted. The main objective of pumping test is to determine the safe yield and optimum installation depth of the pump. In addition, aquifer parameters such as transmissivity was estimated by pumping test result.

Source: JST

Figure 3-5 Pumping Test Layout



Distance from pumping well

Monitoring well No10 (upstream)	27.9m
Monitoring well No5 (downstream)	27.1m
River(Akagera)	33.5m

1. Step test

Step	Yield (m3/hour)	Duration
1	54	180min
2	75	180min
3	80	180min

2. Constant test

Yield (m3/hour)	Duration
81	24 hours

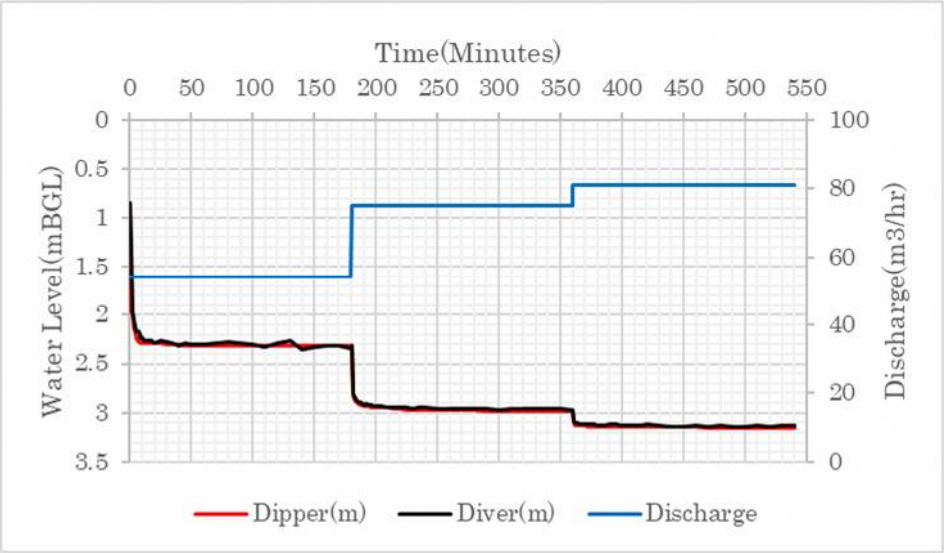
3. Recovery test

Source: JST

Figure 3-6 Details of Pumping Test

(1) Step test

Safe yield and yield to be used for constant test were determined by the result of step test. Maximum yield (Qmax) of borehole can be estimated 137 m^3/hour. Qmax is defined here as pumping rate which dynamic water level reach to pump setting depth. It is estimated by the Sw – Q curve of step test. Safe yield can be 95m3/hour (2,280 m^3/day)(70% of maximum yield). Steady state of drawdown was observed at third step (80 m^3/hour) after 130 min of pumping. Therefore, 80m^3/hour was adapted as pumping rate of constant test.



Source: JST

Figure 3-7 Result of Step Test

Table 3-3 Summary of Step Test

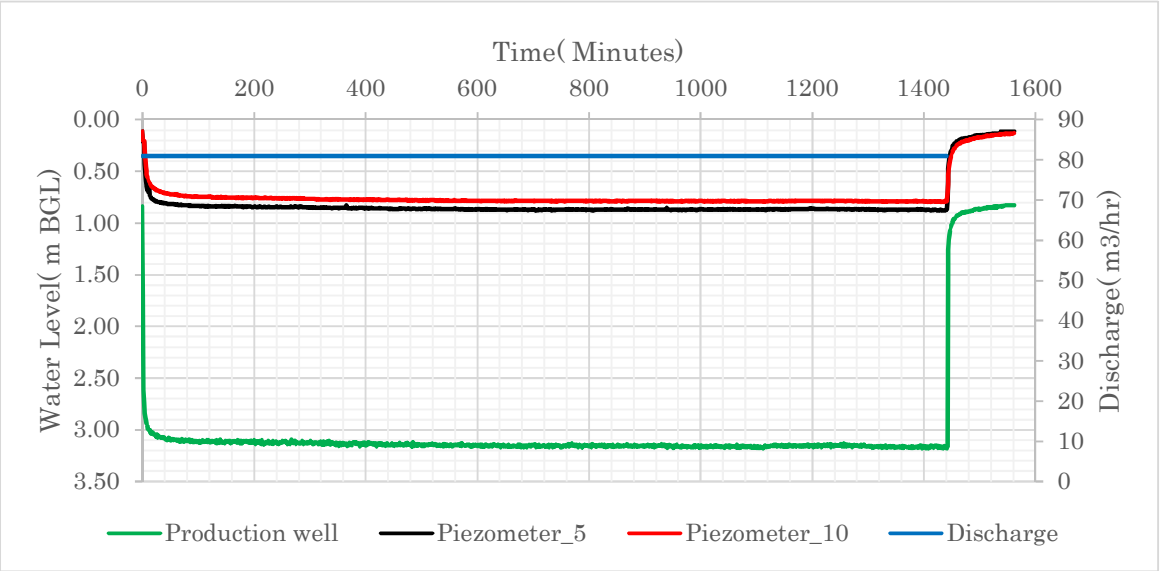
	Step 1	Step 2	Step 3
Initial water level (m bgl)	0.84	2.30	2.98
End water level (m bgl)	2.30	2.98	3.16
Discharge rate m^3/h	54	75	80
Pump installation depth(m bgl)	15m	15m	15m
Time when water level started to stabilize considering starting time of each step	70 minutes	110 minutes	130 minutes

Source: JST

(2) Constant test

The result shows that the water level of pumping well stabilized at 3.18 mbgl at the end of constant test (Q=80m^3/h) which falls within the fine sand alluvium formation according to stratigraphy. High sustainable aquifers are expected in coarse alluvium formation. If the water level does not stabilize during the test pumping exercise, or the drawdown is too high, then safe yield would be determined using the nearest yield to stability with a safety factor of 15 to 30 percent. Pump should not be installed adjacent to screened section. Normally, when the pump is placed adjacent to a plain casing and above the screen to minimize the risk of entry of small particles like silt and damage to the pump. Water level stabilized at 3.18mbgl in 24-hour

constant discharge test is an indicator that the well has a higher specific capacity with an available draw down from 3.18mbgl to 15mbgl (pump setting depth).



Source: JST

Figure 3-8 Result of Constant Test and Recovery

Table 3-4 Summary of Constant Test

	Unit	Observations
Duration	Hours	24
Pumping rate	m^3/h	81
Initial static Water Level	mbgl	0.83
Dynamic water Level at end of the test	mbgl	3.18
Maximum drawdown	m	2.35
Pump installation depth	mbgl	15.0
Borehole depth	mbgl	30.0
Recovery period	miniutes	130

Source: JST

(3) Aquifer characters

Transmissivity determines the rate at which groundwater will flow into a pumping borehole, measured as a unit rate of flow per unit aquifer thickness ($m^3/d/m$) and its unit is m^2/d. Transmissivity determines the borehole yield, hence its pumping rate. Transmissivity was determined for each borehole using the equation: $T=2.3Q4\pi\Delta s$, where T is the transmissivity (m^2/d), Q is the borehole pumping rate (m3/d), π (pi) = 3.142 and Δs is drawdown over a log-cycle of time.

Calculated transmissivity varies from $800m^2/d$ to $1,500m^2/d$. Assuming thickness of the aquifer is 10m, hydraulic conductivity is from 80m/d to 150m/d. High transmissivity values are typical of an alluvial aquifer and shows high groundwater potential. Inflow from River boundary can be observed during pumping.

(4) Concept of well field for Masaka WTP and comparison with other wellfields

According to the result of pumping test concluded water source for New Masaka WTP (20,000 m^3/day) can be provided by wellfield (15bhs). Aquifer characterizes of Masaka area is compared with other wellfields in Kigali.

Table 3-5 Comparison of Wellfields (Yield and Thickness of Aquifer)

	Nzove	Kanzenze	Masaka(plan)
Production of Wellfied	40,000m3/day	40,000m3/day	20,000m3/day
Aquifer thickness	No data	10-30M	2-10M
No of boreholes	31	38	15
Depth of borehole	13.5-16.7 m	30m - 40m	30m
Lower yield (m3/h)	23	48	80m3/hour
Higher yield (m3/h)	65	80	

80m3/hour x 20 hours per day
1,600 m3/day per borehole
1,600 m3/day x 15 boreholes = 24,000m3/day

The area has high potential of development by boreholes than Nzove and Kanzenze. Water sample collected from test well were compared with other wellfields. In Masaka test site, groundwater has lower turbidity than other wellfields. On other hand, the groundwater has high Iron, Manganese concentrations than Nzove and Kanzenze wells. These high parameters can be removed by WTP. Therefore, groundwater quality around proposed Masaka wellfield is acceptable as water source for Maksaka WTP.

Table 3-6 Comparison of Wellfields (Water Quality)

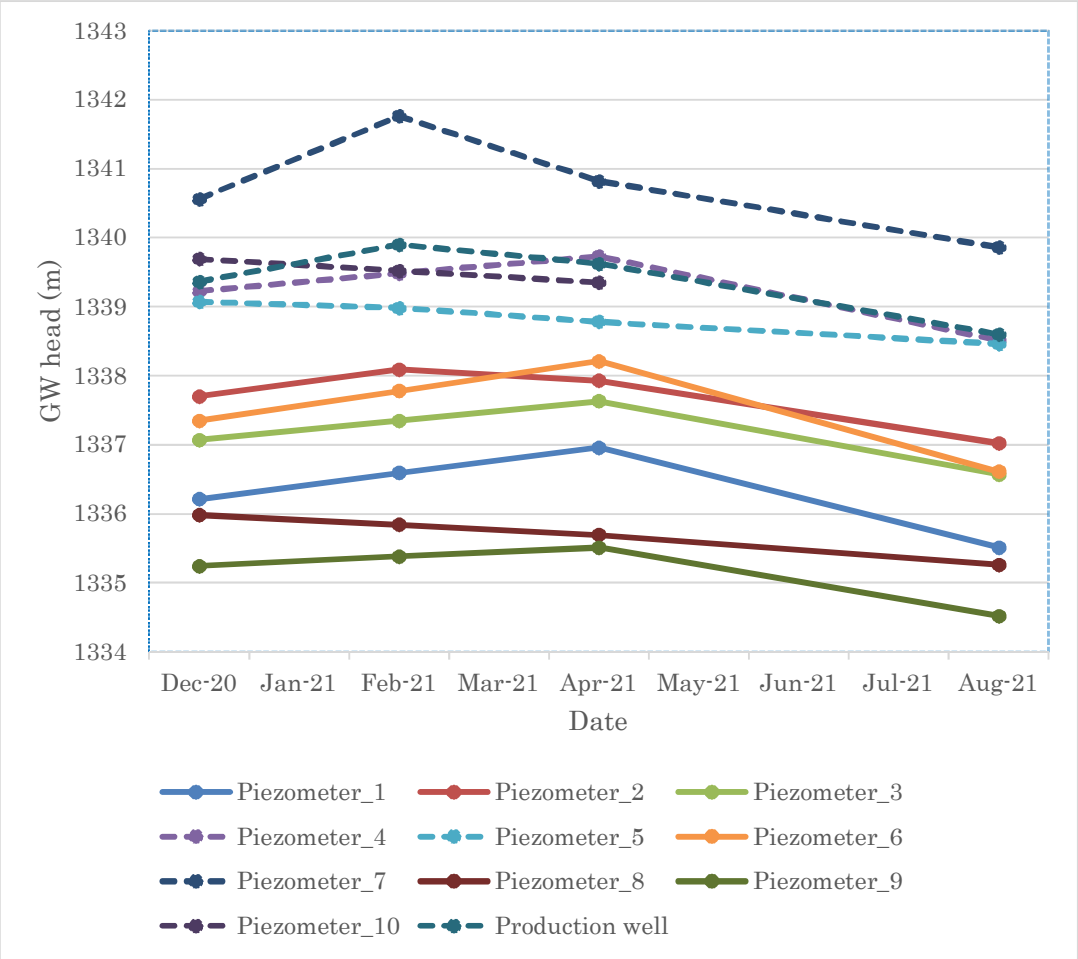
Parameters	G-1	G-2	G-3	Rwanda Drinking Water Quality Standard	WHO Guideline Values (2011)
	Masaka Well	Kanzenze WTP Well No 1	Nzove WTP Well		
Sampling Date	2020-11-10	2020-11-10	2020-11-10		
1. pH	7.51	7.17	7.00	6.5-8.5	-
2. Turbidity (NTU)	21	90	302	5	5
3. Ammonia Nitrogen (NH_4^-,as N) (mg/l)	0.73	0.00	0.03	0.5	-
4. Nitrate Nitrogen (NO_3^-,as N) (mg/l)	1.03	0.50	0.35	10	11.3
5. Nitrite Nitrogen (NO_2^-, as N) (mg/l)	0.07	0.10	0.06	0.001	0.9
6. Fluoride (F^-) (mg/l)	0.49	0.09	0.50	1	1.5
7. Iron (Fe) (mg/l)	2.91	1.54	1.46	0.3	0.3
8. Manganese (Mn) (mg/l)	3.12	1.01	1.30	0.1	0.4
9. Calcium (Ca) (mg/l)	15.62	12.18	14.57	150	-
10. Magnesium (Mg) (mg/l)	11.46	6.34	11.77	100	-
11. Electric Conductivity (EC) (μs/cm)	244	227	292	1,500	-
12. Chloride (Cl^-) (mg/l)	22.2	16.1	17.6	–	-
13. Standard plate count bacteria (cfu/ml)	8.5×10^4	3.6×10^5	1×10^5	–	-
14. E. Coli (cfu/100ml)	1.9 x 10	8.9 x 10	1.4 x 10	Not be detectable	Not be detectable

Source: JST

3.2.4 Groundwater level measurement at test site

Grounwater levels were also measured using boreholes for core drilling. After the core drilling, the PVC casing and screen was installed and converted to monitoring wells. Groundwater level monitoring was conducted by ten monitoring wells and one production well.(See **Figure 3-5**) Manual measurement of goroundwater level of those monitoring wells was conducted four times, which was December 2020, February 2021, April 2021 and August 2021. Result of manual measurement is shown in **Figure 3-9**.

As shown in the result of drilling core analysis, the aquifers within the test site are not uniform. It means that groundwater heads measured at monitoring wells are not equal to the hydraulic head of same aquifer. Therefore, equipotential groundwater head contours couldn't be created by using individual groundwater head at monitoring wells. The result of measurement of groundwater head was only explained as comparison of groundwater head of each well.

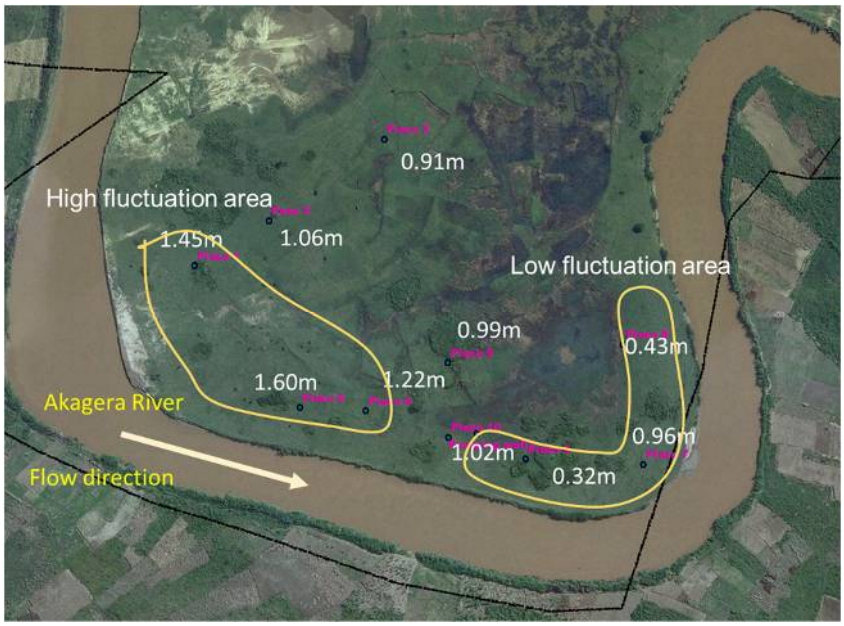


Source: JST

Figure 3-9 Groundwater Head (Elevation minus Measuerd Water Level) by Manual Measurement

As you can see from the graph, groundwater head of all wells was low in August. In August, the lowest groundwater head was observed at P 9 well and highest was P-7. The head difference between two wells is 5.3m. It also noted that monitoring wells situated near Akagera River tend to have high groundwater head.

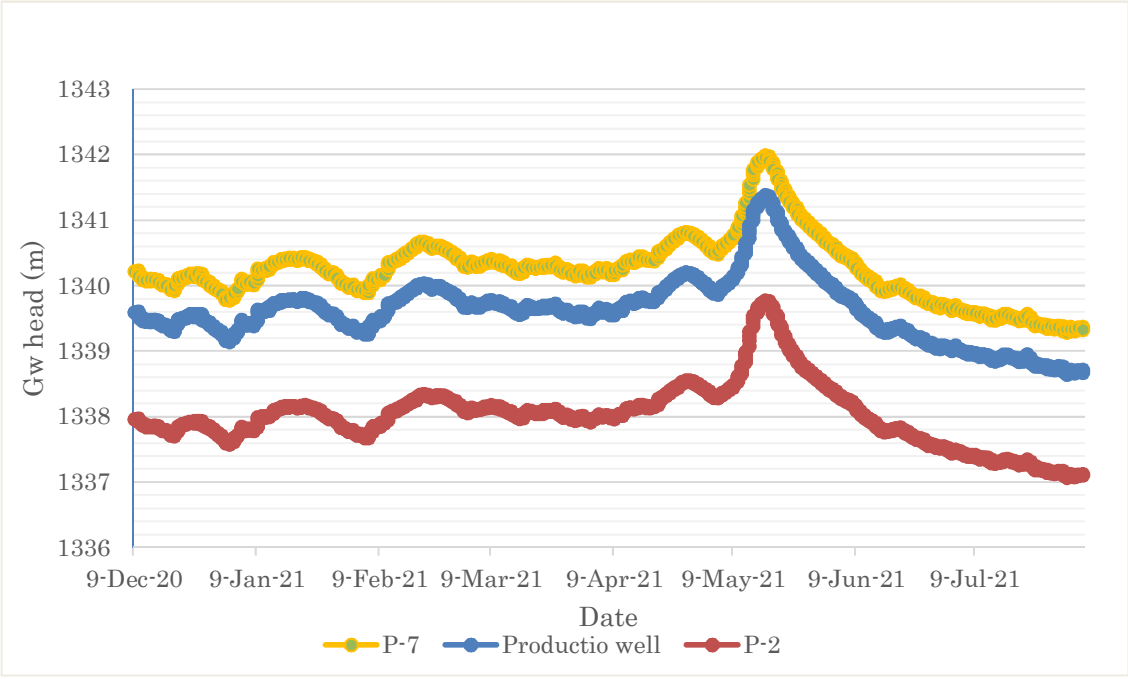
Groundwater heads at two periods (rain and dry) were compared. **Figure 3-10** shows the heads difference between April 2021 and August 2021. Head dffirences between rain and dry period is not uniform at each borehole. High and low groundwater fluctuation area can be observed. Coase sand aquifer is found in the boreholes situated in the low fluctuation area. Possible explanation of those fluctuations is that groundwater in the low fluctuation area might be recharged by river water. That is why heads don't drop much at dry season. On the other hand, groundwater can not gain much river water at high fluctuation area.



Source: JST

Figure 3-10 Groundwater Head Difference (m) (April and August, 2021)

In addition to the manual measurement, continuous measurement by Diver was carried out from December 2020 to August 2021 at three wells (P-2, P-7 and production well) (**Figure 3-11**).



Source: JST

Figure 3-11 Groundwater Head at three wells (continuous measurement)

Fluctuation pattern of three wells is very similar. Highest groundwater head was observed in May and the lowest head was in August. The resul shows the seasonal fluctuation was about 3m. It is also noted that monitoring wells situated near the Akagera River (p-7and production well) has high groundwater head.

3.2.5 Seasonal groundwater fluctuation and well yield

Pumping test at test site was conducted in November, 2021.It was observed that groundwater level was the lowest in August (dry period) in the test site. Statistic groundwater level difference between November and August was around 1.0 m. Thus dynamic water level caused by pumping in August can be lower than that in November. Qmax and safe yield of borehole estimated in November may not be same in August. Pumping rate of test well was considered the pumping in dry period and determined as 80m^3/hours and 65% of Qmax in November. Therefore, this value of the yield still be valid in dry season.

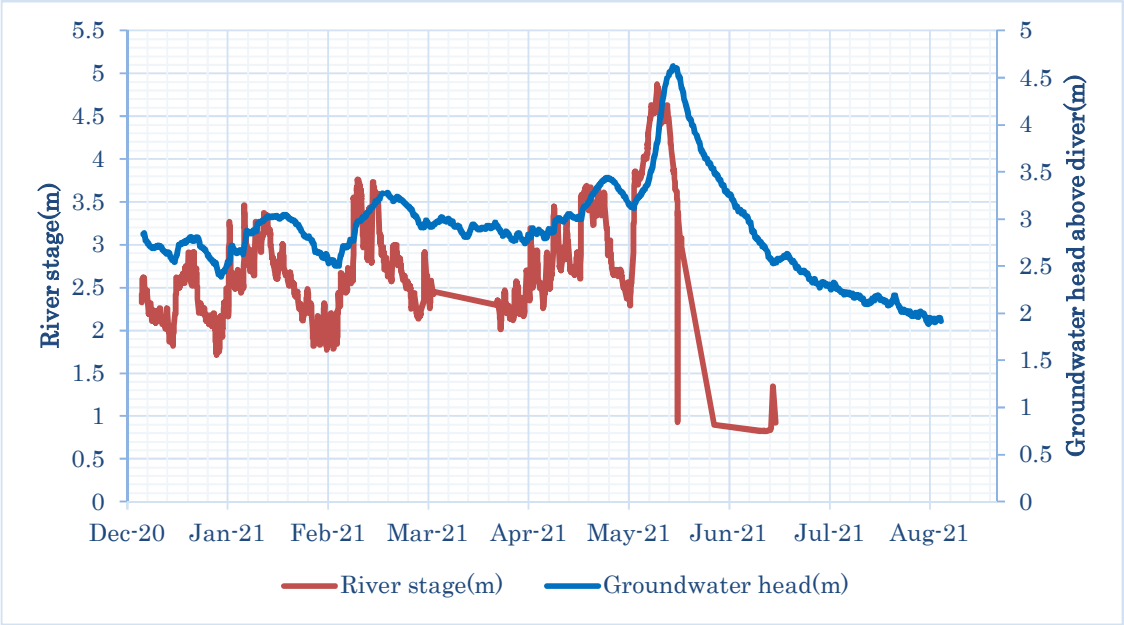
3.2.6 Relationship between river and groundwater at Masaka test site

During pumping test, the extra water inflow from the river boundary was observed. Measured groundwater head was compared with the river stage data taken from RWB hydrological station near the test site. It can be seen from the graph (**Figure 3-12**) that it seems to be certain correlation between groundwater head and river stage at test site.

The interaction between river and groundwater takes place in three basic ways:

- streams gain water from inflow of groundwater through the streambed (gaining stream),
- streams lose water to groundwater by outflow through the streambed (losing stream), or
- both, gaining in some reaches and losing in other reaches.

Unfortunately, there is no river stage measurement station close to the observation wells. Therefore it is difficult to judge the condition of interaction between groundwater and river.

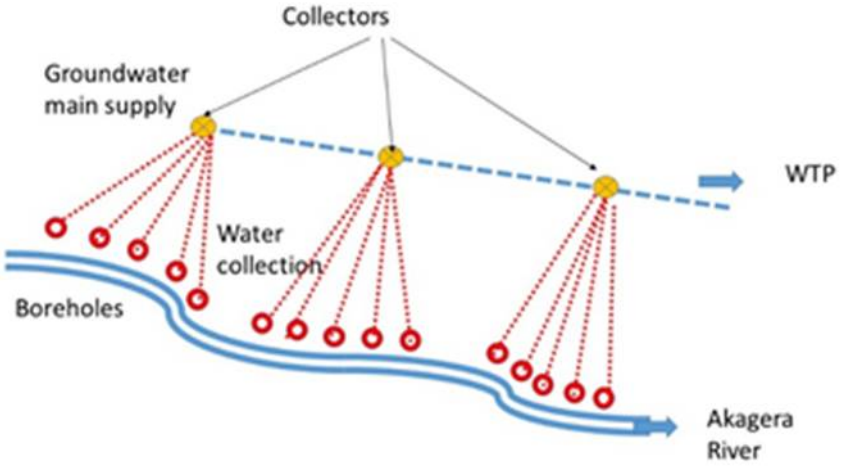


Source: JST

Figure 3-12 Relationship between Groundwater Head and River Stage

3.3 POSSIBLE LOCATION OF WELL FIELD AND CONCEPT DESIGN OF WELLFIELD

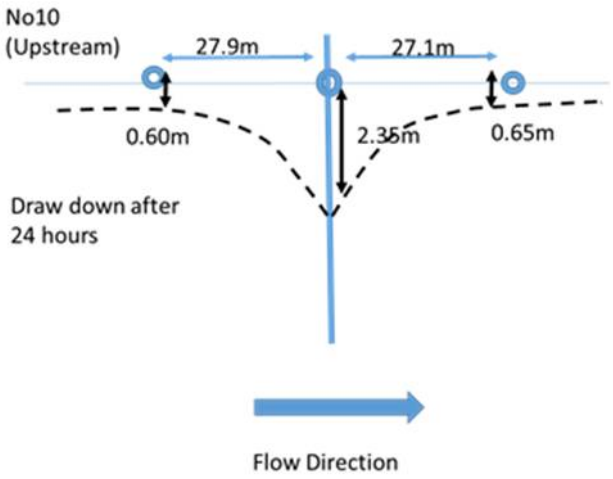
The raw water source for Masaka WTP is derived from boreholes placed in the wellfield with submersible pumps delivering water to the inlet of WTP. As shown in the result of core drilling, with flood plain (alluvial sediments), thick clay deposits limit aquifer permeability and can result in exceptionally low to poor borehole yields and limited hydraulic connection within the aquifer. Therefore, it is recommended to carry out core drilling to identify the aquifer distribution when the access to the planned wellfield can be possible. Pumped water is collected with laterals connected in chambers with DN600 or DN500 pipes delivered to WTP.



Source: JST

Figure 3-13 Concept of Wellfield

Influence of multiple wells also must be considered in addition to individual well location. During the continuous pumping test at the test site, drawdown at the monitoring well was measured and shown in **Figure 3-14**.



Source: JST

Figure 3-14 Area of Influence by Pumping

The drawdown by pumping is around 0.6m at the distance of 30m from pumping well.

Area of influence can be determined by an empirical equation.

$$R = c * \sqrt{\frac{b * K * t}{ne}}$$

Where R is radius of influence (m) , c is constant, b is aquifer thickness(m), K is hydraulic conductivity, t is the time of pumping (day), ne is porosity (20-30% for alluvial aquifer)

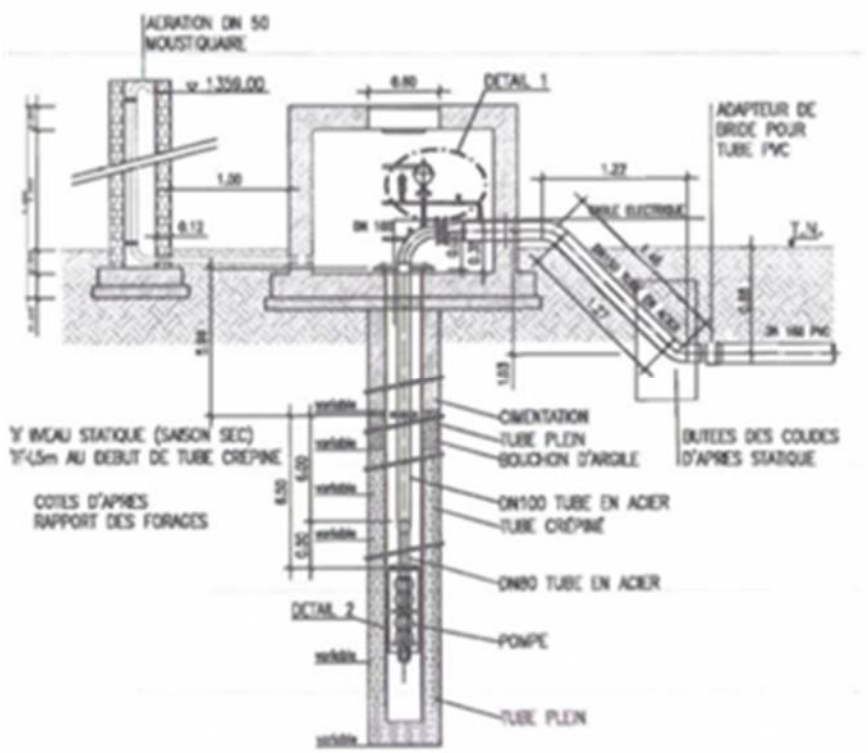
The estimated radius by this equation is more than 100m

Therefore, it is recommended that distance between the boreholes should be from 50 m to 100m if possible.

3.4 STRUCTURE OF WELL AND ACCESS ROAD TO WELLFIELD

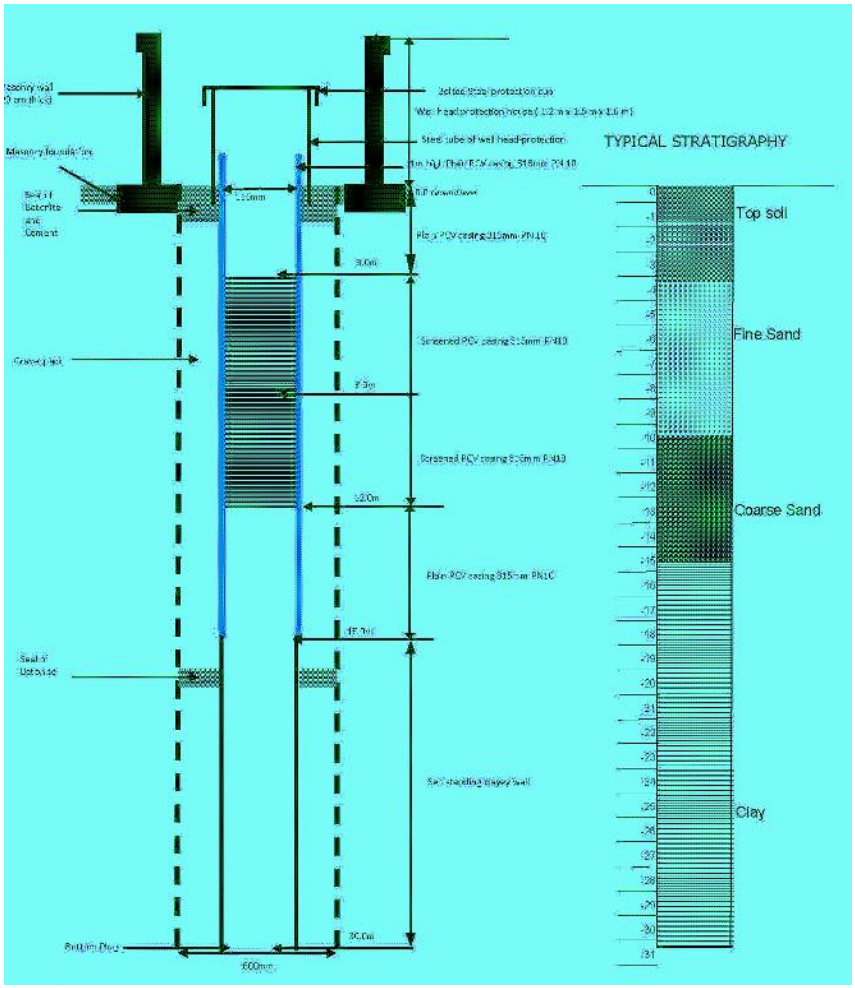
3.4.1 Borehole design

Borehole design in new wellfield at Masaka can be similar to those of test well and existing Nzove well. Drilling is recommended at the depth of clay layer at the bottom of aquifer plus a few meters and diameter of PVC casing & screen is 315mm. Pump setting depth can be around 15m.



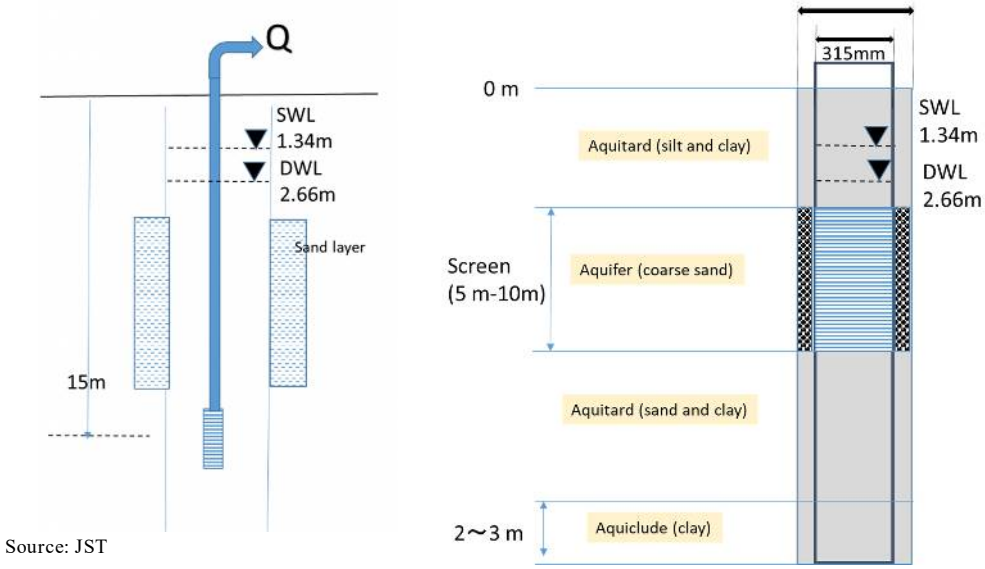
Source: Detailed Design for Rehabilitation of Nzove I Water Treatment Plant and Water Distribution Network in Kigali,WASAC,2021

Figure 3-15 Borehole Design at Nzove Well



Source: Masaka drilling work report by Foraky Africa

Figure 3-16 Borehole Design at Test Well



Source: JST

Figure 3-17 Proposed Borehole Design of Masaka Wellfield

Proposed borehole design is based on the information obtained from Test borehole near proposed wellfield area. Dynamic water level is expected to be at around 3.0 mbgl. General specification of borehole is explained in **Table 3-7**.

Table 3-7 Summary of Borehole

	Description
Drilling diameter	450mm - 540mm to accommodate casing and screen
Casing diameter and material	315mm, PVC blank casing
Screen diameter and material	315mm, Stainless steel wire wrap screen
Gravel packing and centralizers	Grain size is determined by slot size of screen, bentonite grout seal above gravel is necessary.
Riser pipe for submersible pump	Stainless steel is recommended

Source: JST

3.4.2 Protection of Borehole

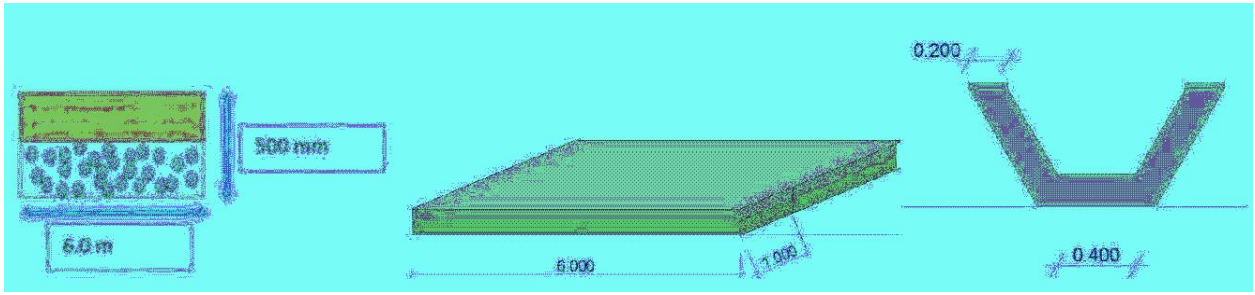
Test site is situated along the Akagera River. Due to flood from river and inland water, the area around well is under water during rain season. Therefore, the production well should be protected by installing a steel casing around the PVC pipe. This steel case is covered by a bolded steel head. This cover can also be removed once necessary by unbolting. As additional protection, a house of 1.2 m x 1.5 m and 1.6 m is needed to build around the well. The house is sitting on a foundation of 40 cm and plastering was done to protect the masonry wall.

Source: JST

Figure 3-18 Protection of Well against Flooding

3.4.3 Access Road

There is no access road to the proposed wellfield area. Access road can be the approximately 1,400 m length, 6 m width and 500 mm thick with soil and stones where applicable. Construction cost of access road is based to the square meters calculated from the total length and width of the road which is 1,400m by 6m makes it 8,400 m^3



Source: JST

Figure 3-19 Concept of Access Road

3.4.4 Summary of Raw Water Supply System

Wellfield is summarized in the flowing table. Maximum number of boreholes to supply raw water is 20 which is expect produce raw water of more than 20,000m^3/d . Yield of each well is varied and depends on the aquifer situation.

Table 3-8 Description of Wellfield

	Description	Remarks
Borehole	Total number: Maximum 20. Depth of borehole: Maximum 30 m Yield: from 25m^3/h to 80m^3/h	Need future study to identify the position of borehole.
Total length of wellfield	Previous study indicated the distance between boreholes should be from 50m to 100m. Therefore, maximum length of 20 boreholes is 1,900m	

Source: JST

In addition to boreholes, raw water supply system is composed of collector pipelines, main pipeline, connection chamber, surge control devices, control room, and power supply.

Table 3-9 Description of Raw Water Supply System

	Description	Remarks
Lateral pipe from borehole to Control chamber	150mm, Total length 3,000 m (150m x20)	Need future study to identify the position of boreholes.
Transmission main from wellfield to WTP	300-500mm, length 1.600m, including raw water collectors, manifolds and transmission	

Source: JST

Source: JST

Figure 3-20 Design of Wellfield

3.4.5 Drillig Period for Wellfield Construction

Proposed wellfield is situated at floodplain of the Akagera River. Due to the flooding, propsed wellfield site is under water and is not accessible during rain period. Therefore the construction of wellfield should be carried out during the dry period (July to September).

Source:JST

Figure 3-21 Overview of Wellfield Area (Dry Period, August 2021)

3.5 EQUIPMENT FOR SUSTAINABLE WELL MANAGEMENT

3.5.1 Well Management

The following equipment is recommended for well management

(1) Dip meter to measure groundwater level
(2) Automatic groundwater level meter
(3) Borehole camera
(4) Borehole rehabilitation equipment such as compressor for air lifting and jetting pipes to clean the boreholes

3.5.2 Monitoring Well

In addition to the equipment, monitoring wells should be installed to understand groundwater level by pumping in the wellfield. Monitoring wells are needed to be protected against flooding during rainy season. After core drilling, the casing & screen are installed and the boreholes can be used as monitoring wells. **Figure 3-22** shows the monitoring well which was converted after the core drilling.

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Source: JST

Figure 3-22 Monitoring Well at Test Site

3.6 FURTHER WATER SOURCE STUDY FOR PROPOSED WATER DEVELOPMENT AREA

As mentioned previously, aquifer distribution is complex at the floodplain of Nyabarongo/ Akagera River. Therefore further study is needed to understand the proposed water sourced development area. At the moment, there is no access road to the proposed site. When the site can be accessible, core drilling (depth 30m x > 30 bhs) should be conducted to confirm the aquifer property around site. In addition, test wells (>3 bhs) should be drilled to determine the safe yield and borehole structure of new wellfield. As mentioned previously, the proposed development area is submerged during rain season and only accessible during dry season (July to September).

Source: JST

Figure 3-23 Contents of Further Study for Water Source Development at Masaka

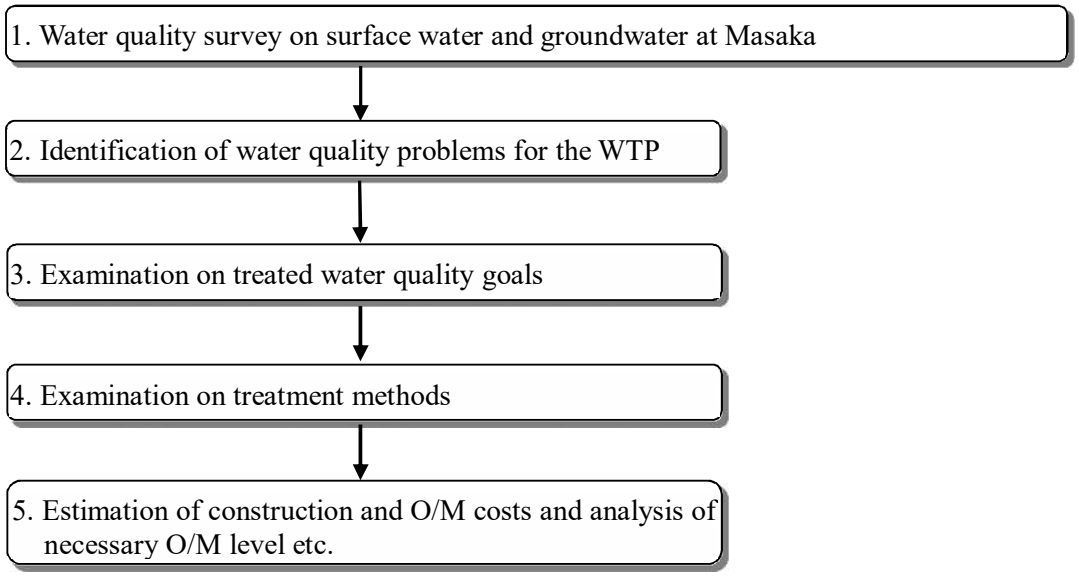
CHAPTER 4 CONSTRUCTION OF WATER TREATMENT PLANT

4.1 SUPPLY CAPACITY OF INTAKE AND WATER TREATMENT PLANT

Water supply capacity of new WTP in Masaka was determined as **20,000 m^3/day** according to the water demand projection as same as the intake water capacity of the wellfields.

4.2 TREATMENT PROCESS DETERMINATION

In order to determine an appropriate treatment process, basic technical approach and methodology for determining the water treatment process are proposed as shown in **Figure 4-1**.



Source: JST

Figure 4-1 Technical Approach and Methodology for Designing Water Treatment Process of Masaka WTP

Considering the fact that no existing water quality information for the surface water or ground water at Masaka was available, water quality surveys have been conducted under the masterplan study and the results are summarized in **Table 4-1**.

Table 4-1 Summary of Water Quality Survey at Masaka

No.	Sampling No.	Unit	Dry Season		Rainy Season		RDWQS [1]	WHO (2017)
	Sampling Date		2019/09/12	2020/11/10	2021/02/19	2019/09/12		
	Sampling Type		Nyabarongo River	Ground Water	Nyabarongo River	Ground Water		
1	pH	-	7.09	7.51	7.17	6.61	6.5-8.5	-
2	Turbidity	NTU	512 [2]	21	1,650	18	5	5
3	Electrical Conductivity		-	292	-	257	1,500	-

No.	Sampling No.	Unit	Dry Season		Rainy Season		RDWQS [1]	WHO (2017)
	Sampling Date		2019/09/12	2020/11/10	2021/02/19	2019/09/12		
	Sampling Type		Nyabarongo River	Ground Water	Nyabarongo River	Ground Water		
4	BOD_5	mg/L	10.8	-	16.65	22 (COD)	-	-
5	Ammonia nitrogen (NH_4-N)	mg/L	0.23	0.73	0.502	0.279	0.5	-
6	Nitrate nitrogen (NO_3^--N)	mg/L	0.16	1.03	1.244	1.425	10	11.3
7	Nitrite nitrogen (NO_2^--N)	mg/L	<0.002	0.07	0.054	0.013	0.001	0.9
8	Fluoride (F^-)	mg/L	0.32	0.49	0.13	0.80	1	1.5
9	Manganese (Mn)	mg/L	0.015	3.12	0.150	3.037	0.1	0.4
10	Iron (Fe)	mg/L	0.16	2.91	1.91	6.70	0.3	0.3
11	Zinc (Zn)	mg/L	0.18	-	0.24	-	-	-
12	Calcium (Ca)	mg/L	5.6	15.62	9.74	18.10	150	-
13	Magnesium (Mg)	mg/L	8.3	11.46	9.21	14.13	100	-
14	Chloride (Cl^-)	mg/L	-	22.2	-	14.2	-	-
15	Standard plate count bacteria	cfu/ml	5×10^4	8.5×10^4	1.4×10^6	3.2×10^5	100	-
16	E. coli	cfu/ 100ml	4×10^1	1.9×10^1	1×10^5	8×10^3	-	-
17	Cyanide (CN^-) [3]	mg/L	<0.001	-	<0.001	-	0.01	0.5
18	Chromium (Cr^{6+}) [3]	mg/L	<0.005	-	0.014[4]	-	0.05	0.05
19	Cadmium (Cd) [3]	mg/L	<0.0003	-	<0.0003	-	0.003	0.003
20	Lead (Pb) [3]	mg/L	0.007	-	0.018	0.002	0.01	0.01
21	Lead in supernatant after Jar Test for coagulation	mg/L			<0.001			
22	Mercury (Hg) [3]	mg/L	<0.00005	-	0.00008	-	0.001	0.006
23	Arsenic (As) [3]	mg/L	-	0.003		0.006	0.01	0.01

Source: JST

1) RDWQS: Rwanda Drinking Water Quality Standard
2) 512 means the value exceeding Rwanda Drinking Water Quality Standard
3) Items analyzed in Japan.
4) Total Chromium

Based on the results of **Table 4-1**, the target parameters for treatment have been identified and their individual treatment methods are also studied as shown in **Table 4-2**.

Table 4-2 Summary of Target Water Quality Parameters and Their Individual Treatment Methods

No.	Target Parameters	Water Quality Level	Unit Treatment Process
1	Turbidity	Low (18-21)	Coagulation-sedimentation, filtration, membrane
2	Ammonia nitrogen (NH_4-N)	Low-Middle (0.28-0.73)	Aeration, biologic treatment, chlorination
3	Nitrite nitrogen (NO_2^--N)	Low (0.01-0.07)	Aeration, biologic treatment, membrane
4	Iron (Fe)	Middle-High (2.91-6.70)	Coagulation-sedimentation, biologic treatment, chlorination, contact oxidation
5	Manganese (Mn)	High (3.04-3.12)	Coagulation-sedimentation, biologic treatment, chlorination, contact oxidation
6	Bacteria	Middle (10^4-10^5)	Coagulation-sedimentation, filtration, O_3, UV, chlorination, membrane

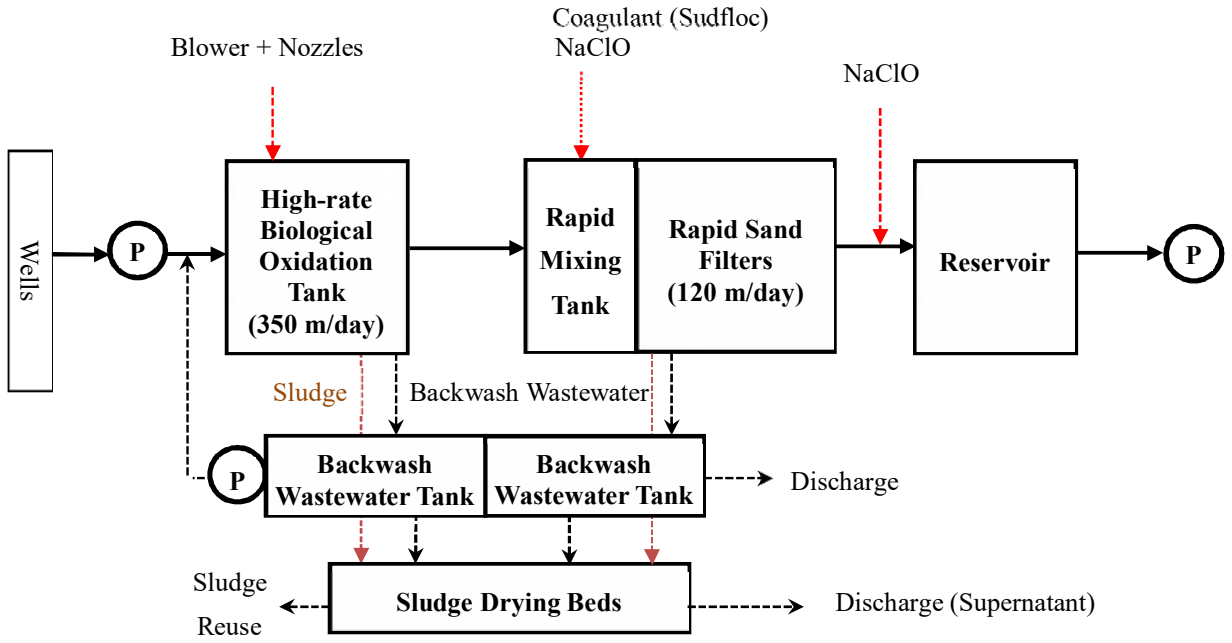
Source: JST 1) Microscope observation, but no Species and quantitative analysis

Regarding drinking water quality standard, there are no significant difference between Rwanda Drinking

Water Quality Standard and WHO guidelines as shown in **Table 4-1**. Therefore, it is proposed to use Rwanda Drinking Water Quality Standard as treated water quality goals for this F/S.

Based on comprehensive consideration of the following aspects and the treatment performance in the existing Nzove 1 WTP and Kanzenze WTP where main issues of raw water quality are also turbidity, ammonia, bacteria, iron and manganese, treatment process for the WTP in the F/S is proposed in **Figure 4-2**.

1) Efficacy against target treatment compounds
2) Adverse byproduct formation
3) Economic efficiency (including both construction costs and O&M costs)
4) Resources requirement (land requirement and O&M levels etc.), and
5) Environmental sustainability of the considered alternative.



Source: JST

Figure 4-2 Proposed Treatment Process

The purpose of each unit treatment process is summarized in **Table 4-3**.

Table 4-3 Summary of Unit Treatment Process

No.	Unit Treatment Process	Purpose of Unit Treatment Process
1	Aeration and Biological Oxidation Tank	1) Providing DO for oxidation of Fe, Mn, nitrite (NO_2^-) and some organic matters etc. 2) Removing ammonia, Fe, Mn in High-rate Biological Oxidation Tank 3) Removing part of odor compounds
2	Rapid Sand Filters	Removing color, turbidity, organic matters, Fe, Mn, bacteria etc.
3	Disinfection	Removing bacteria
4	Backwash	Separating sludge and backwash wastewater and recovering supernatant of backwash

No.	Unit Treatment Process	Purpose of Unit Treatment Process
	Wastewater Tank	wastewater
5	Sludge drying bed	Dewatering sludge

Source: JST

4.3 SUMMARY LIST OF FACILITIES

The facilities to be constructed are summarized in **Table 4-4**. The details of the facilities are as described in **Appendix-A Drawings**.

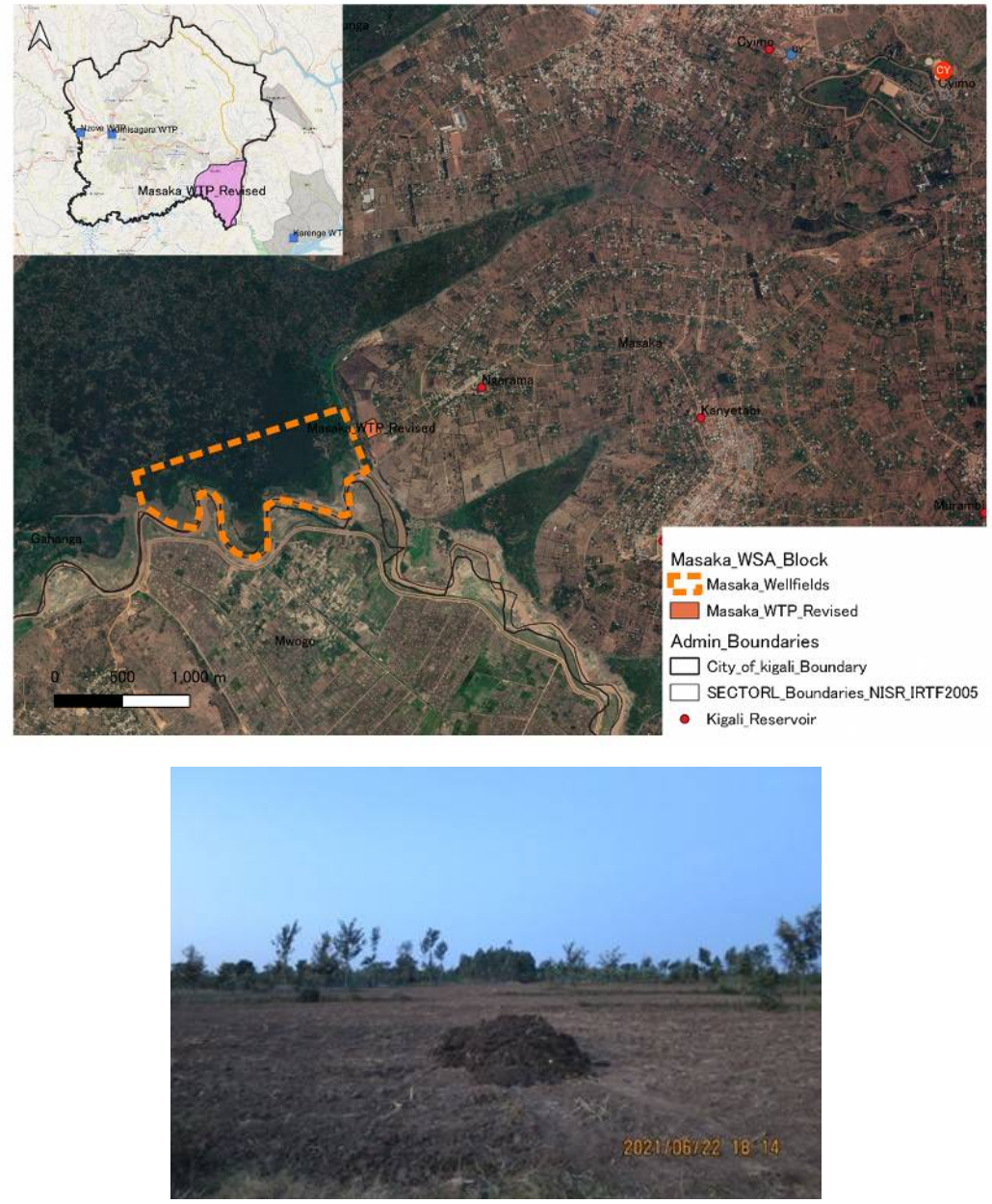
Table 4-4 Summary of the Facilities to be Constructed

Summary of the List of Facilities	
Intake Well Pumps and Pipelines	
Intake Wells	600 mm to accommodate casing and screen Total number: Maximum 20. Depth of borehole: Maximum 30 m Yield: from 25m^3/h to 80m^3/h 315mm, PVC blank casing and Stainless steel wire wrap screen
Electric Panels Room	Incoming Panel, Switchgears Motor Control Center Panels, Telemetry Panels
Raw Water Transmission Pipeline	ND300-500, L=1,600m ND150, L=3,000m
Miscellaneous	Monitoring and Maintenance equipment and tools
Water Treatment Plant	
High-rate Biological Oxidation Basin	3.0 m ^{W} × 5.6 m ^{L} × 6 Basins (LV=350 m/d)
Rapid Sand Filter Basin	4.0 m ^{W} × 7.2 m ^{L} × 6 Basins (LV=120 m/d)
Clear Water Reservoirs	10.0 m ^{W} × 17.0 m ^{L} × 5.0 m ^{H} × 2 Tanks
Clear Water Transmission Pumps	a. Masaka-Cyimo middle Clear Water Transmission Pumps: Q 4.9 m^3/min × H 124 m × (3 unit +1 standby) b. Cyimo middle-high Clear Water Transmission Pumps: Q 5.5 m^3/min × H 100 m × (1 unit +1 standby) c. Masaka-Mbabe Clear Water Transmission Pumps: Q 3.7 m^3/min × H 93 m × (1 unit +1 standby)
Backwash Water Tank	6.8 m ^{W} × 10.0 m ^{L} × 3.0 m ^{H} × 2 Tanks
Backwash Wastewater Tank	8.0 m ^{W} × 8.0 m ^{L} × 3.0 m ^{H} × 2 Tanks
Sludge Drying Bed	25.0 m ^{W} × 12.0 m ^{L} × 1.0 m ^{H} × 6 Beds
Administration Building	150 m^2
Transmission and Distribution Systems	
a. Main Reservoirs and Transmission Mains	
Cyimo Booster Pumping Station	Civil, M&E
WTP-CM	DIP ND 500 L=5.6 km
WTP-MB	DIP ND 300 L=4.2 km
CM-CH	DIP ND 300 L=1.4 km
b. Block Reservoirs and Transmission Sub-mains	
Block Reservoirs	V=100 m^3 x 6, V=500 m^3 x1, V=1,000 m^3 x1
Transmission Sub-Mains	DIP ND 400 L=4.8 km HDPE ND 300 L=7.15 km HDPE ND 300 L=3 km

Source: JST

4.4 LAND ACQUISITION

The land acquisition is necessary both for the WTP and the access road for the well fields. Some areas are private owned, some are public lands, being utilized for the agricultural user as shown in. Therefore, there is no resettlement expected by the project.



Source: JST

Figure 4-3 Proposed WTP's Site

The locations for the wellfields are determined according to the shape of the Akagera River and should be determined well pumping test during the construction implementation. On the other hand, the proposed land for the WTP is just a tentative proposal and can be changed flexibly to the vicinity area.

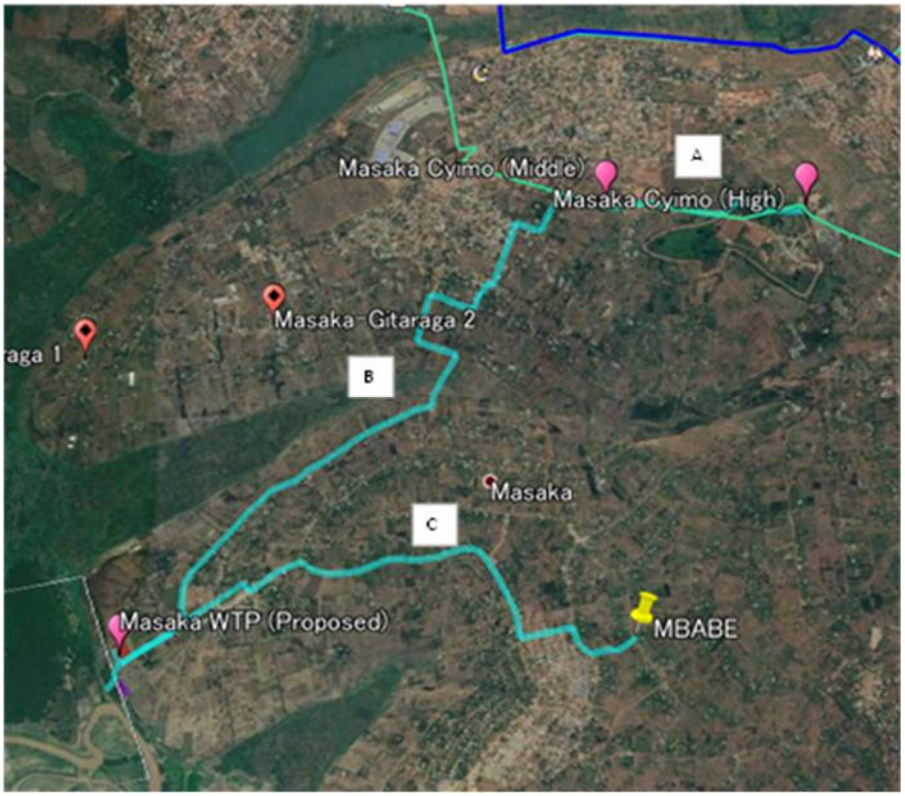
CHAPTER 5 WATER TRANSMISSION AND DISTRIBUTION

5.1 ROUTES OF TRANSMISSION PIPELINES

The main transmission system for the Masaka WTP is the route to the Cyimo reservoirs. Considering the current and future distribution systems, water demand in the middle-lower elevation areas is high. There are two possible transmission systems as shown in **Table 5-1**; A: Direct Transmission to Cyimo High Reservoir and B: Booster pumping at Cyimo Middle. The Plan A: Direct Transmission to Cyimo High Reservoir (EL+1,560). The Plan A is the plan based on the existing water supply systems, which all water come from the Cyimo High Reservoir owing to the water supply from the Karenge 1. The Plan A has a merit to omit the booster pumping station in the middle between Cyimo-high and Masaka WTP but energy inefficient. The Plan B needs a booster pumping stating in the middle of Cyimo hill (EL +1,470[2]) but can distribute many part of the water supply amount by gravity from the location. The comparison shows the energy cost for transmission for the Plan B is significantly lower than that of Plan A (75%, 0.55MUSD compared to 0.73MSUD). Therefore, Plan B was adopted for this study.

The hydraulic calculation was conducted to determine the diameter of transmission pipelines and the required pump head of the transmission pumps based on the abovementioned Plan B. The result of calculation is as shown in **Figure 5-1**.

[2] In this conceptual design, the elevation of this Cyimo-middle reservoir was temporary determined to EL+1970 but can be changed to the location between +1470 to +1485. The level should be determined according to the actual land acquisition and to supply water by gravity to the Rusororo-Kabuga reservoir.



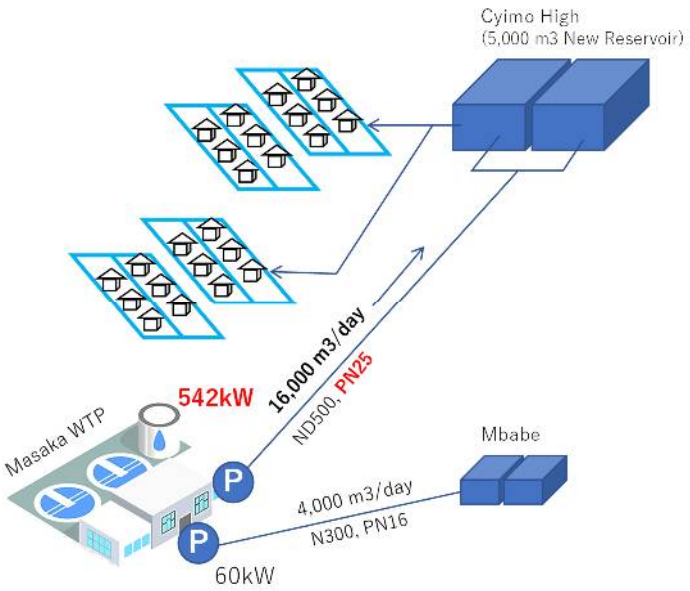
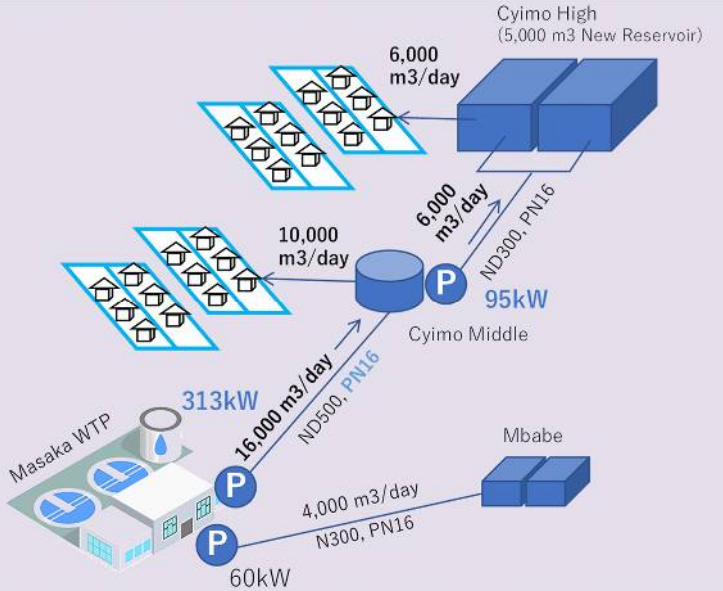
Required Pump Head											
Pipe ID	Name	Elevation, m		Headloss				**Demand (Day Ave)**	**Day Max**	**Total Head, m**
		Start	End	Distance, km	I, permil	Head Loss, m	Allowance, m			
A	From_Cyimo_Middle_To_Cyimo_High	1471.9	1559.3	1.3	5.39	6.97	5.00	**6,000**	**7,800**	**100**
B	From_Masaka_To_Cyimo_Middle	1367.5	1471.5	5.3	2.75	14.54	5.00	**16,000**	**20,800**	**124**
C	From_Masaka_To_Mbabe	1367.5	1444.9	3.9	2.54	9.96	5.00	**4,000**	**5,200**	**93**

Pipe ID	Name	Hydraulic Calculation						
		I (‰)	C	D (mm)	Q (m3/day)	A (m2)	Q (m3/sec)	V (m/sec)
A	From_Cyimo_Middle_To_Cyimo_High	5.39	130	300	7,800	0.071	0.090	1.28
B	From_Masaka_To_Cyimo_Middle	2.75	130	500	20,800	0.196	0.241	1.23
C	From_Masaka_To_Mbabe	2.54	130	300	5,200	0.071	0.060	0.85

Source: JST

Figure 5-1 Adopted Transmission System and its Hydraulics

Table 5-1 Comparison of Transmission System from Masaka WTP

	A: Direct Transmission to Cyimo High Reservoir	B: Booster pumping at Cyimo Middle
Schematic		
Overview	Water from WTP is transmitted directly to the Cyimo High reservoir one step. All water supply is from Cyimo High Reservoir by gravity. No booster pumping station on the way.	Water from WTP is transmitted to Cyimo Middle booster pumping station. Large part (10,000 m^3/day) of is distributed from Cyimo middle. Remaining part (6,000 m^3/day) is pumped up to Cyimo High reservoir.
Transmission Pump Electricity (Cost)	542 kW (100%) (0.73 MUSD/year)	408 kW (75%) (0.55 MUSD/year)
Pump&Motor Initial Cost	(M&E) 0.5 MUSD, (Civil) 0.2 MUSD	(M&E) 0.4 MUSD, (Civil) 0.5 MUSD
Other Cost factors (+; increase factor, -;decrease factor)	(++) Pipeline construction cost will be higher since it needs high-grade materials and fittings (PN25) to be durable for the high-pressure transmission. (+) High leakages are anticipated in case of the leakages.	(+) Maintenance is necessary for booster pumping station. (--) Able to diverse the existing Karenge I pipe (ND300) for transmission from Cyimo middle to Cyimo High.

Source: JST

5.2 DISTRIBUTION SYSTEMS

Planning methodology for distribution systems: the size of each block is determined by considering residential houses, the zoning plan, and the DEM data. The block sizes are constrained by the DEM data because the elevation gap of the blocks should be less than 70 - 100 m. The block boundaries are basically along the road alignments because it is clear to see and easy for monitoring and operation. We check the existing houses on the aerial photo to roughly estimate number of customers in each block so that we can create block reservoirs with appropriate sizes. The size of each reservoir is estimated precisely considering the water demand for each block. The location of the reservoirs and sub-transmission routes should be not only hydraulically but also economically reasonable. Therefore, reservoirs should be located close to the transmission mains as much as possible. We also see if the location is reasonable according to our observation of the aerial photo. The transmission routes and the locations of main reservoirs are determined as mentioned in the previous chapter. The existing water supply facilities such as pipelines, reservoirs, valves, and chambers are considered to utilize it. The capacity of distribution reservoirs is planned based on the water demand in the year 2030 for 8 hours in total of the daily maximum water demand.

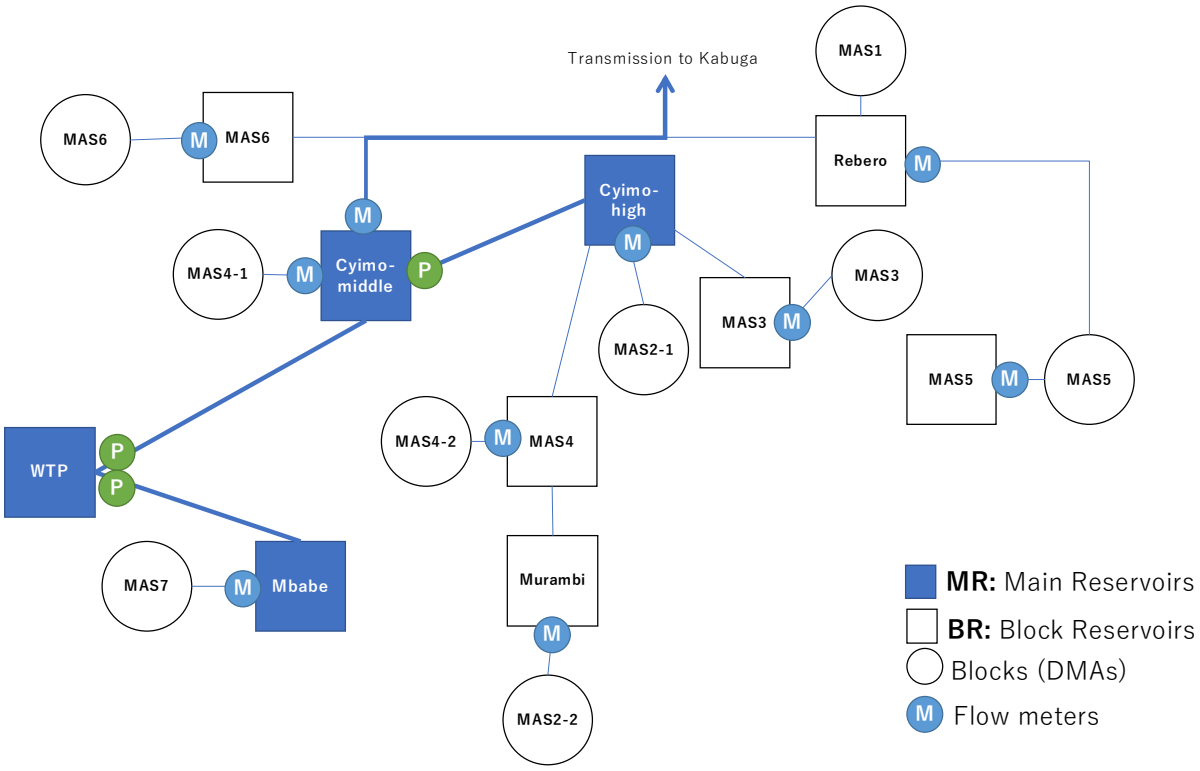
Results: The plan for distribution blocks in the WSA is elaborated in **Table 5-2**. 10 distribution blocks are identified in the WSA. The capacity and the location of the reservoirs are illustrated in **Figure 5-2** and listed in **Table 5-2**. There is a large volume of reservoirs on top of the Cyimo hill side (5,000 m^3/day) and most of the required capacity (approx. 80%) would be covered by this reservoir. Main additional capacity should be constructed on Cyimo middle (500 m^3) and the Mbabe (1,000 m^3).

Table 5-2 Distribution Blocks

Block Name	Name	Description	Elevation Range, (EL+)m	Existing Customers, nos.	Demand in 2030, m^3/day	Demand in 2035, m^3/day	Future Customers in 2035, nos.
MAS0	Gako top-hill	Isolated area where it is difficult to supply water from Cyimo (High Reservoir).	1540-1570	6	-	-	-
MAS2-1	Gako high	High residential area with the edge of Masaka hill, which include higher part of newly developing residential area around Cyimo, and pipeline extends to Murambi.	1480-1560	311	1,200	2,100	4,219
MAS4-1	Cyimo-Middle	Middle of existing Masaka city where existing residential and industrial estates are concentrated.	1410-1500	976	900	1,600	3,204
MAS4-2	Mbabe middle (1)	Middle elevation part of Mbabe-Masaka where it is to be located in the higher elevation than the future "Mbabe" reservoir.	1410-1500	185	900	1,600	3,204
MAS2-2	Mbabe middle (2)	Lower to middle elevation part of the South-western part of Murambi-Masaka, including Cyeru.	1410-1500	24	300	700	1,250
MAS3	Ayabaraya high	Middle elevation zone of Ayabaraya, eastern part of Masaka.	1400-1490	816	1,100	2,000	4,012
MAS5	Ayabaraya low	Lower elevation residential area at the eastern side of Masaka.	1340-1430	252	900	1,700	3,394

Block Name	Name	Description	Elevation Range, (EL+)m	Existing Customers, nos.	Demand in 2030, m^3/day	Demand in 2035, m^3/day	Future Customers in 2035, nos.
MAS7	Mbabe Low	Lower elevation part of the Masaka western hill which includes the existing city site of the veteran residential area	1340-1430	571	2,500	4,400	8,998
MAS6	Gitaraga	Lower elevation part of the Masaka north area, where the logistics parks and commercial-industrial estates are highly concentrated.	1340-1410	1587	2,600	4,500	9,297
MAS1	Gako-Kabuga	Residential and commercial area of Masaka near the National Road NR4. The area is continuously stretched to Kabuga-Rusororo.	1350-1440	1879	1,300	2,300	4,614

Source: JST



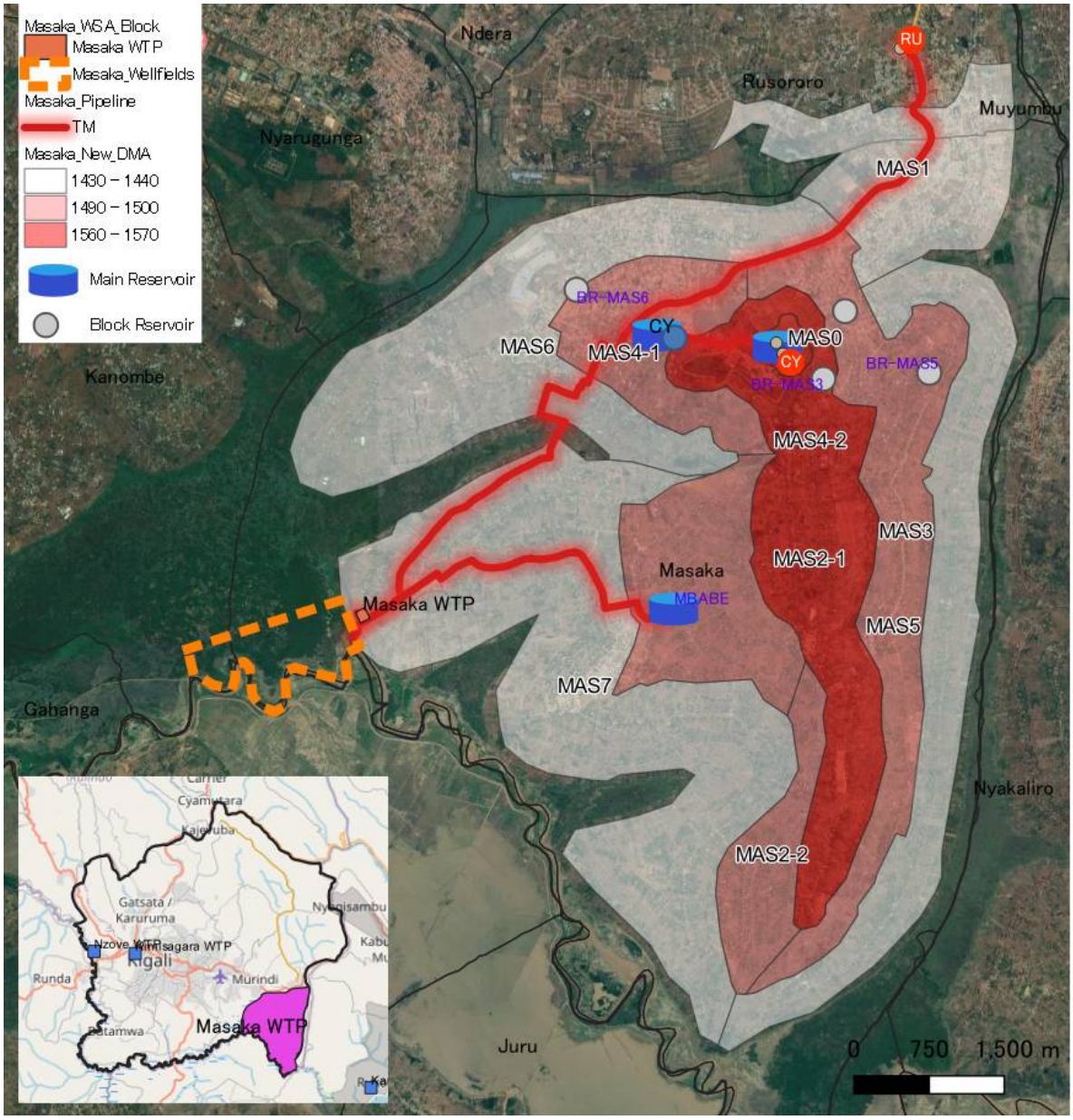
Source: JST

Figure 5-2 Distribution Reservoirs Systems

Table 5-3 Capacity of Distribution Reservoirs

Type	Name	Demand (2030)	Required	Required	Existing/Ongoing, m^3	New (This Project) m^3	Total
MR	Cyimo High	0	0		5,000		
BR	Gako high	2,025	675			**100**	
BR	MAS4	600	200			**100**	
BR	Ayabaraya high	1,926	642			**100**	
BR	(Kabuga)	1,286	429	5,227			6,100
MR	Cyimo Middle	1,538	513			**500**	
BR	MAS5	1,629	543			**100**	
BR	Rebero	4,463	1,488			**100**	
BR	Murambi	2,215	738			**100**	
MR	Mbabe	4,319	1,440	1,440		**1000**	1000
	Total	**20,000**	6,667	6,667	5,000	2100	7100

Source: JST



Source: JST

Figure 5-3 Distribution Systems for Masaka Water Supply Area

CHAPTER 6 IMPLEMENTATION SCHEDULE

The implementation schedule for the Project is illustrated in **Table 6-1**. The schedule suggests that the water supply can be inaugurated from the end of the Year 2027 if all procedures go smoothly. The remarks and disclaimers for the implementation schedules are as follows;

- The funding for the Project has based on foreign loan aid which the conditions are unknown. It should be revised based on the required procedures in line with the development partners' terms and conditions as well as the domestic procurement guidelines of the GOR.

- The period for construction (24 months) is based on the past experience of the New Nzove construction by WASAC. A usual period for construction may approximately 30 Months, including the commissioning before full delivery. A shorter period was selected for the schedule in order that the delivery of water shall be accelerated. In general, it is recommended to have a longer period in order that the quality of work should be secured. Therefore, the period for the construction may be revised during the Detailed Design, comparing the quality and time for delivery.

- The time for selection of the Consultants and Contractors should be closely related to the budget for the Project, the country risk regarding political and economic stability. The schedule would be delayed in case of re-bidding and dismissal of the bid. The effect of the COVID-19 and the similar pandemic situation may also affect the schedule of procurement and construction.

Table 6-1 Implementation Schedule for Masaka Construction Project

This Page is closed due to the confidentiality.

CHAPTER 7 ENVIRONMENTAL AND SOCIAL CONSIDERATION

7.1 OBJECTIVES OF THE STUDY

The overall objective of this study is to develop an Environmental and Social Impact Assessment (ESIA) for the "Construction of Masaka WTP with its associated Transmission & Distribution Facilities" in order to ensure sustainability of proposed project, avoid, minimize and compensate negative impacts and to enhance positive impacts. Further, the study shall ensure that the project is implemented in an environmentally and socially sustainable manner and in full compliance with Rwanda's regulations and the JICA guidelines for environmental and social considerations.

7.2 APPROACH AND METHODOLOGY

To achieve the above objectives the consultant team followed procedures stipulated in General Guidelines and Procedures for Social and Environmental Impact Assessment. The methodology used involves a number of stages from scoping phase that includes preliminary assessment to understand and establish boundaries of the study; the desk review of available literature, field visits to establish baseline data, analysis of all available data (secondary and primary data), prediction of positive and negative impacts, analysis of alternatives as well as the proposal of mitigation measures leading to an Environmental and Social Management Plan and Monitoring plan.

7.3 ENVIRONMENTAL AND SOCIAL IMPACT PREDICTION

The project is expected to have both positive and negative impacts on ecosystems and local communities. Positive impacts expected from the proposed project include: availability of treated and clean water, improved sanitation conditions, sustainable and wise use of natural resources temporary and permanent jobs creation and employment opportunities, income generation to the local population, transfer of knowledge from skilled to non-skilled people who may interact with the project activities , increasing of social welfare, etc.

Expected adverse impacts range from physical environment, biological and social environment. These include water noise and air pollution in the project area especially during the construction works, possible soil erosion from excavation works of pipes trenches and other water storages facilities, modification of water table flows, generation of sludge from the treatment plant, loss of biodiversity and encroachment of buffer zone of Akagera river etc. Social impacts of the project implementation will also include loss of land at WTP and reservoir areas, Physical resettlement, loss of trees, crops etc. Other project related impacts include onsite occupational health and safety especially during construction and operation phases.

Mitigation measures for identified and projected impacts were proposed for each of the adverse impacts and this to an extent that they can be avoided, reduced, limited or eliminated and therefore manageable. In this context the Environmental Management Plan(EMP) and an Environmental Monitoring Plan indicating

the mitigation measures, procedure to be followed, monitoring indicators, the responsible institutions to implement these measures and estimated cost of implementing each of these mitigation measures.

Given the nature, location of the proposed project, proposed works and the potential impacts associated with the implementation of project, the consultant can conclude that the nature and extent of adverse impacts identified can be avoided mitigated and eliminated by the implementation of appropriate mitigation measures. In fact, the Construction of Masaka WTP and its supply system is bound to be executed in a sustainable manner and in compliance with national environmental regulations, JICA environmental and social considerations. In this regard, it requires full implementation of proposed mitigation measures and regular monitoring. The total estimated cost for the Implementation and Monitoring of the proposed EMP is.42,800 USD. However , this cost does not include the expropriation budget of the project.

CHAPTER 8 OPERATION AND MAINTENANCE (O&M)

8.1 REQUIRED O&M IN WTP

O&M of WTP is to maintain the condition of facilities and equipment so that it can be operated smoothly by performing maintenance and repairs, and replenishing fuel, oils and fats, reagents, etc. Also, it requires patrolling and inspecting the condition of water treatment facilities, discovering abnormal/troubled parts at an early stage, and inspections to maintain a hygienic environment for water treatment facilities and to ensure the safety of workers and visitors.

Table 8-1 Function of WTP

Function	Work Contents
WTP Operation	• Operation: securing and operation of raw water and treated water • Maintenance: maintenance of facilities, design and construction of simple construction, wastewater treatment
Water Laboratory	• Water quality test, treatment process research, facility maintenance

Source: JST

8.2 REQUIRED PERSONNEL AND RESPONSIBLE WORK FOR O&M

Personnel and responsible work for O&M at the new plant is drafted as the following table below. The number of personnel was estimated from the organization and staff allocation of the existing Karenge WTP.

- The number of personnel in WTP will be 35 due to the workload of water as the volume of water purification is expected to be 20,000m^3/day at the new plant.
- Three working shift teams (early morning, day-time and night) are planned.

Table 8-2 O&M Personnel in WTP

Status	Position & Responsible Work	No. of personnel
Open End Contract	Head of Plant	1
	Plant Officer	1
	Laboratory Technician	6
	Operation Technician (Purifier)	5
	Operation Officer (Inventory Management)	1
	Operation Technician (Pump Attendant)	3
	Electrician	1
One Year Contract	Purifier helper	3
	Electrician Helper	7
	Maintenance Helper	2
	Night Watchman	4
	Driver	1
Total Number of Personnel		35

Source: JST

8.3 SKILL AND KNOWLEDGE INPUT FOR O&M FROM IN-HOUSE AND THE EXTERNAL TRAINING

It is necessary to have proper training methods to develop O&M capacity of managers and concerned staff at working at WTP.

- On the Job Training (OJT) is important for staff training, but in countries where OJT is difficult due to lack of experience. In such case, a training facility is built inside the business entity or facilities, then an outside lecturer is invited to transfer technology and knowledge.
- Training centers are required to develop training facilities, formulate training plans based on needs, select and assign instructors, and aim to implement effective training. by introducing fresh lecture content, improving the skills of instructors,
- Inviting external instructors, development experts or having external overseas training by Development Partners is effective for practical skill development.

Source: JST

Figure 8-1 Skills Knowledge Inputs

Table 8-3 Training for O&M Capacity Development

Training Method	Training Contents
In-house Training	• Establishment of training facility Training facility • Strengthening human resources for training management • Lecturer training • Teaching material development
External Training	• Training Seminar, Overseas Training by Development Partners/Experts • Workshop by Educational institutions/College

Source: JST

Suggested Training Program by the Developing Partners/Experts is stated in **Table 8-3**.

Table 8-2 Suggested Training Program by the Developing Partners/Experts

Training Modules	Target Employee	Trainer	Training Program
International Water Quality Standards	Directors, Managers, Engineers	Development Partners/Experts	• Program to draw the WASAC's executives' attention to the issues on water quality control. • Program for capacity development training on water quality control for the concerned staff.

Source: JST

CHAPTER 9 COST ESTIMATE

9.1 PRINCIPLES

The costs for the projects were estimated under the feasibility accuracy basis, not considering the specific routes or the site-specificity of the plants and the pipelines. The cost principles are shown in **Table 9-1** and **Table 9-2**.

Table 9-1 Principles on Cost Estimate as per Facilities

Facilities	Approaches
Water Treatment Plant	The cost was estimated from the past WTP construction project in Rwanda and adjacent countries. The cost for water source development is included in the WTP construction cost since it is deemed to be not significant; large structures such as the dams are not included in the development plan.
Transmission Mains	The cost was estimated from the length of planned routes in the GIS multiplied by the Unit price of the pipelines. The cost includes materials, equipment, labor, construction overhead.
Distribution Mains and Sub-mains	Pipeline length was estimated from the existing pipelines considering the diameter size.
Customer Water Meters	The cost was estimated from the number of new customer connections.
Customer Connections	Length estimated from the actual length per customer connection and proportionally increased as the number of connections.

Source: JST

Table 9-2 Principles on Cost Estimate as per the Cost Items

Cost Items	Description
Construction Cost	Plant: Estimated from other previous project costs in adjacent countries. Pipelines: Calculated from the quotation by manufacturers taken in 2019. All price adjusted for 2021
Indirect Cost (Construction Overhead)	Assume 25% of direct construction costs.
Consulting Services	Assumed 8% of the construction cost.
Land Acquisition Cost	Assumed 1,041 RWF/m^2 (Highest price in Masaka, sector quoted from Institute of Real Properties Values in Rwanda)

Source: JST

Cost for O&M: Chemical cost, salaries and maintenance costs are based on the yearly average cost of each WTP administrative area (the Nzove, the Kimisagara and the Karenge) of WASAC (WASAC Annual Report 2018/2019). Electricity costs are calculated assuming the pump head, which was calculated based on the pipeline routes and elevation differences. The topography is based on the WASAC's GIS data or Google Earth. The electricity tariff is fixed at the current average tariff paid by WASAC (148.68 RWF/kW).
The basic Conditions of the cost estimate are as described in **Table 9-3**.

Table 9-3 Basic Conditions for the Cost Estimate

Assumption	Conditions
Base Year for Cost Estimation:	2021
Exchange Rates	973 RWF/USD
Price Escalation:	FC:1.7%, LC: 5%
Physical Contingency for Construction	5%
Physical Contingency for Consultant	5%
Administration Cost	0.2%
VAT	18%
Import Tax	25%

Assumption	Conditions
Loan interest during const. (Grace Period)	0.00%
Loan interest after Grace Period	0.01%
Front End Fee	Not Applicable
Total period for implementation	9

Source: JST

9.2 CAPITAL COST AND ANALYSIS

The cost for the Project was calculated based on the scope of work as described in the **Chapter 3 to 5**. The cost is summarized in **Table 9-4** and its breakdown is described in **Table 9-5**.

Table 9-4 Cost Summary of the Masaka WTP Project

This Page is closed due to the confidentiality.

Table 9-5 Project Cost Breakdown of Base Cost by the Scope of Work

This Page is closed due to the confidentiality.

9.3 O&M COST AND ANALYSIS

Unit O&M Cost (Cost per produced water supply amount) is estimated in **Table 9-6**. The electricity for WTP was estimated 0.81 kW/m^3 water produced (**Table 9-7**), which is 47% of the existing Karenge System (1.74 kW/m^3) and 54% of the expanded Karenge system (Karenge 2, 1.51 kWh/m^3). As a result, the O&M Cost can be saved up to 200 RWF/m^3, lower than the existing water supply systems.

Table 9-6 Estimated Operation Cost for New Masaka WTP

O&M Cost per year

	Energy Cost /m^3	**Chemical Cost /m^3**	**Mainte nance**	**Salary**	**Total**
	RWF/m^3	RWF/m^3	RWF/m^3	RWF/m^3	RWF/m^3
Expansion	121	36	2	39	198

Source: JST

Table 9-7 Estimated Electricity Consumption for the New Masaka WTP

Items	kVA	kW	Unit	Amount, m3/day	kWh/m3	RWF/m3	Total kWh/day
Intake Pumps	11	9.9	20	20,000	0.24	35.33	238
Water Treatment	-	200	-	20,000	0.14	20.71	4,800
From_Masaka_To_Cyimo_Middle		313	1	16,000	0.47	69.81	7,512
From_Cyimo_Middle_To_Cyimo_High		95	1	6,000	0.38	56.50	2,280
From_Masaka_To_Mbabe		59	1	4,000	0.35	52.63	1,416

Source: JST

CHAPTER 10 FINANCIAL AND ECONOMIC EVALUATION

Both financial and economic evaluation are conducted in this Chapter to ascertain the viability of the project.

10.1 FINANCIAL EVALUATION

10.1.1 Assumptions

The following assumptions are set to carry out financial evaluation.

Table 10-1 Assumptions for Financial Evaluation

<table>
<tr><th>Standard Items for Evaluation</th><th colspan="2">Assumptions</th></tr>
<tr><td rowspan="2">1. Project Cost</td><td>Capex and Opex</td><td>Details in Chapter 8</td></tr>
<tr><td>Import tax and VAT</td><td>Included</td></tr>
<tr><td>2. Foreign exchange rate</td><td>1 US$ = RWF 973</td><td>National Bank of Rwanda: average of medium rate as at end of month during 6 months from October 2020 up to March 2021.</td></tr>
<tr><td rowspan="3">3. Economic Life</td><td>1) Water intake well and pipelines: 30 years on weighted average</td><td><table><tr><th>Composition</th><th></th><th>Econ. Life</th></tr><tr><td>Facilities</td><td>70%</td><td>40 years</td></tr><tr><td>Machinery & Equipment</td><td>30%</td><td>15 years</td></tr></table></td></tr>
<tr><td>2) Water Treatment Plant: 40 years on weighted average</td><td><table><tr><th>Composition</th><th></th><th>Life</th></tr><tr><td>Facilities</td><td>70%</td><td>50 years</td></tr><tr><td>Machinery & Equipment</td><td>30%</td><td>15 years</td></tr></table></td></tr>
<tr><td>3) Pipeline: 40 years</td><td>-</td></tr>
<tr><td>4. Replacement cost</td><td>Every 15 years</td><td>Machinery & Equipment</td></tr>
<tr><td>5. Salvage Value</td><td colspan="2">The residue value of capital cost calculated from the above economic life is salvaged at the last year of evaluation time horizon up until FY 2066/67.</td></tr>
<tr><td>6. Revenues</td><td colspan="2">• Incremental revenues generated by the projects
• Tariff: 890RWF/m^3 – reviewed considering the incremental cost incurred by the project and the recurrent costs projected by WASAC in 2019.</td></tr>
<tr><td>7. Opportunity Cost of Capital</td><td colspan="2">Real interest rate of 6.3% is applied, that is generally calculated:
= (long-term interest rate) – (expected inflation.)
✓ Long-term interest rate:11.25%, yields of 7-years' Rwandan government bond issued in 2019 quoted at the Rwanda Stock Exchange in 2021
✓ Expected inflation: 5%, estimated by IMF</td></tr>
<tr><td>8. Evaluation Time Horizon</td><td colspan="2">• 41 years: from the start year of operation up to the completion year of loan repayment</td></tr>
</table>

Source: JST

10.1.2 Results of Financial Evaluation

Table 10-2 shows the results of the financial evaluation by applying the above assumptions. The FIRR of the base case shows 4.9% which is lower than 6.3% of the opportunity cost of capital (see **Appendix C** in detail). Meanwhile the study revealed that the FIRR goes down to 3.0% if the current tariff of 730 RWF/m^3 is applied to the evaluation. However, it is noted that the FIRR will soar to 17.8% if the donor's concessional loan is financed based on the assumptions below. In this context, the project will achieve well over the

financially feasible level of 6.3% (see **Appendix C** in detail).

Table 10-2 Results of Financial Evaluation

Case	FIRR	NPV	B/C
Base Case	4.9%	-7,802million RWF	0.88
Financing with donor's concessional loan*	17.8%	16,066 million RWF	1.22

Source: JST

*Assumptions for concessional loan

- Loan amount: Construction and engineering only, exclusive of administration and taxes
- Loan terms and conditions are assumed as follows:
  40 years of loan period including grace period, 10 years of grace period, and 0.5% of interest rate per annum.

<Sensitivity analysis on base-case: the variation in capex and revenues for FIRR break-even point >

The minimum variation that can get the FIRR to attain the feasible level over 6.3% is examined as follows.

- ✓ Capex: if decreased by more than 20%, the FIRR goes up over 6.3%
- ✓ Revenues: if increased by more than 15%, the FIRR goes up over 6.3%

10.2 ECONOMIC EVALUATION

10.2.1 Assumptions

The following assumptions are set to carry out economic evaluation.

Table 10-3 Assumptions for Economic Evaluation

Standard Items for Evaluation		Assumptions
1. Project Costs (Capex + Opex)	1) Financial Cost	Same as Table 10-1
	2) Economic Cost	• The above financial cost is converted to economic cost by utilizing the 'Conversion Factor (CF)' formulated by MINECOFIN • This economic cost is applied for economic evaluation • Price escalation is not considered. • The land cost is generally disregarded in the economic cost. • Import tax and VAT are not included.
2. Benefits		• Beneficiaries' "Willingness-to-Pay": RWF/month/household x 4% • CoK: Urban 15,000 and Rural 4,500
3. Opportunity Cost of Capital		• Generally, the range between 10% and 12% is used for economic evaluation. • For this analysis, set at the lower rate of 10% by considering the nature of the projects from the point of view of basic human needs. • This rate can be referred to the same rate applied in the "Sustainable Water Supply and Sanitation Program, 2017, AfDB".
4. Evaluation Time Horizon		30 years from the operation start year

Source: JST

10.2.2 Results of Economic Evaluation

Table 10-4 presents the results of the economic evaluation. It shows that the EIRR will sufficiently exceed 10% of the opportunity cost of capital (see **Appendix C** in detail). Accordingly, the project is judged to be economically viable.

Table 10-4 Results of Economic Evaluation

Item	EIRR	NPV	B/C
Base Case	15.6%	151.743 million RWF	1.41

Source: JST

<Sensitivity Analysis>

Table 10-5 illustrates the results of the sensitivity analysis on the economic evaluation of the project. The benefits show a slightly higher sensitivity than the capex. Provided that the capex increases by 20%, the EIRR results in 13.1% for the base case of benefits; on the contrary, the benefits decrease by 20%, the EIRR goes down to 11.8% for the base case of capex. However, it should be observed that the EIRR yet exceeds 10% of the opportunity cost of capital despite 20% of variations.

Table 10-5 Results of Sensitivity Analysis

Variation Items		Benefits				
		+20%	+10%	Base case	-10%	-20%
Capex	-20%	23.4%	21.3%	19.2%	17.0%	14.7%
	-10%	21.1%	19.2%	17.2%	15.2%	13.1%
	Base case	19.1%	17.4%	**15.6%**	13.7%	11.8%
	+10%	17.5%	15.9%	14.2%	12.5%	10.7%
	+20%	16.2%	14.6%	13.1%	11.5%	9.8%

Note: Figures in blue cells present the feasible level of EIRR.
Source: JST

CHAPTER 11 CONCLUSION

- Emergent needs and necessity to construct Masaka WTP and forwarding infrastructures were contextualized in light of the social backgrounds and the current status of development in the study areas and future development plan in the CoK.

- The target area of the Project mainly focuses on the Masaka sector equivalent to 20,000 m^3/day in the year 2035. The target water supply coverage by the Project is 100% after the completion, including piped water connections and the public tap. The total target population as beneficiaries is approximately 169,000 populations in the year 2035, which means an additional 143,000 will gain access to water by the project.

- The F/S defined the scope of work, including the intake expansion, WTP, water transmission and distribution systems. The WTP assumed high-rate filtration to treat iron & manganese, coagulation and rapid sand filtration system considering the raw water from the well fields in the marshland along the Akagera River.

- The schedule showed that the water supply could be inaugurated from the end of the year 2026 if all procedures go smoothly. The schedule should be reviewed in line with the actual process applied to an international development partner's loan conditions and internal procedures for GoR.

- Preliminary Environmental Impact Assessment shows that the impact from the Project was very limited; there is no resettlement by the plant construction is expected with little concern on the environmental pollution.

- Operation and Maintenance, including the personnel, skills and knowledge input, was assessed based on the scale of the future expansion. The new WTP may be utilized as the training center to develop the skills for WTP operation.

- FIRR was estimated as 4.9% and it would be feasible if the concessional loans (Soft loans: 40 years, 10 years' grace period and 0.5% per annum) were applied. EIRR was estimated as 15.6 %, which was significantly higher than the social discount rate (10%), thus the project was proved economically viable.

APPENDIX

List

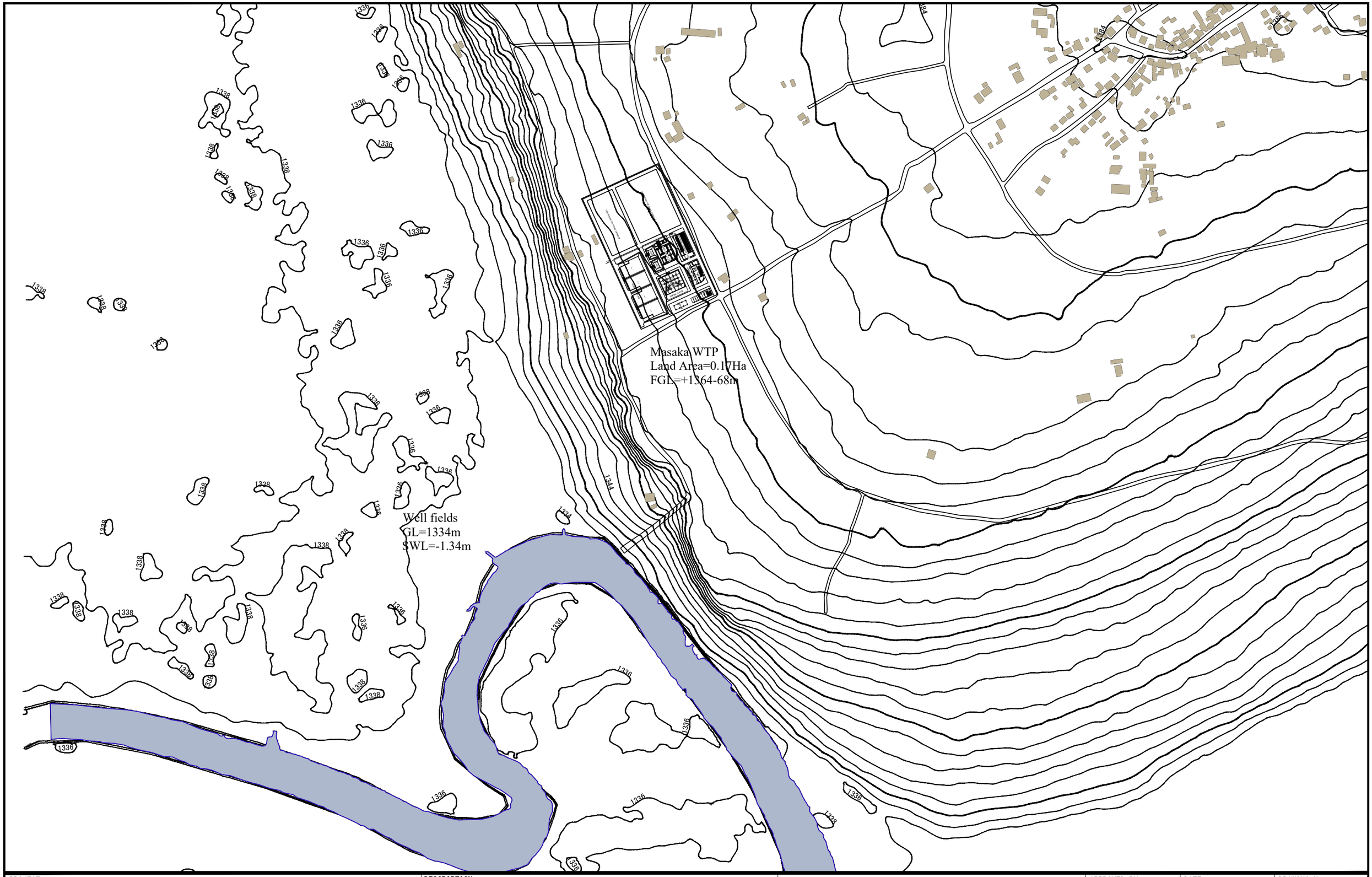
Appendix A: Drawings for the Project

Feasibility Study (F/S) Report for
The Project for Construction of Masaka Water Treatment Plant

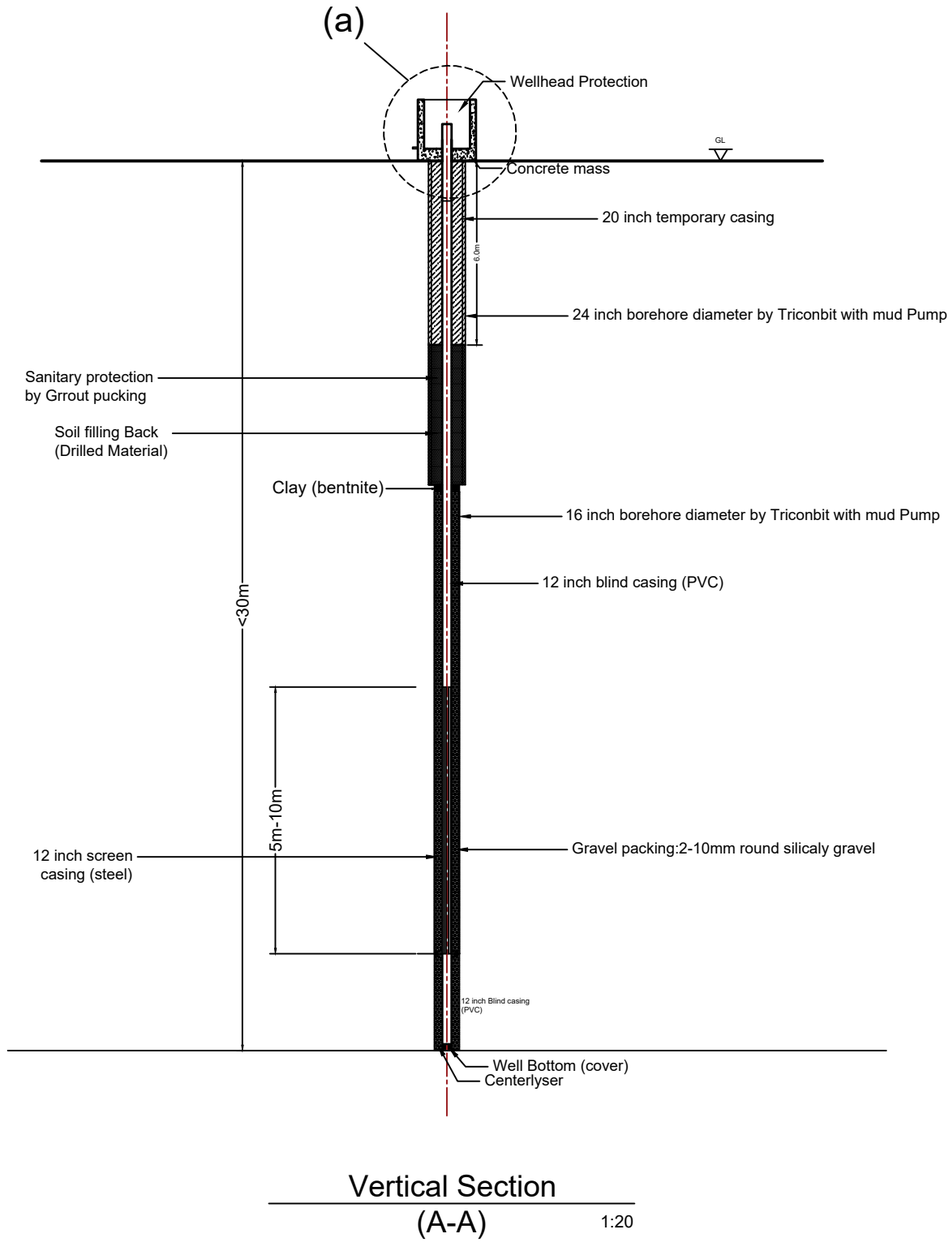
Drawing List

Drawing No.	Name	Scale
W01	Location Map of Masaka WTP	1:4000
W02	General Layout of Masaka WTP	None
W03	Biological Oxidation Filter	1:300
W04	Filtration Basin	1:200
W05	Drainage Basin Structure	1:200
W06	Clear Water Reservoir Structure	1:200
W07	Sludge Drying Bed Structure	1:300
W08	Process and Instrumentation Diagram	None

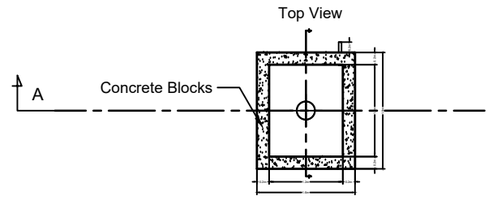
PROJECT *KIGALI WATER SUPPLY MASTERPLAN:* *FEASIBILITY STUDY FOR THE CONSTRUCTION OF MASAKA WTP*	DESCRIPTION Drawing List	*Nihon Suido Consultants CO., LTD. and Yachiyo Engineering Co., Ltd. joint venture in cooperation with Water & Sanitation Corporation (WASAC)*	APPROVED BY MAMIYA Takemasa	DATE 2021.8.6	DRAWING No 000
			PREPARED BY NISHIDA Kosei	DATE 2021.8.6	SCALE –



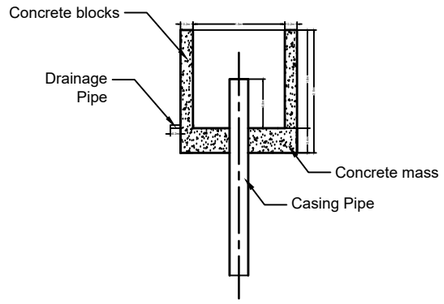
PROJECT	DESCRIPTION		APPROVED BY	DATE	DRAWING No
KIGALI WATER SUPPLY MASTERPLAN: *FEASIBILITY STUDY FOR THE CONSTRUCTION OF MASAKA WTP*	Location Map of Masaka WTP	*Nihon Suido Consultants CO., LTD. and Yachiyo Engineering Co., Ltd. joint venture in cooperation with Water & Sanitation Corporation (WASAC)*	MAMIYA Takemasa	2021.8.6	M01
			PREPARED BY MATSUBARA Koichi	DATE 2021.8.6	SCALE 1:4000



Vertical Section
(A-A) 1:20

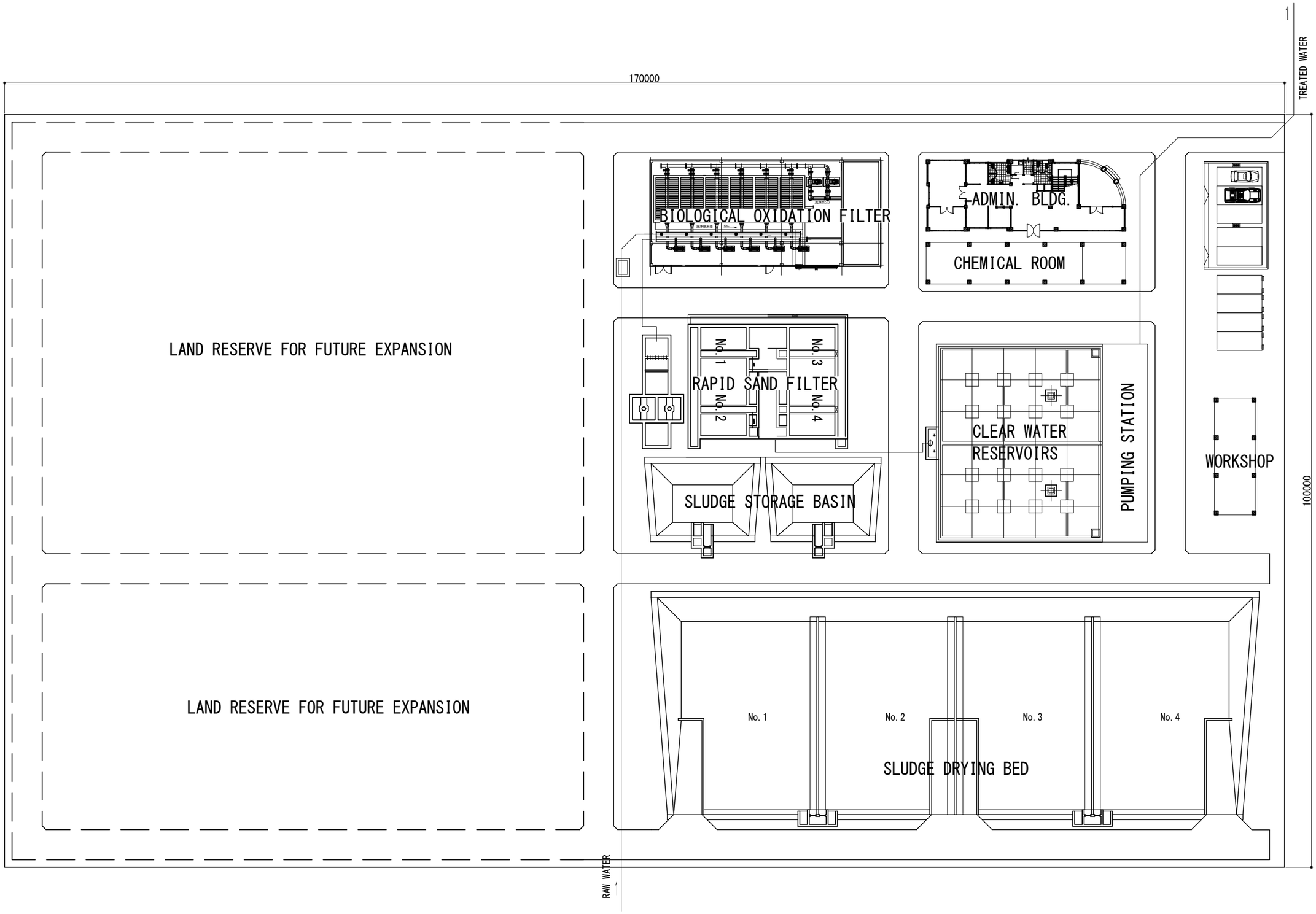


Top View
1:10

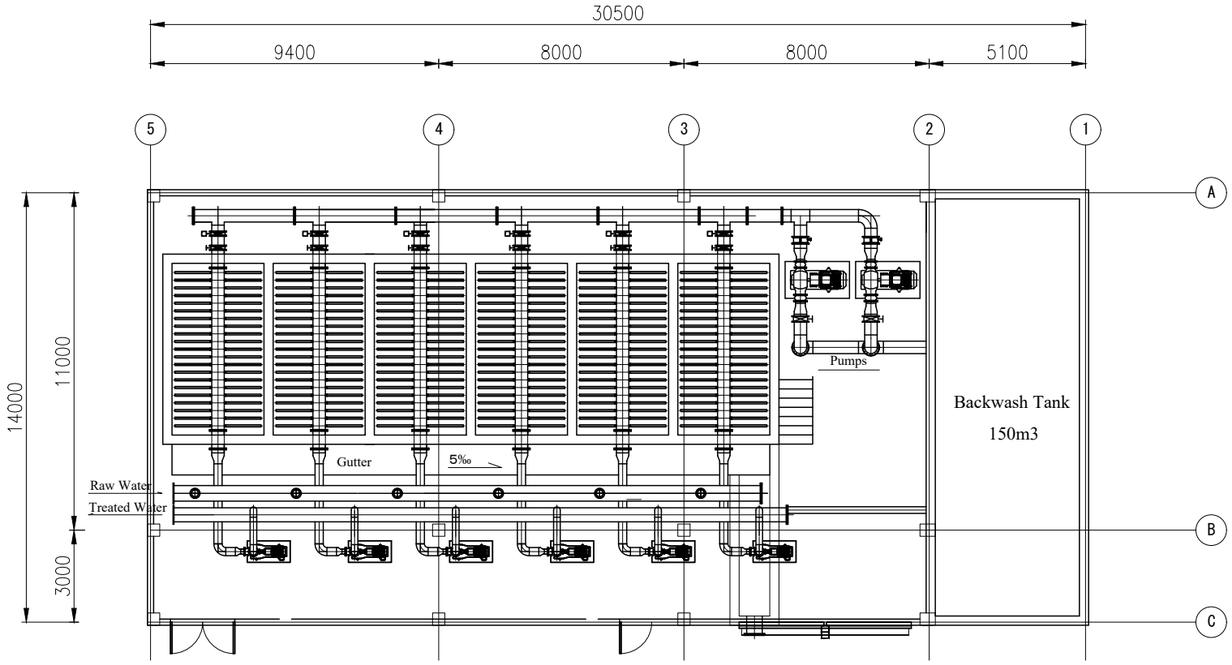


Detail (a)
1:10

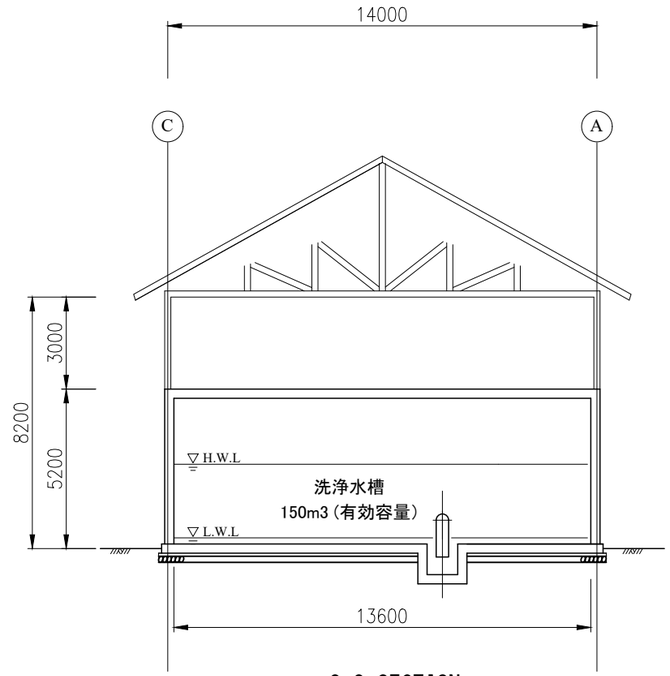
PROJECT	DESCRIPTION		APPROVED BY	DATE	DRAWING No
KIGALI WATER SUPPLY MASTERPLAN: *FEASIBILITY STUDY FOR THE CONSTRUCTION OF MASAKA WTP*	**Typical Structure of Water Wells**	*Nihon Suido Consultants CO., LTD. and Yachiyo Engineering Co., Ltd. joint venture in cooperation with Water & Sanitation Corporation (WASAC)*	.....	2021.XX.XX	.....
			PREPARED BY	DATE 2021.XX.XX	SCALE **As Shown**



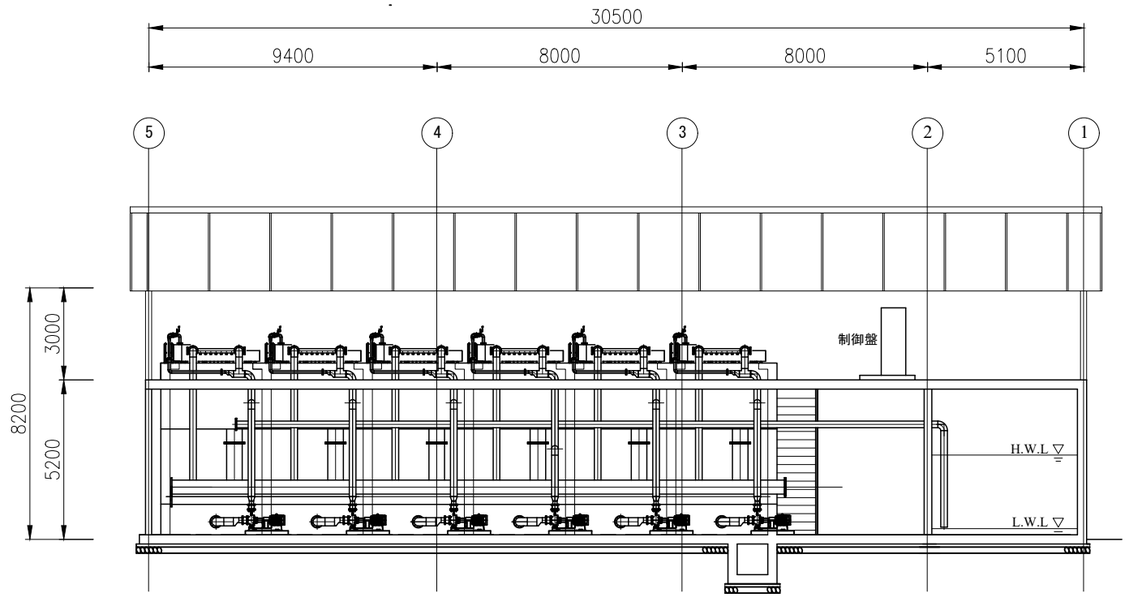
PROJECT	DESCRIPTION		APPROVED BY	DATE	DRAWING No
KIGALI WATER SUPPLY MASTERPLAN: *FEASIBILITY STUDY FOR THE CONSTRUCTION OF MASAKA WTP*	General Layout of Masaka WTP	*Nihon Suido Consultants CO., LTD. and Yachiyo Engineering Co., Ltd. joint venture in cooperation with Water & Sanitation Corporation (WASAC)*	MAMIYA Takemasa	2021.8.6	M02
			PREPARED BY MATSUBARA Koichi	DATE 2021.8.6	SCALE 1:500



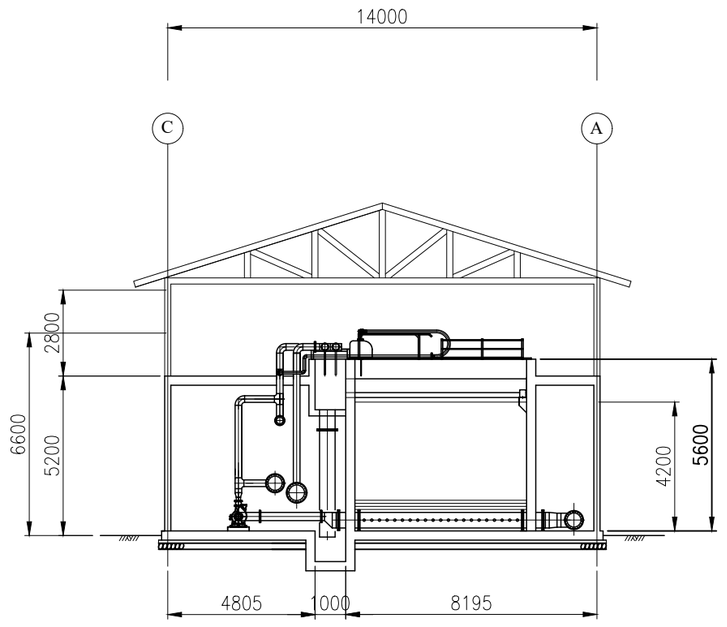
1F PLAN



2-2 SECTION

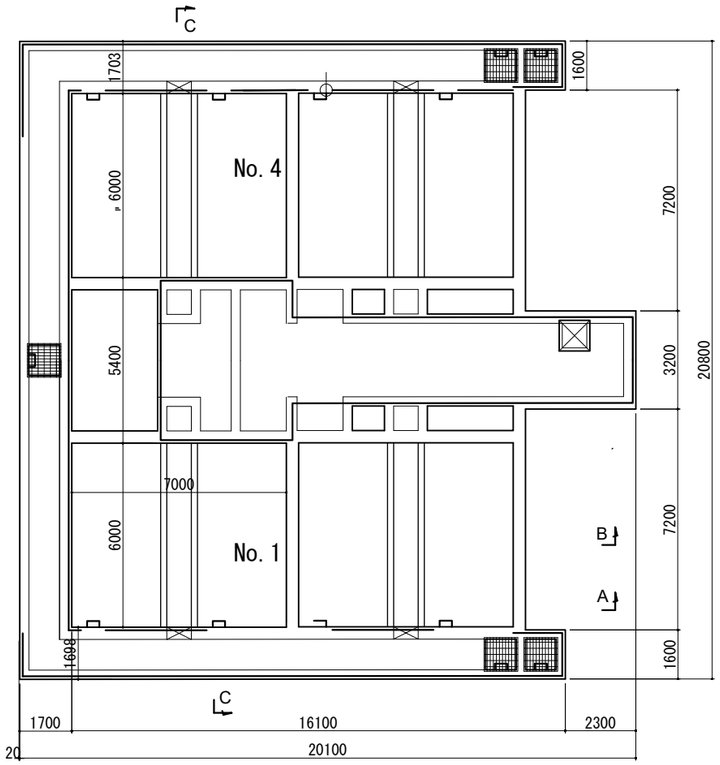


B-B SECTION

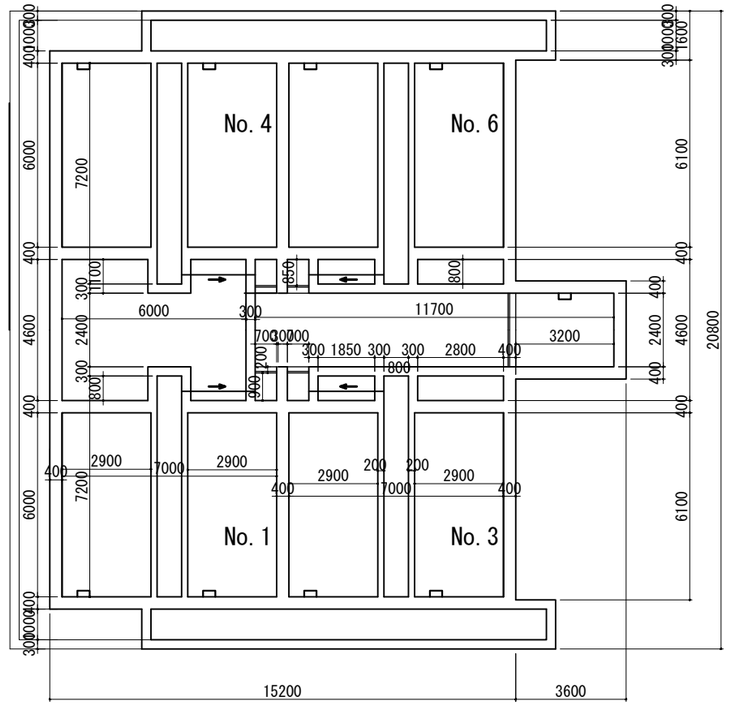


3-3 SECTION

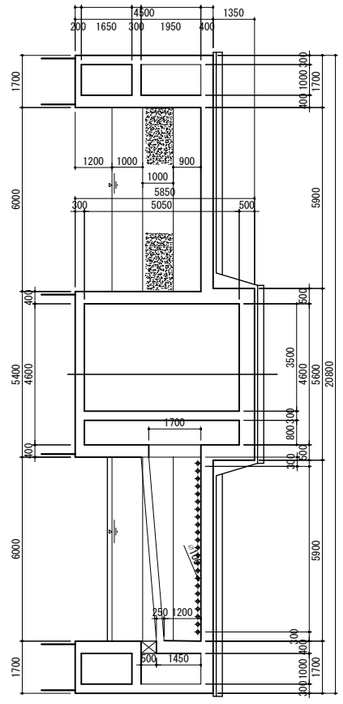
PROJECT	DESCRIPTION		APPROVED BY	DATE	DRAWING No
KIGALI WATER SUPPLY MASTERPLAN: *FEASIBILITY STUDY FOR THE CONSTRUCTION OF MASAKA WTP*	Biological Oxidation Filter	*Nihon Suido Consultants CO., LTD. and Yachiyo Engineering Co., Ltd. joint venture in cooperation with Water & Sanitation Corporation (WASAC)*	**MAMIYA Takemasa**	**2021.8.6**	M03
			PREPARED BY **MATSUBARA Koichi**	DATE **2021.8.6**	SCALE 1:200



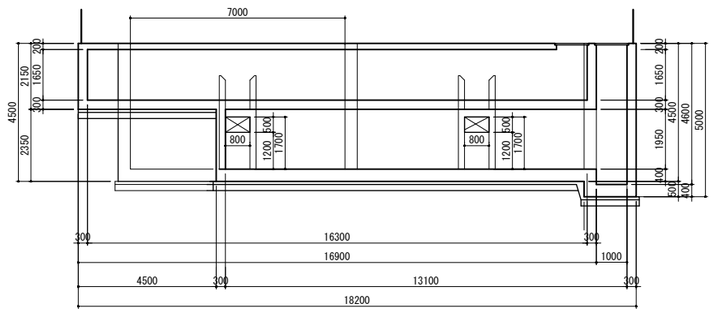
C - PLAN



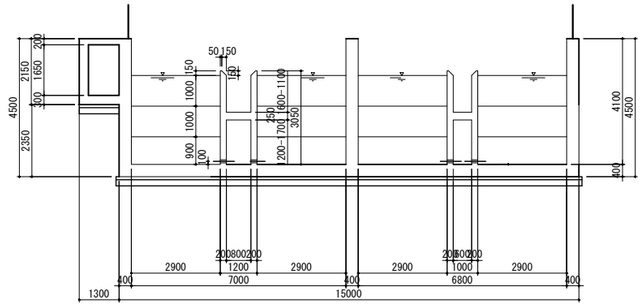
SECTIONAL PLAN



C-C section

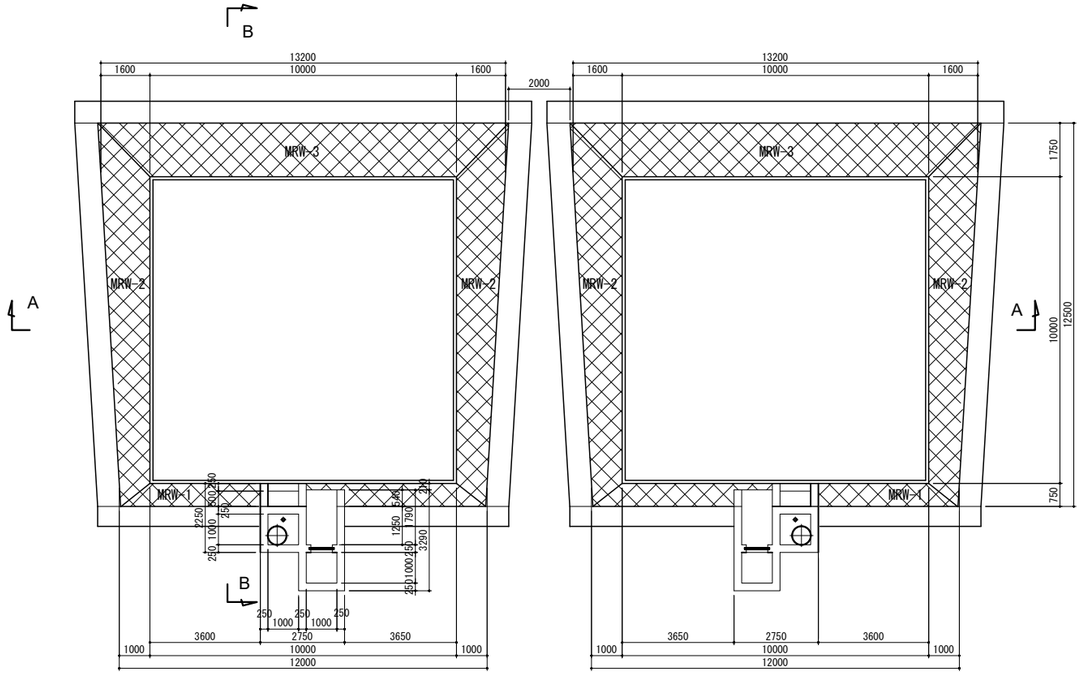


A-A section

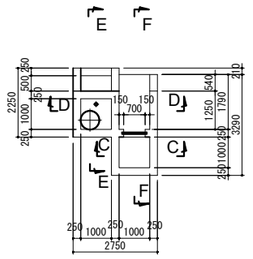


B-B section

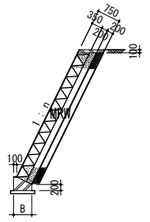
PROJECT	DESCRIPTION		APPROVED BY	DATE	DRAWING No
KIGALI WATER SUPPLY MASTERPLAN: *FEASIBILITY STUDY FOR THE CONSTRUCTION OF MASAKA WTP*	Filtration Basin	*Nihon Suido Consultants CO., LTD. and Yachiyo Engineering Co., Ltd. joint venture in cooperation with Water & Sanitation Corporation (WASAC)*	**MAMIYA Takemasa**	**2021.8.6**	M04
			PREPARED BY **MATSUBARA Koichi**	DATE **2021.8.6**	SCALE 1:200



PLAN



Inlet and Outlet Structure



	1 : n	B(mm)
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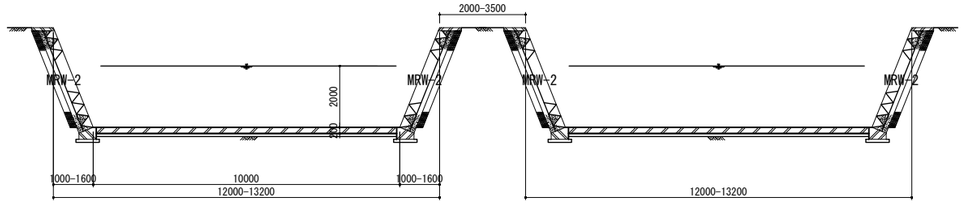
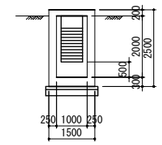
MRW-2	1:0.4	610
MRW-3	1:0.4	610



A - A section



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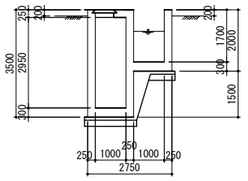
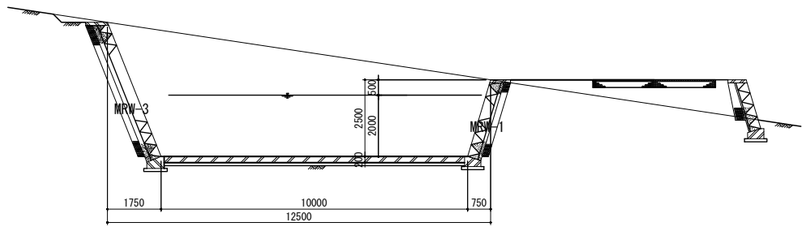
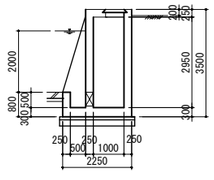


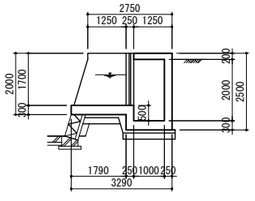
D - D section



B - B section

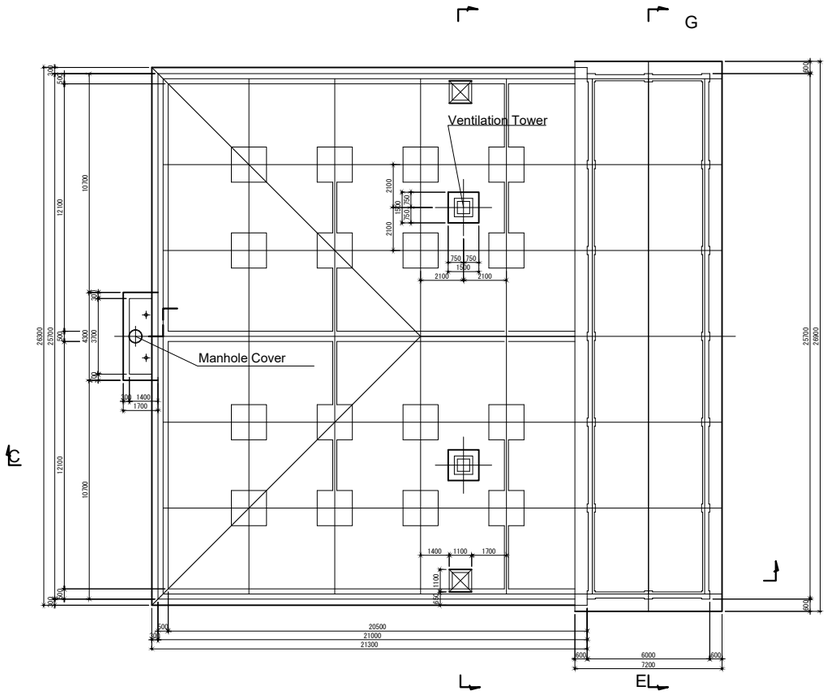


E - E section

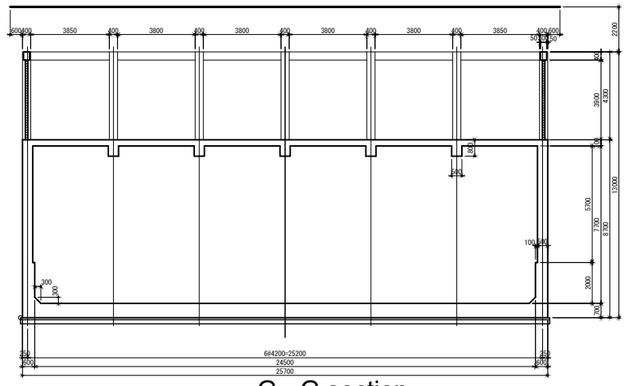


F - F section

PROJECT	DESCRIPTION		APPROVED BY	DATE	DRAWING No
KIGALI WATER SUPPLY MASTERPLAN: *FEASIBILITY STUDY FOR THE CONSTRUCTION OF MASAKA WTP*	Drainage Basin Structure	*Nihon Suido Consultants CO., LTD. and Yachiyo Engineering Co., Ltd. joint venture in cooperation with Water & Sanitation Corporation (WASAC)*	MATSUBARA Koichi	2021.8.6	M05
			PREPARED BY NISHIDA Kosei	DATE 2021.8.6	SCALE 1:200



PLAN



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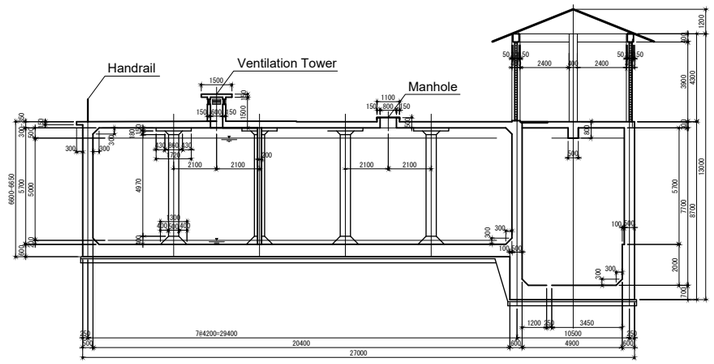
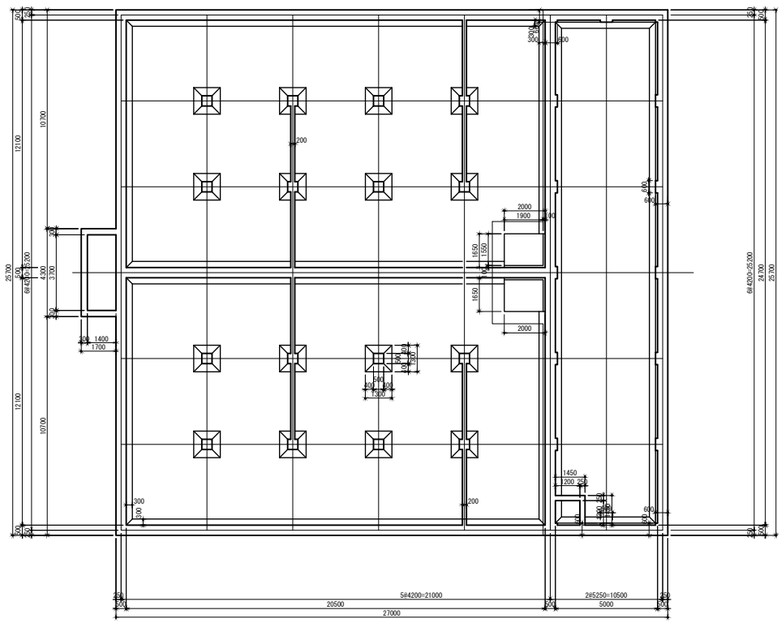
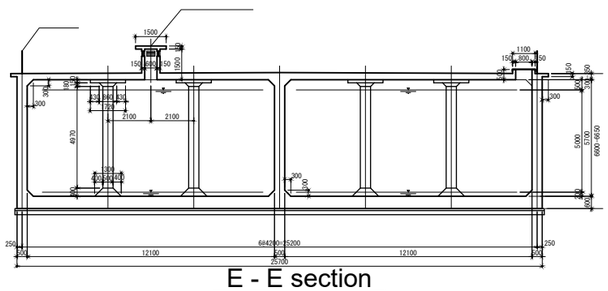


C - C section

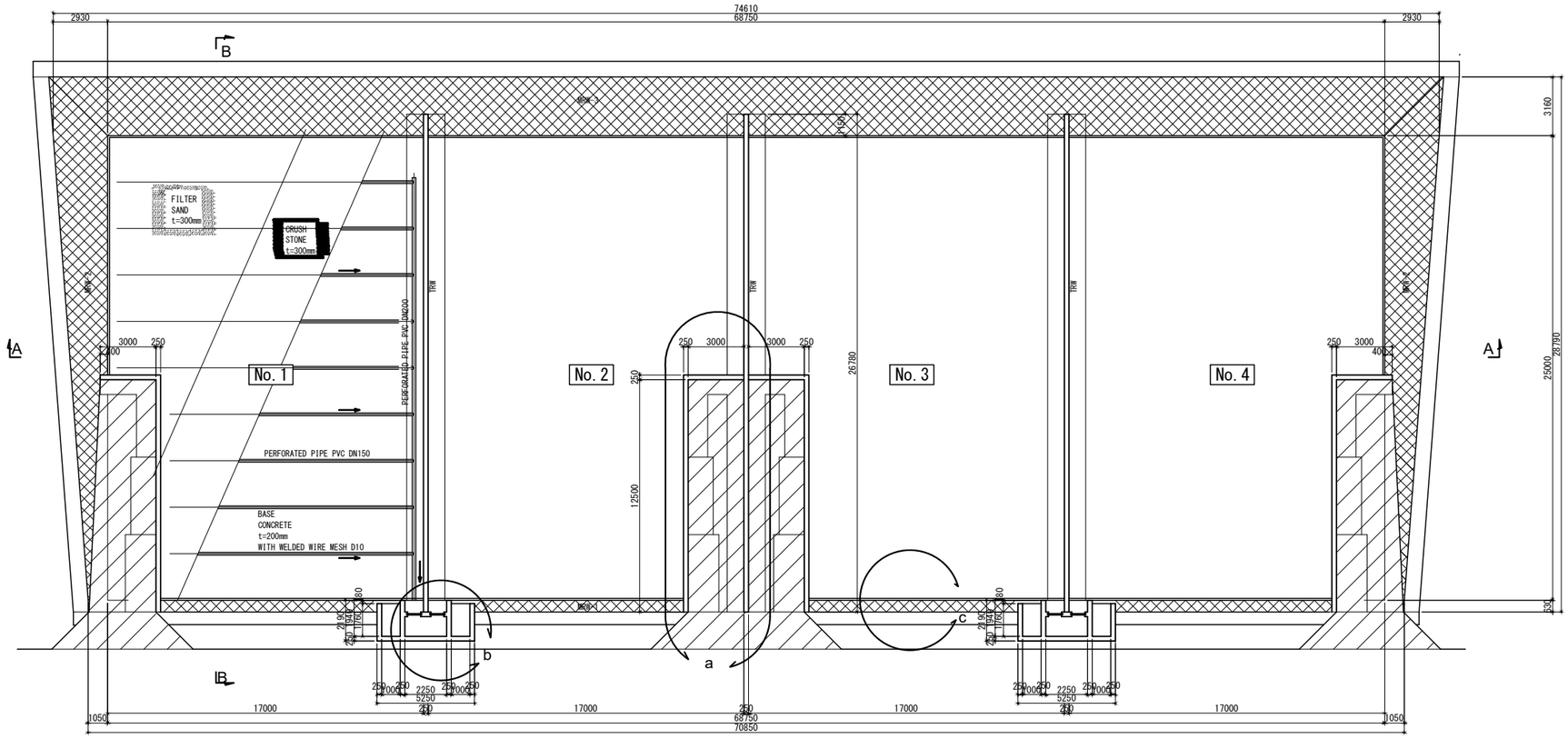


SECTIONAL PLAN B - B

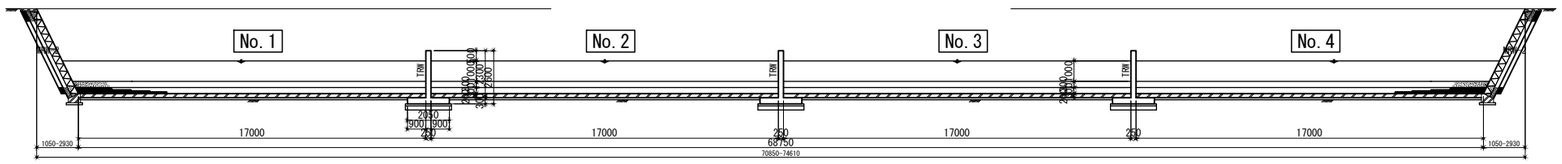


E - E section

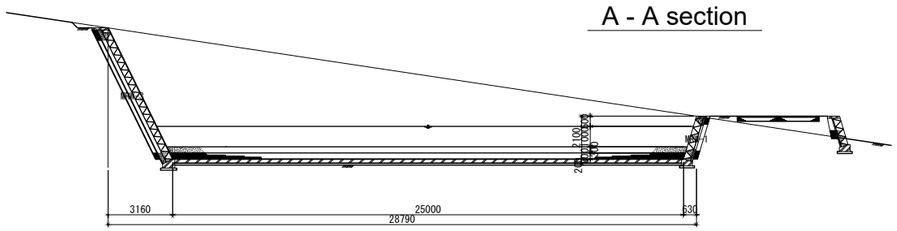
PROJECT	DESCRIPTION		APPROVED BY	DATE	DRAWING No
KIGALI WATER SUPPLY MASTERPLAN: *FEASIBILITY STUDY FOR THE CONSTRUCTION OF MASAKA WTP*	Clear Water Reservoir Structure	*Nihon Suido Consultants CO., LTD. and Yachiyo Engineering Co., Ltd. joint venture in cooperation with Water & Sanitation Corporation (WASAC)*	MAMIYA Takemasa	2021.8.6	M06
			PREPARED BY MATSUBARA Koichi	DATE 2021.8.6	SCALE 1:300



Sectional Plan



A - A section

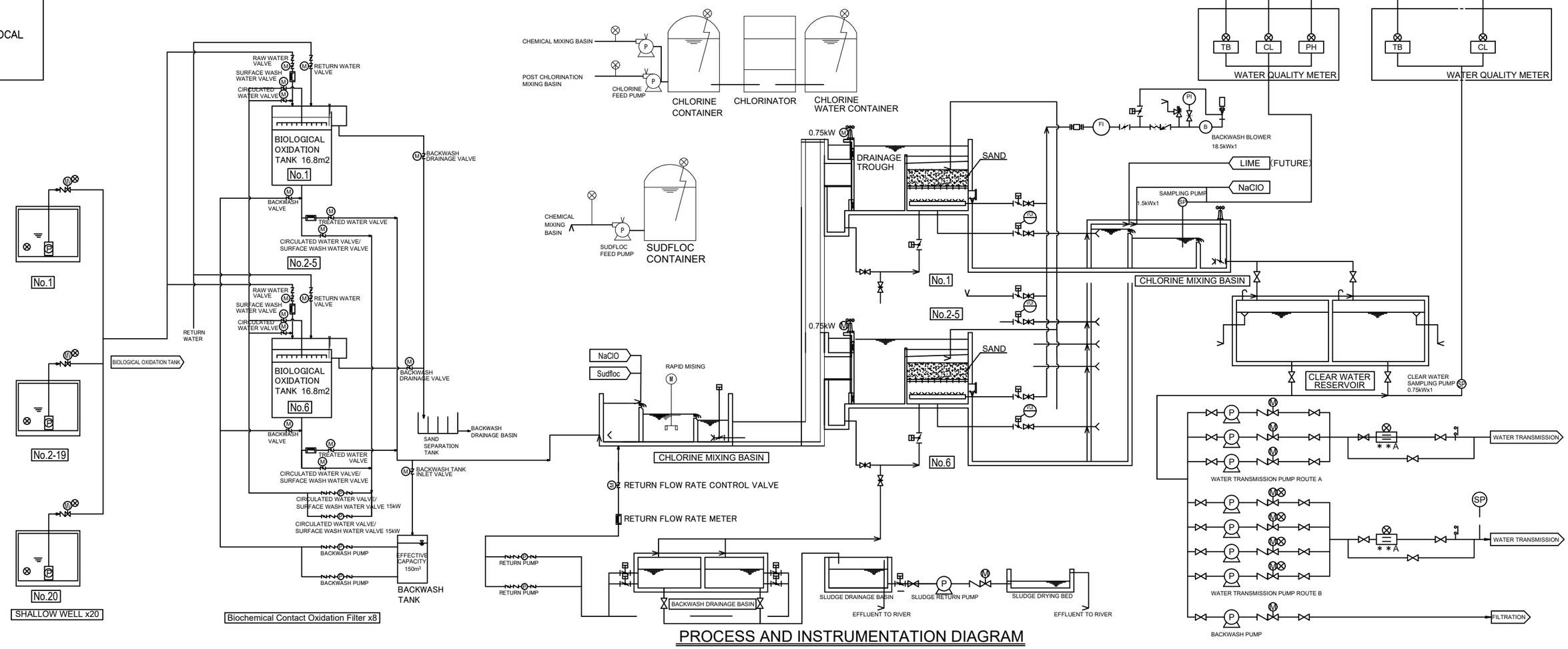


B - B section

MRW ; MASONRY RETAINING WALL
TRW ; T-TYPE RETAINING WALL
LRW ; L-TYPE RETAINING WALL

PROJECT	DESCRIPTION		APPROVED BY	DATE	DRAWING No
KIGALI WATER SUPPLY MASTERPLAN: *FEASIBILITY STUDY FOR THE CONSTRUCTION OF MASAKA WTP*	Sludge Drying Bed Structure	*Nihon Suido Consultants CO., LTD. and Yachiyo Engineering Co., Ltd. joint venture in cooperation with Water & Sanitation Corporation (WASAC)*	MAMIYA Takemasa	2021.8.6	M07
			PREPARED BY	DATE	SCALE
			MATSUBARA Koichi	2021.8.6	1:300

LOOP NAME	TREATED WATER FLOW RATE	RETURN WATER FLOW RATE	BIOLOGICAL TREATED WATER FLOW RATE	FILTERED WATER OUTLET FLOW RATE	FILTERED WATER OUTLET FLOW RATE INTEGRATED QUANTIT	FILTERED WATER INLET TURBIDITY	FILTERED WATER TURBIDITY	FILTERED WATER RESIDENTIAL CHLORINE	TRANSMITTED WATER TURBIDITY	TRANSMITTED WATER RESIDENTIAL CHLORINE
	–	–	–	–	–	–	–	–	–	–
THIS SYSTEM	1	1	1	1	1	1	1	1	–	–
WHOLE SYSTEM	1	1	1	1	1	1	1	1	1	1
SCADA Log	○	○	○	○	○	○	○	○	○	○
SCADA Disp	FI	FI	TBI	FI	FQ	TBI	TBI	CLI	TBI	CLI
ISOLATOR PANEL										
CONTROLLER <cot-1>										
Inst panel <KP-1>										
PLC Panel				PLC						
LOCAL										



PROCESS AND INSTRUMENTATION DIAGRAM

PROJECT	DESCRIPTION		APPROVED BY	DATE	DRAWING No
KIGALI WATER SUPPLY MASTERPLAN: FEASIBILITY STUDY FOR THE CONSTRUCTION OF MASAKA WTP	Process and Instrumentation Diagram	*Nihon Suido Consultants CO., LTD. and Yachiyo Engineering Co., Ltd. joint venture in cooperation with Water & Sanitation Corporation (WASAC)*	MAMIYA Takemasa	2021.8.6	M08
			PREPARED BY SAITO Shuichi	DATE 2021.8.6	SCALE

Appendix B : Environmental Impact Assessment (EIA) Report

Japan International Cooperation Agency

FINAL REPORT

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE PROJECT OF CONSTRUCTION OF MASAKA WATER TREATMENT PLANT IN KICUKIRO DISTRICT

Prepared for
Water and Sanitation Corporation (WASAC Ltd)
www.wasac.rw

by
Bureau for Engineering and Environmental Studies (BESST Ltd)
Kigali City, Gasabo District, KG 182st, Martin Plaza, Second Floor
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September, 2021

DISCLOSURE OF CONSULTANT

I hereby undertake that all requirements included in terms of reference provided by the client and approved by Rwanda Development Board (RDB) for the preparation of Environmental Impact Assessment for **Masaka Water Treatment Plant in Kicukiro District** complied with. I also undertake that the facts given in this EIA report are factually correct to the best of our knowledge.

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Kigali-Rwanda

EXECUTIVE SUMMARY

Project background

The government of Rwanda through Water and Sanitation Corporation (WASAC Ltd) and with the support from Government of Japan through, Japan International Cooperation Agency (JICA) is preparing a Water Supply Master Plan for City of Kigali (hereafter referred as Master Plan). The objective of this Master Plan is to enhance stability of water supply and to catch up growth of water demand in the City of Kigali and neighbouring sectors.

As part of the Master Plan, WASAC through NIHON SUIDO CONSULTANTS CO., LTD. and YACHIYO ENGINEERING CO., LTD JV is conducting Feasibility studies for selected projects including **Construction of Masaka Water Treatment Plant in Kicukiro District ,** to supply clean water at both City of Kigali and a part of Rwamagana district. . In accordance with the provisions the **Law N°48/2018 of 13/08/2018 on environment** determining the modalities of protection, conservation and promotion of environment in Rwanda; (ii) Ministerial Order **N°001/2018 of 25/04/2018** determining the list of works, activities and projects subject to an environmental impact assessment and, (iii) JICA guidelines for Environmental and social Consideration, the present project falls under category one that require the conduct of full EIA.

Objectives of the study

The overall objective of this study is to develop an Environmental Impact Assessment (EIA) for the "Construction of Masaka WTP with its associated Transmission & Distribution Facilities" in order to ensure sustainability of proposed project, avoid, minimize and compensate negative impacts and to enhance positive impacts. Further, the study shall ensure that the project is implemented in an environmentally and socially sustainable manner and in full compliance with Rwanda's regulations and the JICA guidelines for environmental and social considerations.

Approach and methodology

To achieve the above objectives the consultant team followed procedures stipulated in General Guidelines and Procedures for Social and Environmental Impact Assessment. The methodology used involves a number of stages from scoping phase that includes preliminary assessment to understand and establish boundaries of the study; the desk review of available literature, field visits to establish baseline data, analysis of all available data (secondary and primary data), prediction of positive and negative impacts, analysis of alternatives as well as the proposal of mitigation measures leading to an Environmental and Social Management Plan and Monitoring plan.

Project location and description

Administratively, Masaka WTP is located in Kigali city, Kicukiro district, Masaka sector, Mbabe cell; Kamashashi village. This is the same location for the wellfield where a maximum of 20 boreholes will be placed in the wellfield with submersible pumps delivering water to the inlet of WTP located at at the edge of Akagera River on the side of Masaka sector. The Water Supply Area Includes Entire Masaka Sector Which Is Geographically Separated From The Adjacent Sectors Which Are Kanombe, Nyarugunga And Rusororo Sectors Of The City Of Kigali, And Muyumbu, Nyakaliro, Juru And Mwogo Sectors Of The Eastern Province.

The key activities to be undertaken by the project include **(i)**: Construction of new water source and WTP (Phase 1: 20,000 m^3/d, Phase 2: 20,000 m^3/d); (ii) construction of **Transmission pipelines and reservoirs**: Clearwater transmission pipeline to Masaka (L=6 km, ND500 x2) Reservoir, Block distribution reservoirs (3 nos.), Clearwater transmission pipeline and a reservoir in Ndera (L=6km, ND400) and Construction of distribution network in Masaka Sector.

Environmental and social impact prediction

The project is expected to have both positive and negative impacts on ecosystems and local communities. Positive impacts expected from the proposed project include: availability of treated and clean water, improved sanitation conditions, sustainable and wise use of natural resources temporary and permanent jobs creation and employment opportunities, income generation to the local population, transfer of knowledge from skilled to non-skilled people who may interact with the project activities , increasing of social welfare, etc.

Expected adverse impacts range from physical environment, biological and social environment. These include water noise and air pollution in the project area especially during the construction works, possible soil erosion from excavation works of pipes trenches and other water storages facilities, modification of water table flows, generation of sludge from the treatment plant, loss of biodiversity and encroachment of buffer zone of Akagera river etc. Social impacts of the project implementation will also include loss of land at WTP and reservoir areas, Physical resettlement, loss of trees, crops etc. Other project related impacts includes onsite occupational health and safety especially during construction and operation phases..

Mitigation measures for identified and projected impacts were proposed for each of the adverse impacts and this to an extent that they can be avoided, reduced, limited or eliminated and therefore manageable. In this context the Environmental Management Plan(EMP) and an Environmental Monitoring Plan indicating the mitigation measures, procedure to be followed, monitoring indicators, the responsible institutions to implement these measures and estimated cost of implementing each of these mitigation measures.

Given the nature, location of the proposed project, proposed works and the potential impacts associated with the implementation of project, the consultant can conclude that the nature and extent of adverse impacts identified can be avoided mitigated and eliminated by the implementation of appropriate mitigation measures. In fact, the Construction of Masaka WTP and its supply system is bound to be executed in a sustainable manner and in compliance with national environmental regulations, JICA environmental and social considerations. However, this requires full implementation of proposed mitigation measures and regular monitoring. The total estimated cost for the implementation and Monitoring of the proposed EMP is.42,800 USD. However , this cost does not include the expropriation budget of the project.

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ABBREVIATIONS

BESST	: Bureau for Engineering and Environmental Studies
CBA	: Cost benefit analysis
CBD	: Convention of Biological Diversity
CITES	: Convention of International Trade of Endangered Species
EA	: Environmental Assessment
EIA	: Environmental Impact Assessment
EMP	: Environmental Management Plan
ESMP	: Environmental and Social Management Plan
FS	: Feasibility Study
GIS	: Geographic Information System
IUCN	: International Union for the Conservation of Nature
JICA	: Japan International Cooperation Agency
JST	: JICA Study Team
JV	: Joint venture
MININFRA	: Ministry of Infrastructure
MoE	: Ministry of Environment
NISR	: National Institute of Statistics of Rwanda
NST1	: National Strategic for Transformation
OHS	: Occupational, Health and Safety
RAP	: Resettlement Action Plan
RAPEP	: Rwanda Association for Professional Environmental Practitioners
RDB	: Rwanda Development Board
REMA	: Rwanda Environment Management Authority
RLMUA	: Rwanda Land management and Use Authority
RURA	: Rwanda Utilities Regulatory Agency
RWB	: Rwanda Water Board
RWFA	: Rwanda Water and Forest Authority
SDGs	: Sustainable Developments Goals
ToRs	: Terms of Reference
WASAC	: Water and Sanitation Corporation
WTP	: Water Treatment Plant

LIST OF ANNEXES

CHAPTER I: INTRODUCTION

1.1 Project background

Nowadays, Rwanda is undergoing massive socio-economic development and is doing its best to have infrastructure that can support the country's ambitions and targets with the aim of Rwandans well-being and development. Among key services to be achieved include the sustainable and reliable clean water supply and to ensure safe, reliable and affordable water supply services for all Rwandans at 100 % coverage by the year 2024, thereby ensuring universal and equitable access to safe and affordable drinking water for the people aimed at achieving NST-1 along with Sustainable Development Goals (SDGs).

In this regards, the government of Rwanda through its agency Water and Sanitation Corporation Limited (WASAC Ltd) with the support from Government of Japan through Japan International Cooperation Agency (JICA) prepared a Water Supply Master Plan towards the year 2050 for the Kigali City and its environs with the main objective to enhance stability of water supply and to catch up growth of water demand, by preparing Master Plan for developing and maintaining water supply facilities in Kigali City, thereby contributing to provide access to safe water and stable economic growth in Rwanda.

As part of the Master Plan, Water and Sanitation Corporation (WASAC) through NIHON SUIDO CONSULTANTS CO., LTD. and YACHIYO ENGINEERING CO., LTD JV, is conducting Feasibility studies for the construction of Masaka Water Treatment Plant. This Project is one of the critical components of the Water Supply Master Plan to serve essential water to local population of Kigali City and its environs especially those living in the growing east of the City. The Project intends to construct a new WTP sourcing groundwater along Akagera River with a capacity of 20,000 m^3/day (Phase 1) and 40,000 m^3/day (Phase 2). The project is also associated with the construction of the water transmission and distribution pipes in different areas of Kigali City especially Kicukiro District,

1.2 Project developer/Water and Sanitation Corporation

Water and Sanitation Corporation (WASAC) Ltd is an entity established by the Government of Rwanda to manage water and sanitation services as per the law Nº 87/03 of 16/08/2014. The Company was created in the on-going government reform intended to deliver water and sanitation utility sufficiently focused to deliver new infrastructure; efficient and effective service delivery; build a strong people capability; and meet key national milestones. It is expected to reverse the status quo that includes inadequate planning and investments; inefficient and wasteful operations; inadequate institutional management focus; improve viability and autonomy; and establish a sustainable and customer-centric utility to deliver an important mandate that touches people of all walks of life. The mission of the company is providing quality, reliable and affordable water and sewerage services through continuous innovations and detailed care to customers' needs.

1.3 Presentation of the consultant

BESST LTD (Bureau for Engineering and Environmental Studies) is a Rwandan private company Registered with Rwanda Development Board (RDB). The company is certified by Rwanda Association professional Environmental Practitioners (RAPEP) to conduct Environmental studies with license number RAPEP/EA/O72 (list of Certified experts is available at www.repep.org). The company has its headquarters in Kigali City, Gasabo District, KG 182st, Martin Plaza, Second Floor. The company is specialized in Environmental studies, Resettlement Actions Plans (RAP, climate change risk assessment, socio-economic assessment, baseline surveys, waste management, water and sanitation, advisory services in sectors ranging from Agriculture, energy development, Infrastructure and housing development, transport and water supply. For this specific assignment of preparation of EIA of the project of construction of Masaka Water Treatment Plant, the company used the following consultants:

Théogène HABAKUBAHO, Team leader – He is an authorized EIA Lead expert **(RAPEP/EA/024)**. He holds a Master of science in environmental science management and development and BSc in physical geography. He has over 12 years professional experience in the field of environmental assessment and management. He has worked on various projects as team leader of environmental studies. Key projects worked on include irrigation projects, green house agriculture, Water supply, mining projects, road and bridge construction projects, building and house constructions, schools and hospitals, among others.

Fabien NSHIMIYIMANA, Hydrologist: He is an authorized EIA Lead Expert (**RAPEP/EA/035).** He-holds a Master of Science in Water resources and environmental Management and a BSc in Biology. He is a Water Resources Engineer with over 10 years' experience in planning, management, design and construction supervision of water resources infrastructure.

Conversant with water resources studies, Environmental and Social Impact Assessment Studies, hydrological, hydrodynamic and groundwater modelling, GIS & remote sensing. In this assessment he assessed impact related to water resources demand and use.

Mrs. Emma BENEMARIYA, Sociologist- holds a Master of Development Studies and a bachelor's degree in Social Sciences. She is tasked with evaluation of social impacts associated with project and has led the socio-economist survey.

Charles KAYIJAMAHE, Ecologist-He has Master of Science in geo-information system and environment with a bachelor's of science in biology. Over the last 8 years he has worked with different institutions involved in biodiversity conservation and natural resources management, research and monitoring, conservation planning, establishment and empowerment of local conservation groups. He also has skills in institutional development and leadership, strategic planning, proposal writing and projects management. He has participated in different EIA as ecologist. He assessed impacts of the project on site ecology, flora and fauna.

Jovine NSEKANABANGA, Statistician: He is an experienced data collection and analysis and he has a bachelor's degree in applied statistics with over five years in data collection and analysis. He supervised data collection, data entry and conducted data analysis.

Clarisse MUKANDINDA CYUZUZO, GIS Expert: She is an authorized EIA Junior Expert **(RAPEP/EA/138)**. She assisted the team in data collection and in mapping, noise and vibration measurement. She also participated in assets inventory, impacts prediction and mitigation measures. The above team was supported by field enumerators and data entry officers.

1.4 Objectives of the study

The overall objective of the present study is to prepare an Environmental Impact Assessment (EIA) report and Environmental Management/Monitoring Plan (EMP) for the project of construction of Masaka Water Treatment Plant. Specifically, Social and Environmental assessment was done with the aim of:

- Identify and evaluate environmental and social risks and impacts of the project implementation.
- Propose mitigation measures to anticipate and avoid, or where avoidance is not possible, minimize and, where residual impacts remain, compensate for risks and identified impacts to workers, affected and local community and the environment in general.
- Identify key stakeholders and their responsibilities before and during the implementation activities/ operation phase that should play roles in the EMP Framework.

1.5 Scope of the study

The present study covered the impacts of the projects from planning phase, construction and operational phases and considered the decommissioning phase of the project with considerations of the project sites and its surroundings. The study was also prepared in compliance with national environmental regulations and JICA guidelines for environmental and social considerations guidelines. Therefore, the scope of the study was to:

- Identify legislation, policies (both local and international) that are likely to influence the implementation of the project;
- Develop an overview of the baseline environment of the project intervention area. i.e. study area description, physical, biological and social- economic-environment etc
- Description of the likely significant impacts (both positive and negative) of the proposed project that could be caused by the project implementation on environment and local community
- Description of the methods used in the analysis, description and classification of the impacts;
- Description of impacts on human health especially workers during the construction and operation phases.
- Propose mitigation measures against of the predicted adverse impacts identified.
- Propose an Environmental Monitoring Plan with measurable indicators and parameters for these mitigation measures to ensure sustainability of the project.

1.6 Approach and methodology

To achieve this EIA objectives the consultant team followed procedures stipulated in General Guidelines and Procedures for Environment and Impact Assessment. The methodology used involves a number of stages from scoping phase that includes preliminary assessment to understand and establish boundaries of the study; the desk review of available literature, field visits to establish baseline data, analysis of all available data (secondary and primary data), prediction of positive and negative impacts, analysis of

alternatives as well as the proposal of mitigation measures leading to an Environmental and Social Management Plan and Monitoring plan. Approach and methodology used include: (a) Literature review and primary data collection, (b)Field Survey and measurements and**,** (c) stakeholder consultation and engagement. The present EIA followed the conventional methods that meet the requirements of the Organic law N° 48/2018 of 13/08/2018 on Environment determining the modalities of protection, conservation and promotion of environment in Rwanda, the Ministerial order No 001/2019 of 15/04/2019 establishing the list of projects that must undergo environmental Impact assessment, instructions, requirements and procedures to conduct environmental impacts assessment and JICA guidelines on Environmental and Social considerations.

- **Scoping**

A scoping study involved the consultation with WASAC Ltd and JICA. Initially, a field visit was conducted at the proposed site for project infrastructures, and scoping continued again by visiting the project sites to understand the confirmed area proposed for infrastructures and receiving environment. The scoping exercise further entailed the following:

- Preliminary findings of the existing environment; (primary, biological and socio-cultural environment)
- Review of the ToRs for common understanding with client and RDB
- Preliminary prediction of likely positive and adverse impacts, and
- To establish clear boundaries of the study and focus on relevant issues concerning the study.

- **Field survey**

Field surveys were made from the initial stage of the project designs with the aim of assessing the baseline environmental and social conditions of the project areas and to identify environmental and socio-economic components that are likely to be significantly affected by this proposed project. During field survey, basic data and information on the biological and physical resources, and socio-economic have been collected.

- **Document review**

Secondary data and legal framework were mainly obtained through desk work review was done on existing institutional legislation, policies, plans and programs, which are likely to influence different parts of the implementation of the present project. Key legal instruments consulted include but not limited to the following:

- The law N° 48/2018 of 13/08/2018 on Environment in Rwanda;
- Ministerial order N° 001/2019 of 15/04/2019 establishing the list of projects that must undergo environmental Impact assessment, instructions, requirements and procedures to conduct environmental impacts assessment;
- National Water Resources Master Plan;
- National Land Use Development Master Plan;
- Kigali Water Supply Master Plan;
- Water supply and sanitation policy;
- Feasibility Study Report for the project.

In addition to national policies and regulations influencing this project, considered international policies and standards especially JICA guidelines on environmental and social consideration, regional protocols and World Bank safeguard policies.

- **Stakeholders consultations and engagement**

Discussions have been conducted with WASAC Ltd, key stakeholders and specialist experts from different institution including Rwanda Environmental Management Authority, Rwanda Water Board, City of Kigali and Kicukiro district, Rwanda Development Board and local communities. The objectives of these consultations were:

- To ensure effective project implementation
- To make the EIA study participative and transparent and hence build a trusting project sustainability based on principles of transparency, accountability, accuracy, trust, respect and mutual interests with affected communities and other stakeholders
- To ensure effective engagement with local communities and other key stakeholders throughout all phases of the project.

- **Impact prediction and analysis**

Impacts prediction and analysis involved assessment of the entire project cycle i.e. project mobilization, construction, operation and decommissioning phases. Positive and negative impacts of the project were identified using regulations, guidelines (national and international) standards and norms related to water supply projects, biodiversity protection, environmental protection and social-economic assessment. The impacts were assessed by its nature, location magnitude, timing (during construction, operation, immediate, delayed) duration (short term/long term, intermittent/continuous), reversibility/irreversibility, likelihood (probability, uncertainty) and significance (local, regional, global) etc. Among key tools used to predict impacts include:

- ***Geographical Information System (GIS)*** - used to show the extent of a particular project activity influence on the area by mapping it out.
- ***Checklist-*** project activities that might affect or enhance the livelihood in the project areas were listed and drawn against environment indicators and occurrence.
- ***Cost benefit analysis (CBA)*** - Which involved analysis of project activities in terms of their financial and economic effects to establish the cost implications of the impacts and the mitigation measures. Impacts was analysed according to market costs, foregone costs or opportunity cost. The CBA was used to assign economic values where feasible to impacts both adverse and beneficial.
- ***Impact Matrix-*** under the Impact matrix, the analysis by these tools of GIS, checklist, CBA, have been tested against their significant effect on recipients in the project area of intervention. Impact matrix in tabular format was drawn, in which impacts from project activities were tested against their significant effect on the areas of intervention.

For each adverse impact identified, its level of significance was indicated, mitigation measures proposed and an Environmental Management Plan (EMP) was developed.

1.7 Structure of the report

This report is organised in eight chapters structured as follow:
Chapter 1: Introduction
Chapter 2: Location and Description of the project
Chapter 3: Legal, regulatory and institution framework
Chapter 4: Baseline information of the projects
Chapter 5: Project need and alternatives
Chapter 6: Public Consultaion and stakeholders engagment
Chapter 7: Identification, evaluation of impacts and proposed mitigation measures
Chapter 8: Environmental Management Plan and Environmental Monitoring Plan
Chapter 9: Conclusions and recommendations

CHAPTER II: PROJECT LOCATION AND DESCRIPTION

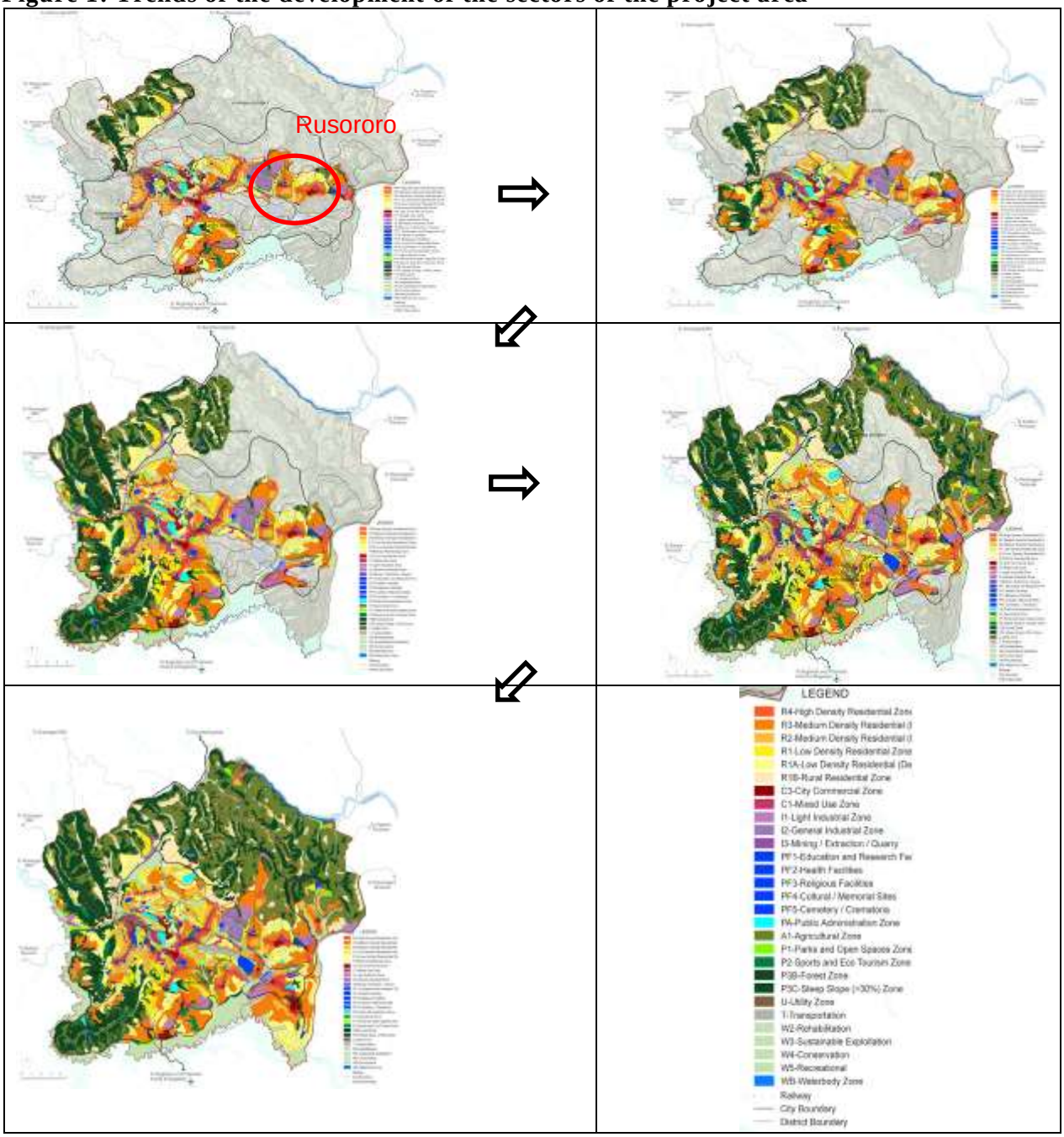
The present chapter describes the location of the project and its proposed activities in its different phases of implementation. The description was made from planning and designing phases, construction phases, operation and maintenance phase as well as the decommissioning phase.

2.1 Background and issues of the study area

Population projection in the City of Kigali is based on the High Growth Scenario of the City Master Plan (2019). The City of Kigali Master Plan also presents a phased development plan that is divided into five phases (Phase 1: 2019 – 2024, Phase 2: 2025 – 2031, Phase 3: 2032 – 2038, Phase 4: 2039 – 2045, Phase 5: 2046 – 2050), and indicating priority areas for development.

As shown in the abovementioned figures below (Figure.1) the Master Plan Report of the City of Kigali pointed out that the trend of development and growth in the City of Kigali would be moving towards the eastern and southern parts of the City. Masaka and Rusororo sector are the areas that the earliest development is expected (Phase1). Adjacent sectors, including the Gahengeri, Muyumbu and Nyalaliro sectors are also expected to be developed along with the CoK's development. The Master Plan (sectoral development plan) for those sectors is as shown in the figure below.

Figure 1: Trends of the development of the sectors of the project area



Source: Kigali City Urban Master Plan Report (2019 Edition)

2.2 Kigali Water Supply Master Plan and 15-Years Investment Plan

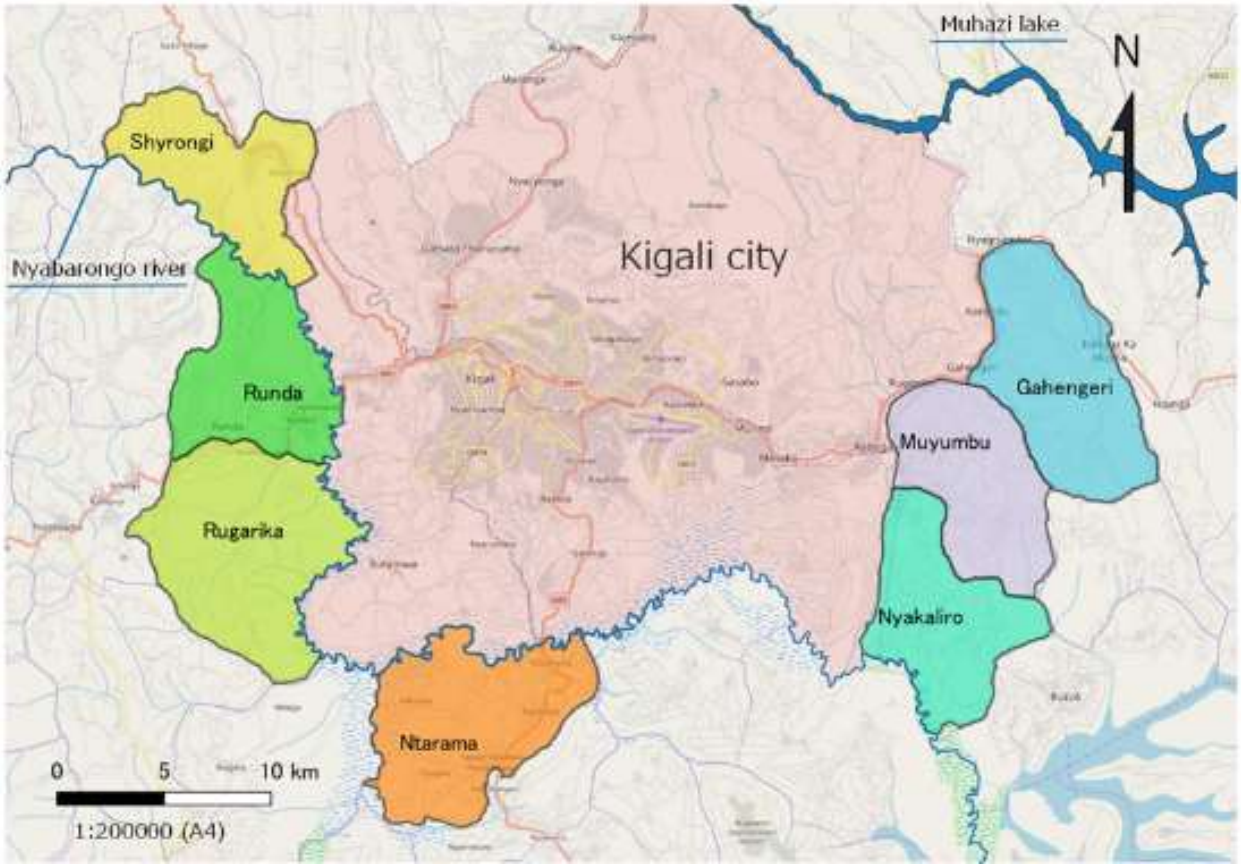
The present project of Construction of Masaka Water Treatment Plant in Kicukiro District is part of Kigali Water Supply Master Plan including 15-Years Investment Plan and Feasibility study of selected projects namely: (i) Rehabilitation and Expansion of Karenge WTP and Transmission & Distribution Facilities Rwamagana District, and (ii) Construction of Masaka Water Treatment Plant in Kicukiro District.

2.2.1 Kigali Water Supply Master Plan

The Master Plan was initiated by the Government of Rwanda through Water and Sanitation Corporation (WASAC) with the support from Government of Japan through, Japan International Cooperation Agency (JICA) with the main objective to enhance stability of water supply and to catch up growth of water demand, within the Kigali City and its environs and hence contributing to access to availability of safe water and stable economic growth in Rwanda.

The Master Plan covers the City of Kigali and its surrounding seven (7) sectors namely Shyorongi, Runda, Rugarika, Ntarama r, Muyumbu, Gahengeri and Nyakaliro. The objective of preparing the Master Plan is to enhance stability of water supply and to catch up growth of water demand, by preparing Master Plan for developing and maintaining water supply facilities in Kigali City, thereby contributing to provide access to safe water and stable economic growth in Rwanda. The area coverage by the Kigali Water Master Plan is summarized in the map below:

Figure 2: Spatial coverage of Kigali Water Supply Master Plan



Source: JST, 2020

Together with Master Plan, a Strategic Environmental Assessment (SEA) was prepared and cleared by Rwanda Environment Management Authority (REMA).

2.2.2 15-Years Investment Plan

In addition to the overall Master Plan, a 15-Years Investment Plan is under preparation. Project considered under 10yeras investments Plan include:

- A 04 NRW Reduction for Ntora-Remera Area: Pressure control and pipe renewal and;
- A 05 NRW reduction project through pipe renewal and pressure control are combined and will be proposed in the Master Plan as an integrated project which should be implemented in a phased manner.
- A 01: Construction of Masaka WTP and Clear Water Transmission & Distribution Facilities and
- A 02: Rehabilitation and Expansion of Karenge WTP and Transmission & Distribution Facilities

are selected for the F/S in this study. The capacity and phasing plan should be reviewed in the F/S.

- A 06: Capacity development for Sustainable Use of Water Resources and Water Supply Facilities was shortlisted under those projects.
- A 07: Kigali Central Transmission Main are shortlisted without the priority since it is regarded as not an urgent project because the expansion at Nzove until 2035 will be limited to on-going projects.
- A 03: Reconstruction of Nzove WTP was omitted from the shortlist because the on-going procurement of the Nzove rehabilitation work was on track as of the day of the JCC.

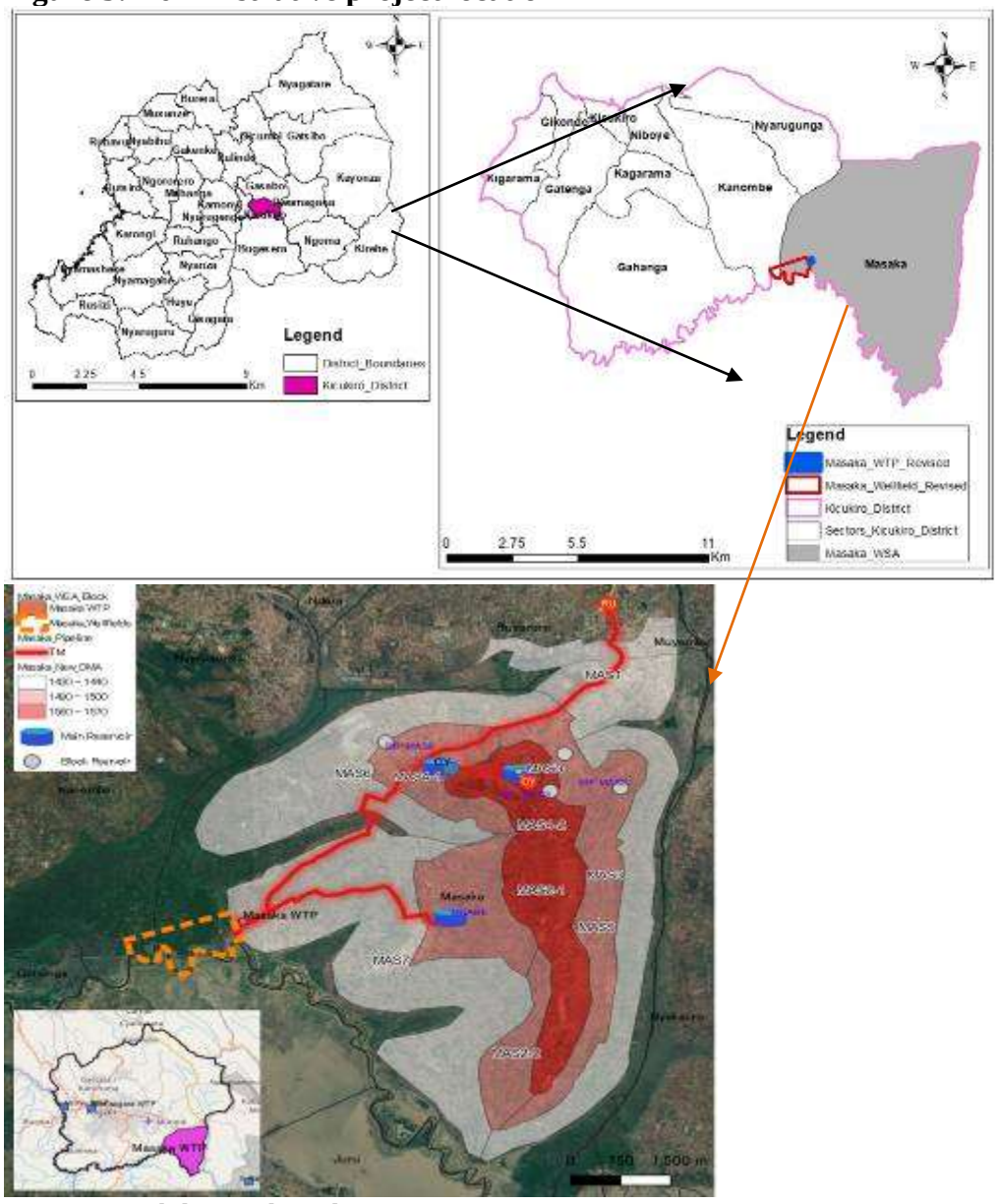
The Strategic Environmental Assessment is being reviewed and updated to included details included under the 15 Years Investment Plan. Further, feasibility studies are ongoing for (i) Rehabilitation and Expansion of Karenge WTP and Transmission & Distribution Facilities and (b) Construction of Masaka WTP and Clear Water Transmission & Distribution Facilities. The present EIA covers the Construction of Masaka Water Treatment Plant.

2.3. Masaka Water Treatment Plant Project

2.3.1. Administrative location of Masaka WTP

Administratively, Masaka WTP is located in Kigali city, Kicukiro district, Masaka sector, Mbabe cell; Kamashashi village. This is the same location for the wellfield where a maximum of 20 boreholes will be placed in the wellfield with submersible pumps delivering water to the inlet of WTP located at at the edge of Akagera River on the side of Masaka sector. The map below shows the project areas of intervention

Figure 3: Administrative project location

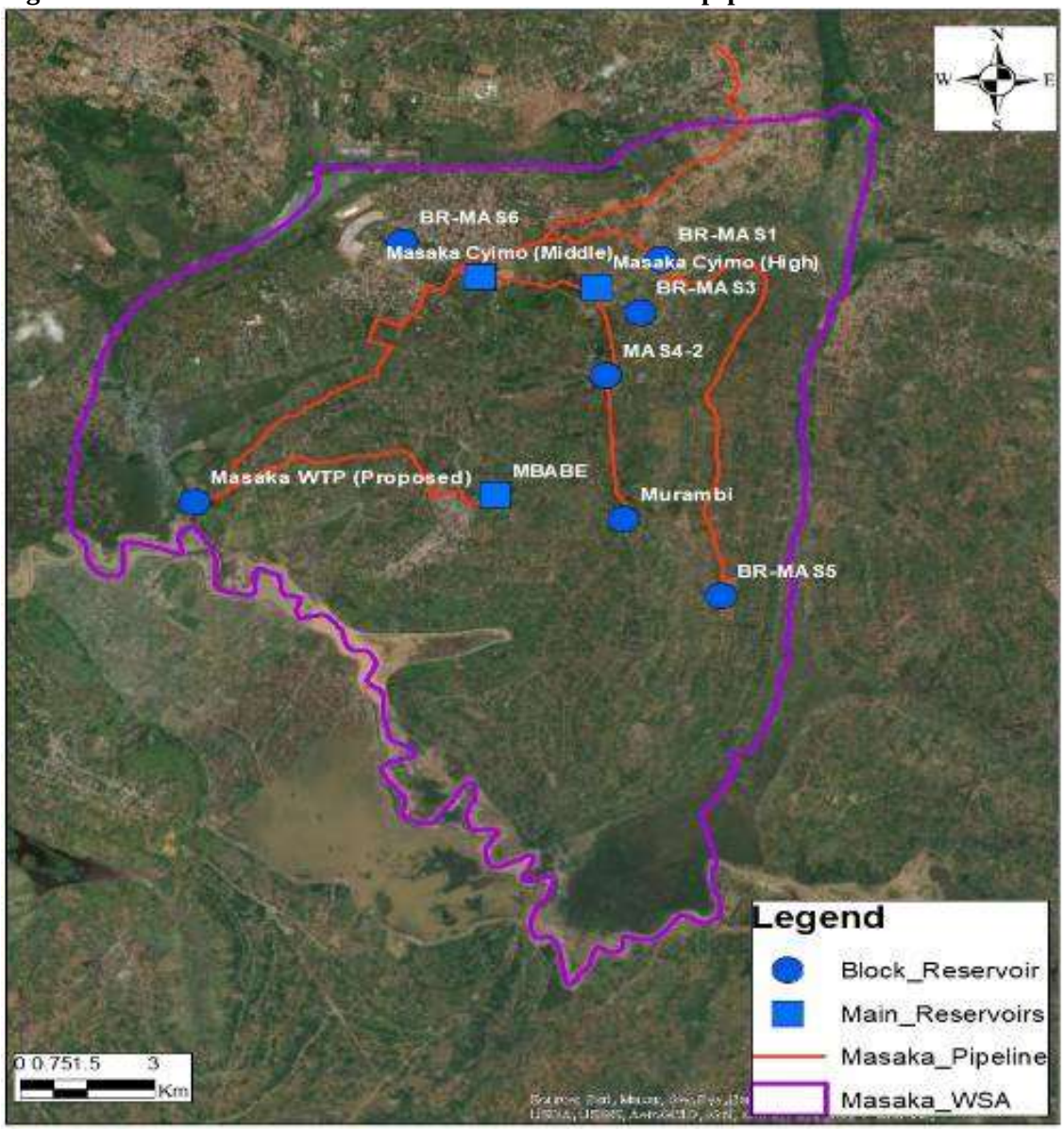


Source: Feasibility study and BESST, 2021

2.3.2. Location of water storage reservoirs and pipelines

In this project of construction of Masaka Water Treatment Plant, there will be a number of reservoirs and different pipelines to help in the supply of treated water in their respective targeted supplied areas. The main transmission system for the Masaka WTP is the route to the Cyimo reservoirs as shown on the map below. The project will consist 10 reservoirs including three main reservoirs namely Cyimo High, Cyimo middle and Mbabe. Map showing the transmission pipelines, reservoirs and main reservoirs

Figure 4: Location of the reservoirs and transmission pipes

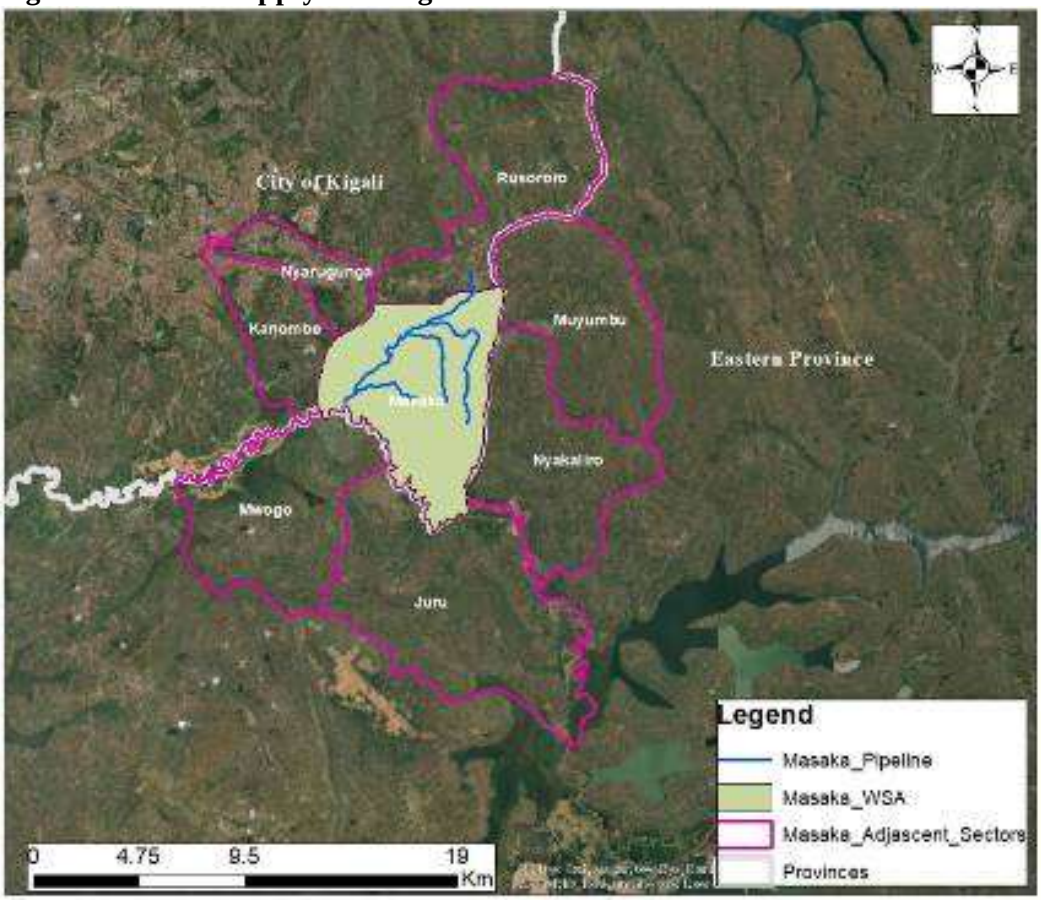


Source: Draft feasibility study , JST 2021

2.3.3. Water supply area and existing coverage

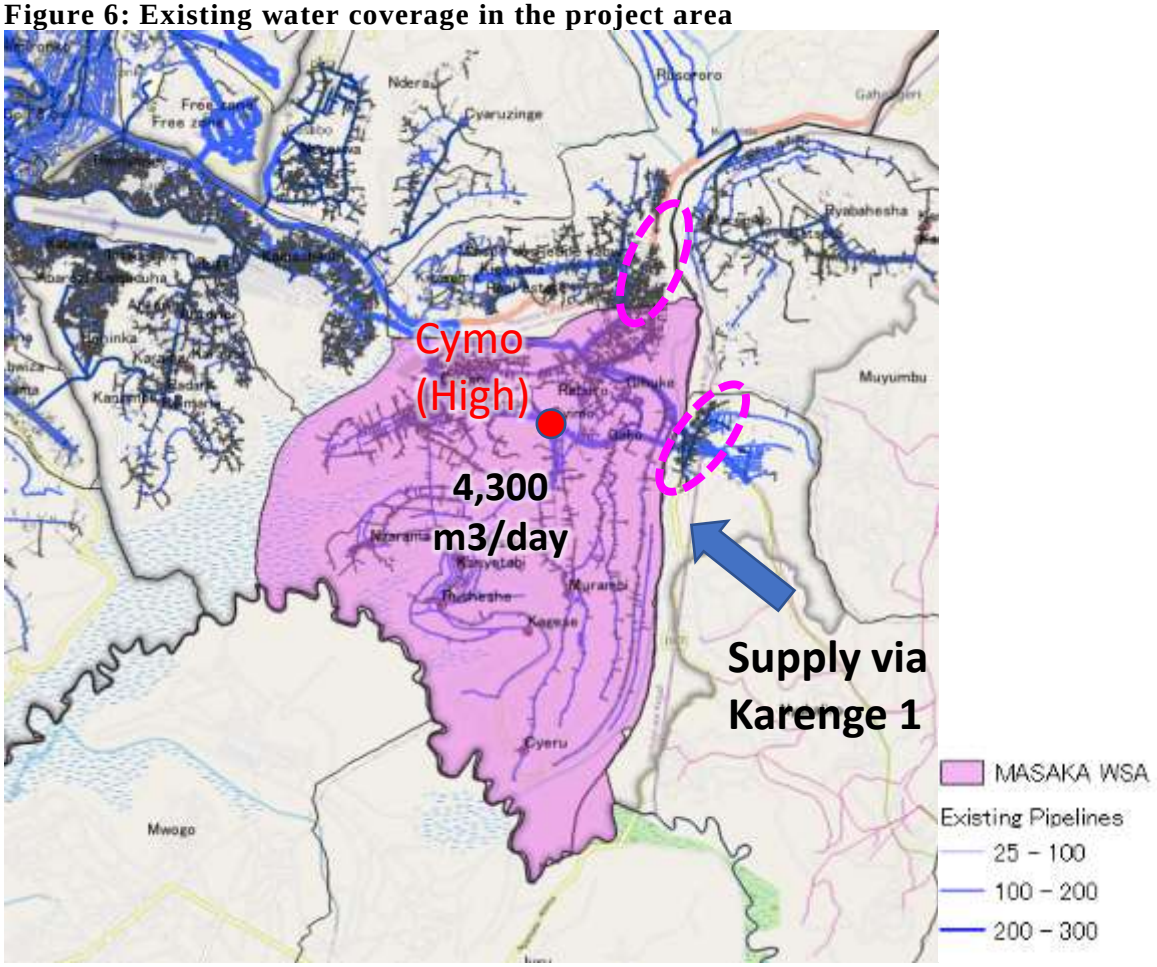
The Water supply area includes entire Masaka sector which is geographically separated from the adjacent sectors which are Kanombe, Nyarugunga and Rusororo sectors of the city of Kigali, and Muyumbu, Nyakaliro, Juru and Mwogo sectors of the Eastern Province. The existing customers in this area are approximately 6,000, from which the water consumption is estimated to be approximately 4,300 m3/day. According to the City of Kigali Master Plan, it is pointed out that the trend of development and growth in the City of Kigali would be moving towards the eastern and southern parts of the city, where Masaka and Rusororo sectors are the areas that the earliest development is expected (Phase1). The below map shows the expected water supply coverage and adjacent sectors of Masaka sector.

Figure 5: Water supply coverage



Source: Draft feasibility study , JST 2021

Figure 6: Existing water coverage in the project area



Source: Draft feasibility study , JST 2021

Table 1: Existing number of customers and consumption

Area	Number of Customer	Estimated Existing Demand (m3/day)*	Estimated Existing Consumption with leakages(m3/day)**
In Masaka Sector	6,045	2,592	4,180
Neighboring Area (Nyakaliro, Rusororo)	1,200	515	830

*Assumed industrial demand is 21.8% of total demand ** Assumed Leakage Ratio is 38%. 88 lpcd as per existing water consumption in Kanombe branch.

Source: Draft feasibility study , JST 2021

2.3.4. Existing facilities

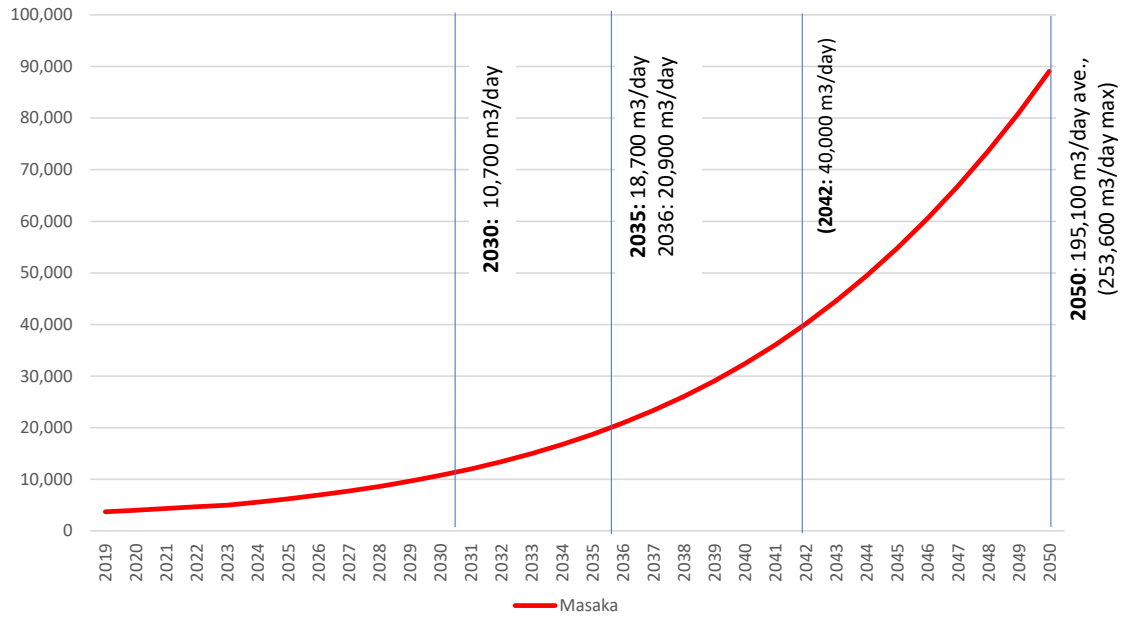
There is an existing water supply pipeline supplying water to the project area, Karenge 1 (DIP ND300) from Karenge WTP via Nyabubare booster pumping station (SP3). The Karenge 1 pipeline was constructed in the 1980's[1] and getting aged at some section of the pipelines. The pipeline causes some leakages especially at the Nyakaliro site (e.g. Air valves and the pipe installed in the marshland).The major distribution pipelines is connected to the existing Cyimo (High) reservoir located on top of the Masaka hill. The distribution pipelines also extend to a lower part of Nyakaliro sector and the Rusororo sector for approx. 600 customers each by ND 110 pipes.

However, The Karenge 1 is an old pipeline (installed in 1985) but can be utilized if there are no leakages. The pipeline causes some leakages especially at the Nyakaliro site (e.g. Air valves and the pipe installed in the marshland). it is not recorded how much water is leaked during the transmission line because there is no flow meter in the pipeline. Major pipe materials are PVC and HDPE. However, more than 63.5 km of the pipelines are the Galvanized Steel Pipe (GSP) with 40A diameter. This small diameter GSP causes many leakages from the WASAC's experience in the entire city of Kigali reason. The pipes concentrated on the lower part of the northern area of WSA, where existing city development is concentrated. Therefore, at least this 63.5 km of GSP needs to rehabilitated in line with the new expansion of the water supply systems. The major distribution pipelines are connected to the existing Cyimo (High) reservoir located on top of the Masaka hill. The distribution pipelines also extend to a lower part of Nyakaliro sector and the Rusororo sector for approx. 600 customers each by ND110 pipes.

2.3.5. Water demand and projection

The projected water demand in the water supply area is shown in figure7 below. The total daily average water demand will reach 10,700 m^3/day in the year 2030, and 18,700 in the year 2035. The demand will then doubled to 40,000 m^3/day in the year 2042, and will reach 195,100 m^3/day in the year 2050 ultimately. Despite these figures, it is important to note that there is an uncertainty in the timing of the demand increase affected by the actual urban development. Given that the water supply development project will be completed in the year 2027, the water supply capacity can be set to the 187,000 m^3/day.

Figure 7: Water demand projection in project area



Source: Draft feasibility study , JST 2021

[1] Not identified the exact year of installation.

The table below illustrates the coverd population and the coverage of water demand

Table 2: Covered population, coverage and water demand

Item	Unit	2021	2026	2030	2035
Population in the Supply Area	number	74,935	95,802	121,616	169,220
Estimated/Target Total Covered Population	Number	26,428	95,800	121,600	169,200
Water Supply Coverage*	m^3/day	80%	100%	100%	100%
Total Demand w/ NRW	m^3/day	4,334	6,900	10,700	18,700
Remaining water supply amount allocated to other area	m^3/day		13,100	9,300	1,300

*Including public taps

Source: Draft feasibility study , JST 2021

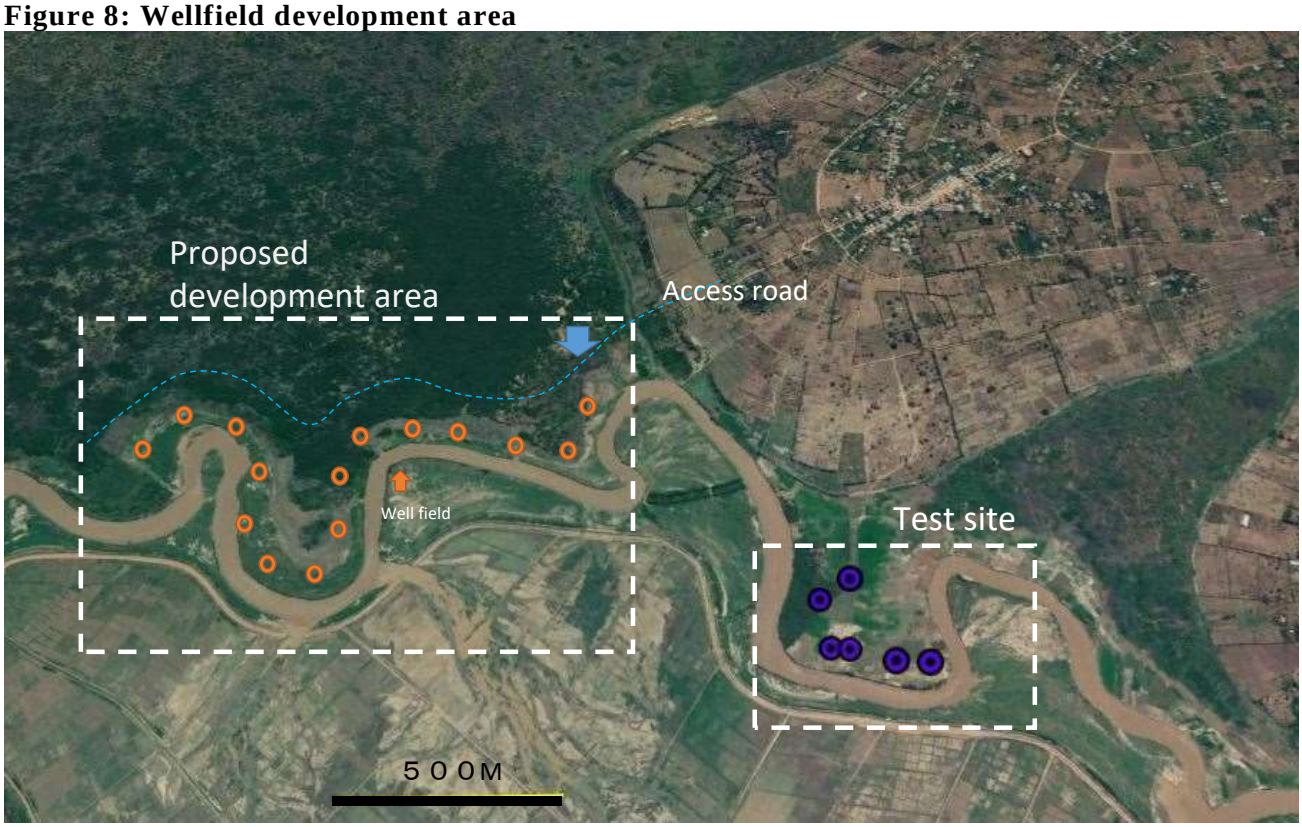
2.3.6. Availability of water for the proposed water treatment plant

Various water sources have been used by WASAC's WTPs, and apart from WTPs there are some pumping stations that use independent water sources such as springs and wells. The water from such sources are connected to water tanks located at the pumping stations and are chemically treated at site before its use. For the new Masaka WTP, water from boreholes along Akagera river and water intake directly from Akagera river are considered as sources of water for this project but the maximum turbidity for Akagera river reaches over 10000 NTU which results in intake stop and causes the high cost of water treatment. Therefore, groundwater quality around proposed Masaka wellfield is acceptable as water source for Maksaka WTP.

For that, it would be better to use water from boreholes to avoid high turbidity and possible contaminations of river water.

The test conducted by core drilling and water well drilling at the site close to the proposed development area as shown on figure below, resulted to the estimated 24000m^3/day from 15 boreholes and this is a promising result towards the achievement of Masaka WTP water supply in phase 1 where the expected production of water per day will be 20,000m^3.

Figure 8: Wellfield development area



Source: Draft feasibility study , JST 2021

2.4. Project components and activities

2.4.1. Project components

The project of construction of Masaka Water Treatment Plant includes:

- **Well fields and WTP**: Construction of new water source and WTP (Phase 1: 20,000 m^3/d, Phase 2: 20,000 m^3/d)

- **Transmission pipelines and reservoirs**: Clearwater transmission pipeline to Masaka (L=6 km, ND500 x2) Reservoir, Block distribution reservoirs (3 nos.), Clearwater transmission pipeline and a reservoir in Ndera (L=6km, ND400)
- **Construction of distribution network in Masaka**

Table 3: Summary of the expansion stage of Masaka WTP

Component	Description	Capacity	Unit
1. Boreholes	Total number: Maximum 20. Depth of borehole: Maximum 30 m	Yield: from 25m3/h to 80m3/h per borehole	
2. Masaka WTP Phase 1	1	20,000	m^3/day
3. Reservoirs	10	20,000	m^3
4. Water Supply System			
– Lateral pipe from borehole to Control chamber	150mm, Total length 3,000 m (150m x20)		
– Transmission main from wellfield to WTP	300-500mm, length 1.600m, including raw water collectors, manifolds and transmission		

Source: Draft feasibility study , JST 2021

2.4.2. Structure of wells and wellfield

✓ **Borehole design**

Borehole design in new wellfield at Masaka WTP can be similar as those common in similar project such as Nzove WTP. Drilling depth can be recommend at 30m and diameter of PVC casing & screen is 315mm. Pump setting depth can be around 15m and the distance between the boreholes should be from 50 m to 100m where possible. The schematic drawing of the borehole is provided below:

Figure 9: Drawing of the proposed borehole at Masaka WTP

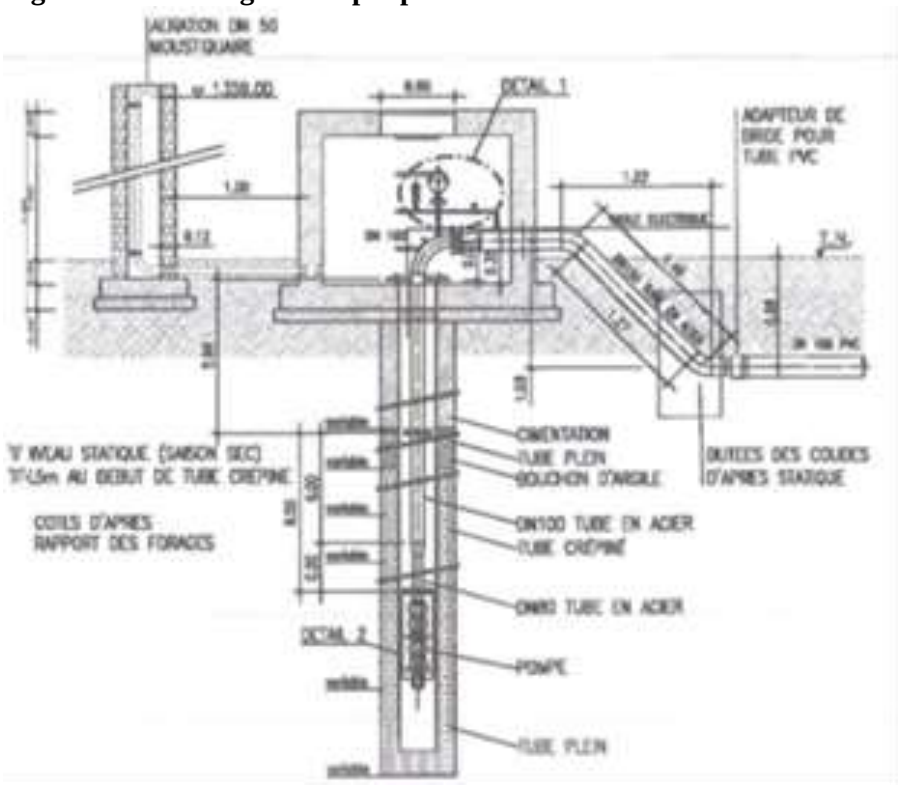


Figure 10: Borehole design at test well

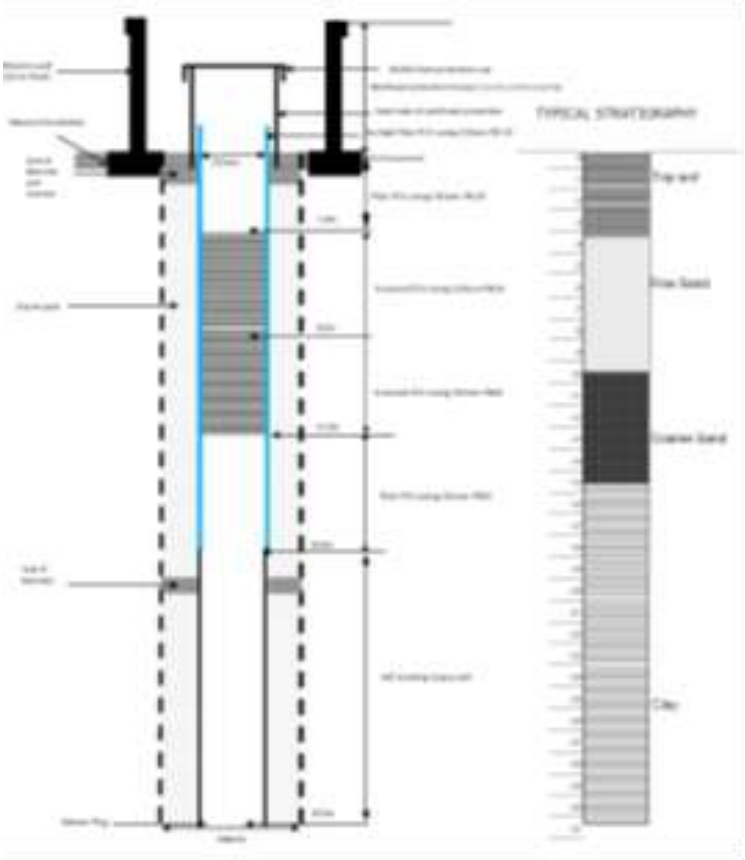
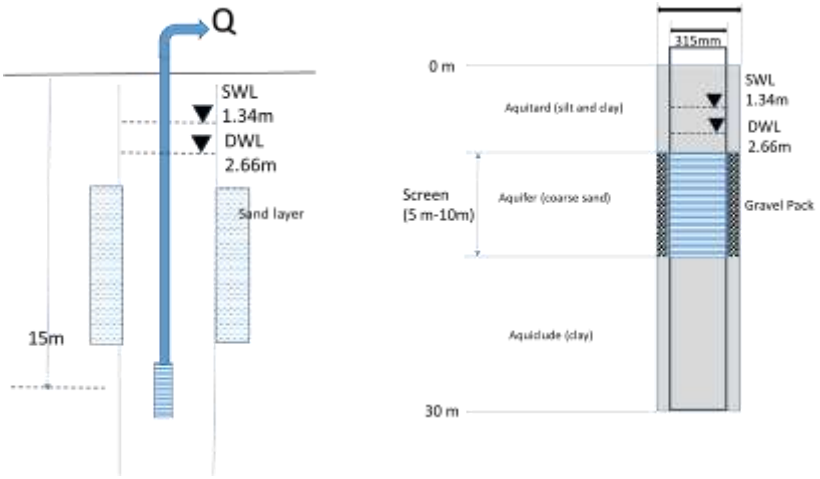


Figure 11: Proposed borehole design of Masaka wellfield



Source: Draft feasibility study , JST 2021

Proposed borehole design is presented in the table below and was done based on the information collected from the test borehole conducted in the wellfield area. Dynamic water level is expected to be at around 2.66 mbgl. General specification of borehole is explained in the table below:

Table 4: Summary of borehole

	Description
Drilling diameter	600 mm to accommodate casing and screen
Casing diameter and material	315 mm, PVC blank casing
Screen diameter and material	315 mm, Stainless steel wire wrap screen
Gravel packing and centralizers	Grain size is determined by slot size of screen, bentonite grout seal above gravel is necessary.
Riser pipe for submersible pump	Stainless steel is recommended

Source: Feasibility Study

- ✓ **Summary of raw water supply system**

Wellfield is summarized in the flowing table (table 6). Maximum number of boreholes to supply raw water is 20 which is expect produce raw water of more than 20,000m^3/d . Yield of each well is varied and depends on the aquifer situation.

Table 5: Description of wellfield

	Description	Remarks
Borehole	Total number: Maximum 20. Depth of borehole: Maximum 30 m Yield: from 25m3/h to 80m3/h	Need future study to identify the position of borehole.
Total length of wellfield	Previous study indicated the distance between boreholes should be from 50m to 100m. Therefore, maximum length of 20 boreholes is 1,900m	

Source: Feasibility Study

In addition to boreholes, raw water supply system is composed of collector pipelines, main pipeline, connection chamber, surge control devices, control room, and power supply.

Table 6: Summary of description of water supply system

	Description	Remarks
Lateral pipe from borehole to Control chamber	150mm, Total length 3,000 m (150m x20)	Need future study to identify the positon of boreholes.
Transmission main from wellfield to WTP	500-600mm, length 1.600m, including raw water collectors, manifolds and transmission	

Source: Feasibility Study

2.5. Project activities

Different activities will be carried out throughout the project implementation and among them include: construction of boreholes and access road to wellfield, WTP construction, construction of water transmission and distribution facilities. The construction works will involve different activities including pre-construction, construction and operational activities.

2.5.1. Pre-construction activities

Pre-construction activities consist at preparatory survey to provide the project orientation, project effectiveness, technical and economic validity of the Project, preliminary design, and scope of project as well as the outline of project cost and implementation plan. The pre-construction activities will results in three main outputs including:

- **Preliminary technical design**: The preliminary technical design provides information on size and location of project features, mapping of project area that need to be cleared, associated structure/infrastructure such as access paths, road crossing, estimates of staff and duration, construction materials and its sources and storing, equipment and tools, etc.
- **Environmental Impact Assessment (EIA):** the environmental and Social Impact Assessment provide baseline information of the projects area both physical and Social, assess the legal requirement, identify potential impacts associated with the projects and proposes an environmental management and monitoring plan;

Pre-construction works do not have any environmental and social impacts but provide the basis for deep analysis of potential impact during construction, operation and decommissioning phases.

2.5.2. Construction phase activities

The construction works will consist of construction of boreholes and access road to wellfield, WTP construction and construction of water transmission and distribution facilities. Others works connected to the project and involved in the construction phases include:

- Manufacturing and importation construction materials (pipes, pumping machines)
- Site clearance and excavation;
- Stones masonry with mortar
- Electrical installation
- Roofing
- Plumbing
- Construction of sedimentation tanks and reservoirs
- Construction of administrative building
- Construction of pumping station
- Pipe installation;

A maximum of 20 boreholes of a recommended drilling depth of 30m, diameter of PVC casing and screen to be 315mm, and pump setting depth of around 15m are designed in the wellfield of Masaka WTP. These boreholes will be protected from floods and other possible damages by installing a steel casing around the PVC pipe which will be covered by a holed steel head that can be removed once necessary by unbolting. Additional protection will be a house of 1.2 m x 1.5 m and 1.6 m to be built around the well, the house is sitting on a foundation of 40 cm and plastering to protect the masonry wall. Since the wellfield area is not accessible, there is proposed an access road of approximately 1400m length, 6m width and 500mm thick with soil and stones where applicable. The table below summarises the list of facilities to be constructed in this project.

Table 7: Summary of facilities to be constructed by the project

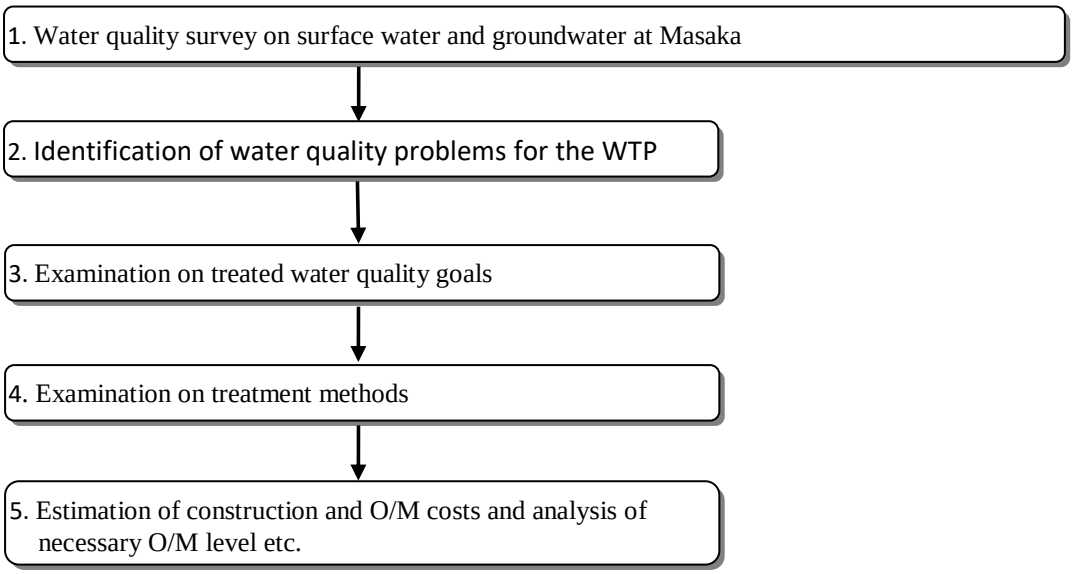
Summary of the List of Facilities	
Intake Well Pumps and Pipelines	
Intake Wells	600mm to accommodate casing and screen Total number: Maximum 20. Depth of borehole: Maximum 30 m Yield: from 25m3/h to 80m3/h 315mm, PVC blank casing and Stainless steel wire wrap screen
Electric Panels Room	Incoming Panel, Switchgears Motor Control Center Panels, Telemetry Panels
Raw Water Transmission Pipeline	ND300-500, L=1,600m ND150, L=3,000m
Miscellaneous	Monitoring and Maintenance equipment and tools
Water treatment plant	
Receiving Well	
Rapid Filtration Basin	LV=300 m/sec
Rapid sand filter Basin	LV=140 m/sec
Clear Water Reservoirs and Pumping Station	
Clear Water Transmission Pumps	
Backwash Tank	
Sludge Basin	
Drainage Basin	
Sludge Drying Bed	
Administration Building	
Transmission and distribution systems	
a. Main reservoirs and transmission mains	
Cyimo Booster Pumping Station	
WTP-CM	DIP ND 500 L=5.6 km
WTP-MB	DIP ND 300 L=4.2 km
CM-CH	DIP ND 300 L=1.4 km
b. Block reservoirs and transmission sub-mains	
Block Reservoirs	V=100 m3 x 6, V=500 m3 x1, V=1,000 m3 x1
Transmission Sub-Mains	DIP ND 400 L=4.8 km HDPE ND 300 L=7.15 km HDPE ND 300 L=3 km

Source: Draft feasibility study , JST 2021

2.5.3. Operation and maintenance activities

After construction testing and inauguration of the plant, no major works are expected except the raw water treatment processes during the operation phase. Only monitoring works and chemical analysis will be conducted to check any defect or leakage as well as the quality of water for both raw water and treated water to be supplied. If any defect or leakage is identified then, rehabilitation works will be undertaken. The quality is monitored frequently to avoid any water pollution. Mitigation measures are also established to correct pollution that may occur or detected. In order to determine an appropriate treatment process, basic technical approach and methodology for determining the water treatment process, the following chart is proposed to illustrate the treatment processes.

Figure 12: Water treatment process at Masaka WTP



Source: Adapted by Author

Based on the preliminary results of the raw water as shown in chapter of baseline (.Chapter 4) the target treatment compounds have been identified and their treatment methods are also studied as shown in the table below:

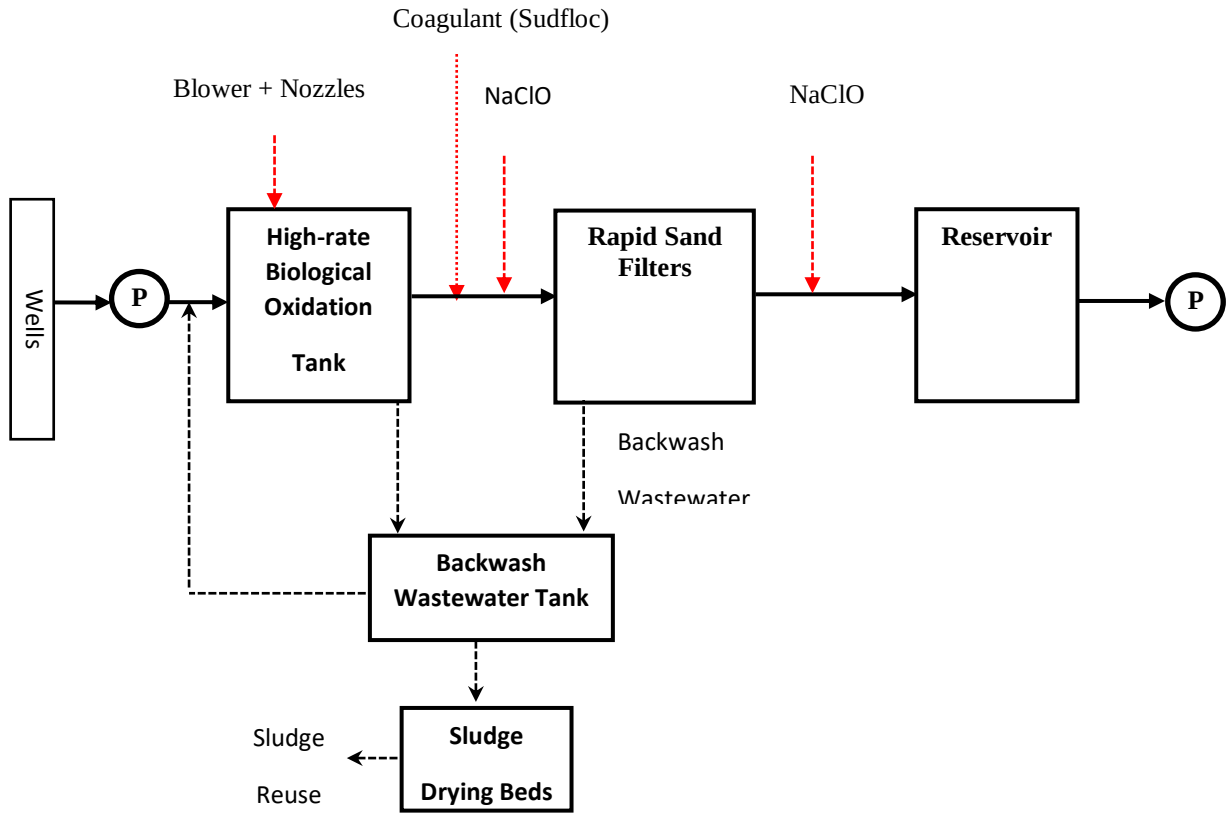
Table 8: Summary of target water quality compounds and their treatment methods

No.	Target Compounds	Pollution Level	Unit Treatment Process	Remark
1	Turbidity	Low (18-21)	Coagulation-sedimentation, filtration, membrane	
2	Ammonia nitrogen (NH_4-N)	Low-Middle (0.28-0.73)	Aeration, biologic treatment, chlorination	
3	Nitrite nitrogen (NO_2^--N)	Low (0.01-0.07)	Aeration, biologic treatment, membrane	
4	Iron (Fe)	Middle-High (2.91-6.70)	Coagulation-sedimentation, biologic treatment, chlorination, contact oxidation	
5	Manganese (Mn)	High (3.04-3.12)	Coagulation-sedimentation, biologic treatment, chlorination, contact oxidation	
6	Bacteria	Middle (10^4-10^5)	Coagulation-sedimentation, filtration, O_3, UV, chlorination, membrane	

Source: Draft feasibility study , JST 2021

Considering the fact that the main issue raw water quality at Masaka WTP are also turbidity, ammonia, bacteria, iron and manganese, treatment process for the WTP is proposed as follow:

Figure 13: Water treatment flow chart at Masaka WTP



Source: JST

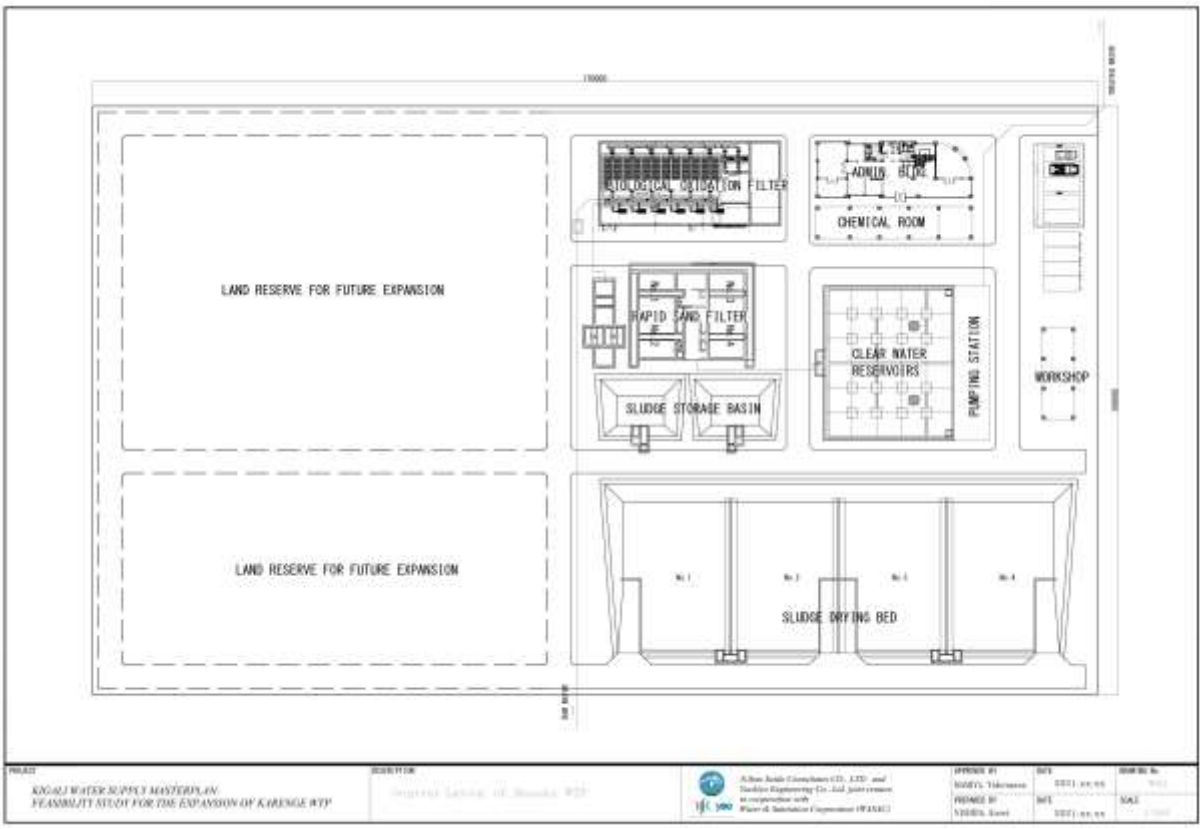
The purpose of each unit treatment process is summarized in the table below

Table 9: Summary of unit treatment process at Masaka WTP

No.	Unit Treatment Process	Purpose of Unit Treatment Process
1	Aeration	1) Providing DO for oxidation of Fe, Mn, nitrite (NO_2^-) and some organic matters etc. 2) Removing ammonia, Fe, Mn in High-rate Biological Oxidation Tank 3) Removing part of odor compounds
2	Rapid Sand Filters	Removing colour, turbidity, organic matters, Fe, Mn, bacteria etc.
3	Disinfection	Removing bacteria
4	Backwash Wastewater Tank	Separating sludge and backwash wastewater and recovering supernatant of backwash wastewater
5	Sludge drying bed	Dewatering sludge

Source: Draft feasibility study , JST 2021

Figure 14: Masaka Water Treatment Plant layout



Source: Feasibility study, JST 2021

2.5.4. Decommissioning activities

Major activities to be considered in this project include movement and demolition of construction facilities such as temporary construction yard; remove all construction debris and restoration of the area. It is important to note that mitigation measures and actions for restoration of the damaged areas is mostly recommended and detailed in the chapter of impacts assessment and mitigation measures.

2.6. Project land requirement

The land acquisition for this project is necessary both for WTP and access road to the wellfield. The existing statuses of those lands are private owned or public land utilised for agriculture activities. The locations for the wellfields are determined according to the shape of the Akagera River and should be determined a well pumping test during the construction implementation. The pipelines and water distribution networks are proposed to follow the roads where there will not be required a resettlement activities.

2.7. Project implementation schedule

The project schedule includes preliminary works and construction works that will be undertaken for completion of the project. The project will be done in two different phases; as illustrated in table below (table 12) The schedule suggests that the water supply can be inaugurated from the end of the Year 2027 if all procedures go smoothly. The remarks and disclaimers for the implementation schedules are as follows;
The funding for the Project has based on foreign loan aid which the conditions are unknown. It should be revised based on the required procedures in line with the development partners' terms and conditions as well as the domestic procurement guidelines of the GoR.

The period for construction (24 months) is based on the past experience of the New Nzove construction by WASAC. A usual period for construction may approximately 30 Months, including the commissioning before full delivery. A shorter period was selected for the schedule in order that the delivery of water shall be accelerated. In general, it is recommended to have a longer period in order that the quality of work should be secured. Therefore, the period for the construction may be revised during the Detailed Design, comparing the quality and time for delivery.
The time for selection of the Consultants and Contractors should be closely related to the budget for the Project, the country risk regarding political and economic stability. The schedule would be delayed in case of re-bidding and dismissal of the bid. The effect of the COVID-19 and the similar pandemic situation may also affect the schedule of procurement and construction works

Table 10: Project implementation schedule

Item		2021/2022												2022/2023												2023/2024												2024/2025											
		7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
	Months																																															
Project Approval and Budetary Arrangement by GoR	12																																															
Approval of Consultant Procurement for D/D	3																																															
Bidding Procedures and Contract Agreement for D/D	6																																														
Detailed Design	12																																														
Bidding Procedures	6																																														
(1) Water Intake Wells and Raw Water Transmission Pipelines	12																																														
(2) Water Treatment Facilities	24																																														
(3) Transmission Systems	18																																														
(4) Distribution Pipelines	18																																														
Land Acquisition																						▲																										

Item		2025/2026												2026/2027												2027												2028											
		7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
	Months																			Completion of the Project																															
Project Approval and Budetary Arrangement by GoR	12																																															
Approval of Consultant Procurement for D/D	3																																															
Bidding Procedures and Contract Agreement for D/D	6																																														
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(4) Distribution Pipelines	18																																														
Land Acquisition																																															

Source: Draft feasibility study , JST 2021

CHAPTER III: POLICY, LEGAL AND REGULATORY FRAMEWORK

The present chapter describes policies, laws, regulations and institutional framework that will govern the implementation of the project and the implantation of proposed mitigation measures. Both international and national regulations were reviewed in order to come up with a consolidated legal and regulatory framework to ensure that the project is implemented in compliance with national regulations and international Policies and standards.

3.1 National legal and regulatory framework

3.1.1 Rwanda's constitution of 2003 with amendments through 2015

The Constitution of the Republic of Rwanda, adopted in June 2003 and revised in 2015, ensures the protection and sustainable management of environment and encourages rational use of natural resources. The Article 22 related to "Right to a clean environment" stipulates that everyone has the right to live in a clean and healthy environment. And the Article 53 on "Protection of the environment" stipulates that everyone has a duty to protect, safeguard and promote the environment. It also indicates that the State ensures the protection of the environment. Lastly, it stipulates that a law determine modalities for protecting, conserving and promoting the environment. The state shall protect the environment. The law determines the modalities for protecting, safeguarding and promoting the environment.

To comply with this constitutional statement and to ensure that the country development is done in sustainable manner, the government has adopted different sectoral policies, laws and set up different institution. Those institutions are responsible of implementation of different policies and laws enforcement.

3.1.2 National policy on Environment and Climate Change, 2019

This policy calls for stocktaking of the achievements, setbacks, future opportunities and alignment with global, regional and national development agenda. The policy provides strategic direction and responses to the emerging issues and critical challenges in environmental management and climate change adaptation and mitigation. This policy is designed within the context of national, regional and global development commitments; and it has the goal for Rwanda to have a clean and healthy environment resilient to climate variability and change that supports a high quality of life for its society. The key issues and challenges identified include high population density, water, air and soil pollution, land degradation, fossil-fuel dependency, high-carbon transport systems, irrational exploitation of natural ecosystems, lack of low-carbon materials for housing and green infrastructure development, inadequate waste treatment for both solid and liquid waste, increase of electronic, hazardous chemicals and materials waste, among others.

The implementation of the proposed project must be in line with objectives and goals of this policy so as to help the institutions in charge (WASAC Ltd) to deal with challenges mentioned in the policy and to ensure the sustainable environment for future generations.

3.1.3 National Strategy for Transformation (NST1), 2017-2024

In the medium term, the National Strategy for Transformation, NST1/Seven Years Government Program (2017-2024) sets the priority for a green economy approach in its Economic Transformation pillar that promotes "Sustainable Management of Natural Resources and Environment to Transition Rwanda towards a Green Economy". Moreover, environment and climate change were highlighted in NST1 as cross-cutting areas of policy concern which can be positively impacted by a range of development activities with priority given to agriculture, urbanization, industries and energy.

Among the main focus of the NST1 in improving cross sectoral coordination, infrastructures are included so as to ensure the smooth implementation of environmental policies and regulations.
Additional emphasis will be put on strengthening monitoring and evaluation. High impact areas selected include implementation of:

(a) Environmental and Social Impact Assessments
(b) Biodiversity and ecosystem management, and
(c) Pollution and waste management.

In terms of (b) and (c) the project is intended to affect a part of project's wetland on the Akagera River, where some varieties of ecosystems are found. The construction works will also result in waste generation of different types as well as pollution of air due to dust and used machines, and/or water pollution as well.

In terms of water supply, NST1's water supply priority is "to ensure universal access to water by 2024". This will be achieved through the construction, extension and rehabilitation of 1,937 km of water supply systems in Kigali City and other towns, and 1,851 km of water supply systems in rural areas. Daily water

production capacity will be increased from 1 82,120 to 303,120 cubic meters per day (MINECOFIN & OPM, 2017). Further infrastructure will be provided to ensure universal access to improved drinking-water on premises as well as availability of safe water when needed. Water production will be stepped up to meet water consumption demand of 80 litres per capita per day in urban areas, and 20 litres per capita per day in rural areas. Water supply will ensure affordability, reliability and quality. The present project is then implemented to cope with the target and NST1 priorities.

3.1.4 National Biodiversity Strategy (NBS), 2016

The revised and updated Rwanda National Biodiversity Strategy (NBS) has a long-term vision which is in line with the Convention on Biological Diversity (CBD) strategic plan to 2020 and states that: "by 2040, national biodiversity be restored and conserved, contributing to economic prosperity and human well-being through delivering benefits essential for Rwandan society in general." NBS as a 'living document', responsive, flexible and practical, including biodiversity conservation in economic decisions and turn it into a driver for national development. Relevant economic development sectors such as agriculture and animal resources, fisheries, forestry, mining and infrastructures will incorporate biodiversity conservation activities into their planning systems as well as in the annual budgets of upcoming years.

The strategy on biodiversity aims at: improving conservation of protected areas and wetlands; sustainable use of biodiversity in natural ecosystems and agro-ecosystems; rational use of biotechnology; development and strengthening of policy, institutional, legal and human resources frameworks; and equitable sharing of benefits derived from the use of biological resources.
Among the goals of NBS 2016 are included:

- To address the main causes of national biodiversity loss by mainstreaming biodiversity conservation in the decision-making process across all governmental, private and civil society's development programs and,
- To reduce anthropogenic pressures on biodiversity resources and promote their sustainable use.
- To ensure equitable sharing of benefits arising from the use of biodiversity and ecosystem services.

The project of construction of Masaka WTP will be implemented in compliance with the NBS goals and national targets for sustainable biodiversity conservation as the project facilities (wells, Water treatment Plant, water transmission pipes etc) are closer to buffer zone of the Akagera River and may be located in the nearby wetland.

3.1.5 National Water Supply Policy, 2016

National water supply policy outlines initiatives to overcome challenges and exploit existing opportunities in an integrated manner, and will effectively contribute towards achieving the goals of the National Development Agenda. The Policy outlines initiatives to overcome challenges and exploit existing opportunities in an integrated manner, and will effectively contribute towards achieving the goals of the National Development Agenda.

One of the objective of water supply policy is to ensure safe, reliable and affordable urban water supply services for all while striving for financial sustainability Urbanization is a key element of Rwanda's development strategy, as laid out National Strategy for Transformation (NST1).The policy will ensure increased sustainability and access to safe and clean water through improving operations and maintenance of existing water supply infrastructure and providing new water facilities. The policy has the following specific objectives:

- Raise rural water supply access to 100 per cent by fast-tracking implementation of a strategic investment programme;
- Ensure sustainable functionality of rural water supply infrastructure by strengthening operation and maintenance management arrangements;
- Ensure safe, reliable and affordable urban water supply services for all while striving for financial sustainability;
- Ensure safe and reliable water supply services for schools, health facilities and other public places;
- Strengthen and consolidate the sector's institutional, legal and capacity building framework and;
- Provide Policy directions on cross-cutting issues.

The proposed project of Construction of Masaka Water Treatment Plant is aligned with this Policy in real meaning that it is providing water for achieving policy objectives in the supply areas of Kicukiro District and its surroundings.

3.1.6 Integrated Water Resources Management Policy (IWRMP), 2018

The IWRMP is the latest development in Government's consistent and continuous efforts to strengthen the water resources management sub-sector. It replaces the 2004 policy and has been necessitated by the ill-alignment between the 2004 policy and water law No. 62/2008, which embraced many modern and cutting-edge principles of sustainable water resources. Additionally, the government has been introducing reforms in the water sector that have significantly changed the context for water resources management and rendered the 2004 policy out of date.

With the promulgation of a law establishing the Rwanda Water Board with the mandate to lead the management of water resources across sectors, there is potential to achieve a coordinated approach to water resources management, in line with the integrated water resources management concept. In order to address the capacity limitations being faced by the sector, it will require concerted efforts in resource mobilization, human resource development and institutional capacity building.

The Water Resources Policy is relevant to the proposed project of construction of Masaka Water Treatment Plant given that is the one providing guidance on water source management and allocation of water to various users.

3.1.7 National Land Policy, 2019

This policy comes at a very important stage when Rwanda is embarking into a shift towards becoming an upper-middle income country by 2035 and a high-income country by 2050.
The project of Construction of Masaka Water Treatment Plant will require the land for intake structures, land for the WTP as well as land for water reservoirs and water pipelines.

The efficient use and management of land is critical to ensure sustainable development. Concerning sustainable land management, the overall principle of this policy is that land must be used for productive and development purposes without compromising its use by future generations.

The policy is further expected to:

- Guide, develop, and monitor the implementation of land use plans.
- Ensure effective and efficient land utilization and management across various sectors such as agriculture, industry, forestry, livestock, human settlement, mining, and other public investment.
- Support investment promotion through allocation of land for strategic investment.
- Strengthen the current land administration system for enhanced land-based service delivery.
- Strengthen mechanisms for effective administration of land fees and real property taxes (e.g., proper and up-to-date land records, maximization of real property tax and lease fees collection, and capacitate decentralized administrative entities in tax administration).
- Enforce land sub-sector coordination to ensure an integrated approach for efficient cross-sectorial land utilization and collaboration towards sustainable land use and management.

The Land policy is relevant to the project of construction of Masaka Water Treatment Plant given that the entire project will need land and hence may change land tenure and may require expropriation at some extent.

3.1.8 Urbanization Policy, 2015

The National Urbanization Policy addresses all aspects of cross-sectoral action in urban development and governance. Rwanda guides urbanization in a way to efficiently use and manage its natural resources while promoting sustainable development, reinforce its system of urban areas and human settlements for local economic development based on local potentialities and inter-linkages, promote densification for cost effective public investment and infrastructure service delivery, and to reserve for agricultural production, open space and conservation of the environment, and plan for the needs of transportation, housing, culture, recreation, utilities, waste management, information and telecommunication, commercial and industrial development in response to macro-economic strategies and citizens views.

The overall intent of the policy is to create the conditions for well-managed growth generating vibrant urban environments and sustainable economic development.

Given that water supply is a major component in urban development the construction of Masaka WTP is aligned with the policy and is intended to meeting the need of growing population in the city of Kigali (Kicukiro District) and its surroundings.

3.1.9 Sanitation Policy, 2016

National Sanitation policy approved in 2016 outlines initiatives to overcome challenges and exploit existing opportunities in an integrated manner, and will effectively contribute towards achieving the goals of the National Development Agenda. The policy aims at ensure expanded access to safe and sustainable sanitation services through a number of means including: establishing District sanitation centres providing a wide range of sanitation technologies; improving operation and maintenance of sanitation facilities; and assisting Districts and the City of Kigali to plan and design projects to mitigate urban storm water issues. Specific objectives of the sanitation policy are:

- Raise and sustain household sanitation coverage to 100 per cent by 2020;
- Implement improved sanitation for schools, health facilities and other public institutions and locations;
- Develop safe, well-regulated and affordable off-site sanitation services for densely populated areas;
- Enhance storm water management in urban areas to mitigate impacts on properties, infrastructure, human health and the environment;
- Implement integrated solid waste management;
- Ensure safe management of e-waste, industrial waste, nuclear/radioactive waste and health-care waste
- Develop the sanitation sub-sector's institutional and capacity-building framework

The policy is relevant to the project of construction of Masaka WTP as the availability of clean water is a key factor to achieve the policy's objectives. The implementation of the project is in line with the requirements and visions promulgated by the policy.

3.2 Relevant Laws

3.2.1 Law N° 48/2018 of 13/08/2018 on environment

The law determines the modalities for protecting, conserving and promoting the environment. In its Chapter II regarding the fundamentals that govern environmental conservation, the law states that Every person has the right to be informed of the state of the environment and to take part in strategies and activities aimed at conserving the environment, Activities considered or suspected to have negative impacts on environment must not be implemented pending results of a scientific assessment ruling out the potentiality of such impacts , The right to development must be achieved in consideration of the needs of present and future generations.

The article 9 of the Law states that, regarding the Use and management of soil and subsoil any land exploitation project for research, industry, urbanisation, rural settlement, **i**nfrastructure, intensive farming or extraction is subject to authorisation issued in accordance with relevant laws. Whereas, the article 12 of the law states that Water resources must be protected from any source of pollution. Swamps with permanent water and full of swamp vegetation must be given special protection considering their role and importance in the preservation of the biodiversity.

The article 42 of the law gives the list of Prohibitions in wetlands and protected areas and among them including:

a. to dump any solid, liquid waste or hazardous gaseous substances in a stream, river, swamp, pond, lake and in their surroundings;
b. to damage the quality of the surface or underground water
c. to build in water sources, streams, rivers and lakes and in the buffer zone in a distance of ten meters (10 m) away from streams and fifty meters (50 m) away from lakes
d. to compact or change the nature of the wetland
e. to build in the swamp and in the buffer zone in a distance of twenty meters (20 m) away from the swamp boundaries;
f. to dump, make flow, dispose of and store any substance in a place where it may cause or facilitate pollution of national waters.

The same article states that "However, the Minister, after consultations with relevant institutions, may authorize some constructions or any other tourism-related activity as well as the use of water and underwater resources.

The law is relevant to the project as all the proposed project activities should be implemented with the main purposes of the protection of environment, with significance and effectiveness of measures to prevent

environmental degradation; the considerations of interests of the local community in the vicinity of the project.

Hence based on the article 42 of this law, WASAC ltd is required to seek for special authorization of the construction of the Plant from the Ministry of Environment and in collaboration with the city of Kigali and other relevant Institutions such as REMA, RURA before project implementation.

3.2.2 Law N° 49/2018 of 13/08/2018 determining the use and management of water resources

The purpose of this law is to determine the use and management of water resources in Rwanda. The natural water identified by this law includes Permanent Streams and rivers, Lakes, Wetlands, springs and aquifers. Protection and rational use of water resources constitute the obligations of each and every person.

Except activities related to the protection of groundwater protection areas, any other activity is subjected to prior authorization by the competent authority. Regarding the priority for water allocation, all persons are entitled to an equitable and reasonable share on the water resources available.
However, in allocating water resources the priority is given to:

- 1º domestic needs;
- 2º environmental protection;
- 3º economic activities.

The article 21 of this law states that the use of water resources in different activities and installations susceptible to modify the flow or the level of water or to degrade their quality, or to threaten water-related ecosystems, wetlands and the environment are subjected to water use permit. A Ministerial Order establishes the list of activities and installation that are subject to a water use permit and determine conditions and procedures of acquisition and use of water permit.

Water abstraction for existing Karenge WTP and the proposed expanded Karenge WTP is in Mugesera Lake at around 500m from the edge of lake, and the pumping station is straight at the edge of the lake where during the rainy season, Lake water occupy a large part of the station.

The Water Law states that it is prohibited to build in water sources, streams, rivers and lakes and in the buffer zone in a distance of ten meters (10 m) away from streams and fifty meters (50 m) away from lakes and the boundaries of streams, rivers and lakes, are delimited by the line reached by the highest waters before overflowing. Therefore, this line constitutes the starting point for the delimitation of the longitudinal strip of land included in the public domain. The article 7 stats that Water resources are used and managed in accordance with the following principles:

- prevention of pollution with priority to source;
- precaution, according to which activities considered or suspected to have negative impacts on water resources shall not be implemented even if such impacts have not yet been scientifically proved. Scientific uncertainty must not be taken into consideration for the benefit of destroyers of water resources, instead it may be used in conservation of water resources;
- integrated management of water resources within catchment, taking into account the interests of all water users, land and other natural resources and related ecosystems;
- participation, according to which all interested stakeholders, including water users through their representatives, are entitled to participate in water resources management and planning;
- "user-pays and polluter-pays" principles, according to which the user of water and the polluter must support a significant part of expenses resulting from measures of prevention, of pollution reduction and restoration of the water resources in quality and quantity;
- subsidiary, whereby development and protection of water resources is planned and implemented at the lowest appropriate level

The water law is relevant to the project as the water abstraction facilities are located in the Akagera swamp and therefore all the requirements and obligations of the law during the project implementation have to be respected and complied with the law requirements.

3.2.3 Law N° 32/2015 of 11/06/2015 relating to expropriation in the public interest

This law determines the procedures relating to expropriation in the interest of the general public. The law stipulates that the government has the authority to carry out expropriation. However, the project, at any level, which intends to carry out acts of expropriation in public interest, shall provide funds for inventory of assets of the person to be expropriated. According to the organic law, no person shall hinder the implementation of the program of expropriation on pretext of self-centred justifications and no land owner

shall oppose any underground or surface activity carried out on his or her land with an aim of public interest. In case it causes any loss to him or her, he or she shall receive just compensation for it.

This law is relevant to the present project as there will no doubt people's land and properties who will be compensated to pave the way the project activities. Even though no inventory is yet done at this stage some individual land and properties will be affected by water treatment, water storage and distribution facilities. Those affected will be expropriated and according to the obligations of the present law. The wellfield area is classified as conservation area and the WTP area is allocated to medium dansety residential area(R3) and to comply with Land Use Master Plan, WASAC will request for cange in land use.

3.2.4 Law N° 27/2021 of 10/06/2021 governing land in Rwanda

The New law governing land in Rwanda was gazetted in the official gazette No Special of 10/06/2021. The Law determines modalities of acquisition, registration, allocation, possession, transfer, management and use of land. The law defines land as a field, a plot or a farm located in a known geographical area and with boundaries, including its airspace, the objects underground, the surrounding biodiversity, structures and developments on that surface. The article 29 of the law classifies the land into: 1 º lands in public domain; 2 º lands in private domain.

Accordingly, the article 31 subsides the state land into different into different type of state land including (i) the lands occupied by lakes or rivers as listed by an Order of the Minister in charge of water resources; (ii) lands on the banks of lakes or rivers up to a distance determined by an Order of the Minister in charge of water resources starting from the furthest line reached by water depending on successive floods, excluding exceptional floods. Article 33 determines that Swamp lands belong to the State. They cannot be definitively allocated to individuals and no person can use the ground of holding swamp lands for a long time to justify the definitive takeover of lands.

However, swamp lands may be granted through concession to a person based on a concession agreement concluded between the Ministry and the concessionaire. A Prime Minister's Order outlines a list of swamp lands, their classification and boundaries and sets up modalities of their use, development and management for the sustainable benefit of the Rwandan population. Furthermore, the article 39 determines that A public institution or decentralized entities have the right to use the State lands required for accomplishing its mission and responsibilities.

A part of the land required for the implementation of the present project is located in state land. The other land will be required from private land. Therefore, the law is relevant to the project as it determines the modalities of allocating, acquisition, transfer, use and management of land in Rwanda as well as the equal protection to the rights over land possession.

3.2.5 Law N° 66/2018 of 30/08/2018 regulating labour in Rwanda

The article 5 of the labor law in Rwanda sets the Minimum age for admission to employment as sixteen (16) years. The article 6 of the same Law emphasize that it is prohibited to subject a child below the age of eighteen (18) years to any of the following forms of work:

- forms of work which are physically harmful to the child;
- work underground, under water, at dangerous heights or in confined spaces;
- work with dangerous machinery, equipment and tools, or which involves the manual handling or transport of heavy loads;
- work in an environment which exposes the child to temperatures noise levels or vibrations damaging to his/her health;
- work for long hours or during the night or work performed in confined spaces.

The law also prohibits Sexual harassment in any form against supervisee

The law is relevant to the project as during the implementation of the project, employment will be created either being permanent or of short term. The contractor therefore will ensure that the labor law is respected and applied to the project works accordingly.

3.2.6 Law N° 58/2018 of 13/08/2018on mining and quarry operations

During the implementation of this project, the construction works (WTP, intake and pipelines) will require some materials including stones and sand. The law defines mining area as an area for which a mining licence is issued. The Chapter IV and V of the law determine the quarry licence and the environment protection, health and Safety respectively. Therefore, the mining and quarry exploitation law provide the process of acquiring quarries for mining activities, the licensing process and the environmental consideration in exploiting a quarry. Nevertheless the quarry component will be conducted by a contractor

who will be required to fully respect strictly the process. Actually, an EIA Certificate is required for each quarry to be exploited.

The law is relevant to the project as the contractor will be requested to acquire material from a certified quarry and in respect to environmental requirement.

3.2.7 Ministerial order N°. 001/2019 on environmental assessment requirements and procedures

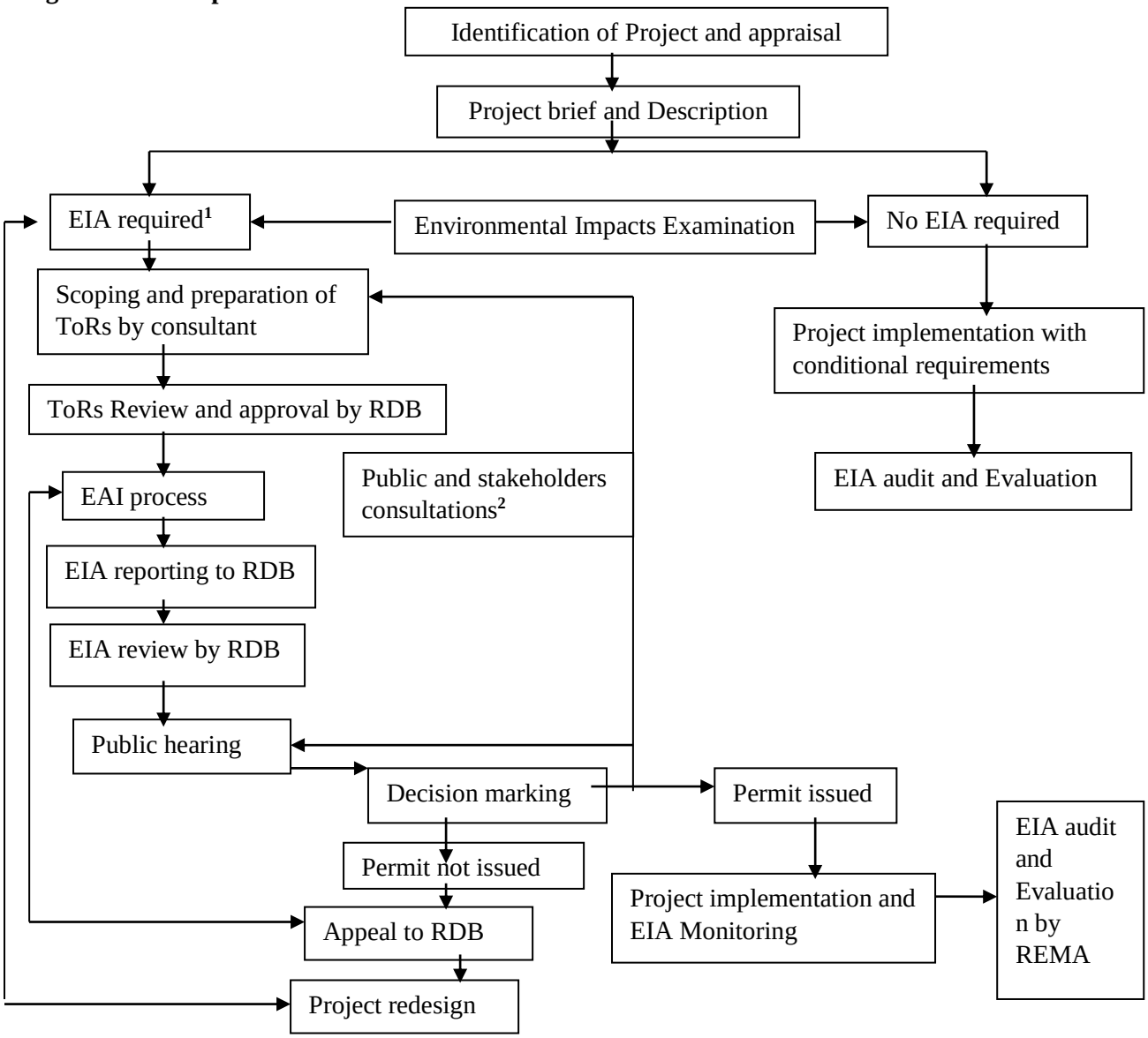
This Order establishes:
1° the list of projects that must undergo an environmental impact assessment before they obtain authorisation for their implementation;
2° instructions, requirements and procedures for conducting environmental impact assessment.

In its article 3, Annex 1 it gives the list of works, activities and projects that have to be subject to a full environmental impact assessment before being granted authorization before their implementation. And the article 4, Annex II clarifies the list of works, activities and projects that must undergo a partial environmental impact assessment before being granted authorization for their implementation.

Projects, works and activities which are not listed on the Annex I and II to this Order are not subject to the environmental impact assessment. However, when it is evident that work, activity or project not listed on the Annex I and II to this Order has a negative and irreversible impact on the environment and is similar in nature to the work, activity or project listed in Annex I and II of this Order, the Authority or authorised organ may request the developer to conduct an environmental impact assessment.

In the water treatment plant and pumping station are performed a variety of activities for which might be hazardous to the workers and the environment as well. In those can be considered the inhalation of chemicals by operator working inside the chamber, electric circuit, risks of drowning during water sampling in the lake. All these hazardous risks and others which are not mentioned in this paragraph makes the proposed project fall under the projects that must undergo full EIA as mentioned in the Annex I of this law in buildings with activities which can cause hazards.

Figure 15: EIA procedures flowchart



3.2.8 Ministerial Order N°007/2008 establishing the list of protected animal and plant species

Chapter II Article 2 of this order classifies protected animals in three categories as Mammals, birds, and reptiles. The list is published in Appendix 1 of this Order as follows:

- **Animals:** Gorilla, Chimpanzee, Black rhinoceros, Elephant, Roan antelope, Sitatunga, Lions, Leopard, Klipspringer, Buffalo, Cheetah, Zool mongoose, Cephalophus, Zoolserval, Wild dog, Bushbuck, Hippopotamus, Burchell's zebra
- **Birds**: Black-headed Heron, Cattle Egret, Grauer's Swamp Warbler, Owls, All Lemuroids, Grey Crowned-Crane, wallow, Arrow-marked Babbler, Cape Robin-Chat, All pangolins, Vulture, Bee eater, Scimitar bills, Hamerkop, Sunbirds.
- **Reptile:** Tortoises (all species), Python, Crocodile, Viper.
- **Plants:** Ficus thonningii, Prunus Africana, Pentadesmareindersii, Myrianthusholstii, Thonningiasanguine,Hypoestestrifolia,Aloesp.,Syzygiumguineense,Erythrinaabyssinica,Fagaracha lybea,Kigelia,Africana,Orchidaceae,Eulophiastreptopetala,Eulophiahorsafalli,Diaphananthebilosa, Disaemili,Disperiskilimanjarica,Euggelingialigulifolia,Polystachyiahastate,Tridactyleanthomaniac a,Entandopheragmasp,Podocarpususambarensis,Albizziasasa,PiptadeniaAfricana,Podocarpusmilin jianus,grandiflora,Strombosia,Scheffleri.

The Order specifies that the listed animals and plant species shall not be destroyed without permission of the competent authorities. For that, the proposed Masaka WTP will be implemented in part of Akagera swamp where different living and non living species can be found especially birds, reptiles and plants that makes this order relevant to the proposed project. Ecological survey was conducted and results are presented in Chapter 4

3.2.9 Water use permit

The article 21 of law **N° 49/2018 of 13/08/2018** determining the use and management of water resources in Rwanda states that the use of water resources in different activities and installations susceptible to modify the flow or the level of water or to degrade their quality, or to threaten water-related ecosystems, wetlands and the environment are subjected to water use permit. A Ministerial Order establishes the list of activities and installation that are subject to a water use permit and determine conditions and procedures of acquisition and use of water permit. The water permit helps

- **To manage water resources** effectively and efficiently for optimal beneficial use of water for economic development of the country
- **To ensure fair share allocation**: to be able to allocate water, the water resource managers must know both how much water is available and how much is being used
- **To protect the environment**: water resources managers must ensure that water use is efficient, is well planned, and that pollution is reduced to a minimum. When allocating water resources to different uses, water resources managers have to make sure that the water for environmental flow remains available.

Below are the required documents for application for water use permit

1. Application letter addressed to the director general of Rwanda water resources board through the Mayor of the district in which the activities will be carried out
2. Identification of the applicant and other necessary document to enable easy understanding of the category and activities of the applicant
3. A detailed and complete description of the project
4. A certificate and copy of EIA report for new project or Environmental Audit report for existing project certified by the competent institution where required
5. The receipt of payment of thirty-five thousand Rwandan francs

Benefits of having a water permit are as that:

- Your water use promptly and correctly will improve your claim to lawful use established in accordance with water law and related regulations
- You will not have to face prosecution for non-compliance
- If you do not have a water permit, you might lose your claim to use water
- If you do not have water permit, the water resources managers will not be aware of your use and your place (abstraction point) may be allocated to anyone because you are not known
- In case of shortage of water, you will have a priority over those who have not a permit depending on priority order in water allocation.

It is important to note that water abstraction permit from Mugesera lake was guaranteed from Rwanda Water Board with permission of 48,000 m^3 /day

In terms of operations licensing, Rwanda Utilities Regulatory Authority (RURA) does the licensing of water supply operators. Currently, there are three categories of licenses.

- **Water (and sewerage) utility license:** The licensee under this type of license shall run as a commercial entity in accordance with good business practices in water service provision and shall adhere to the performance indicators as directed by the Regulatory Authority. This type of license shall be granted to any operator who owns and manages water infrastructures and sells water to customers. Currently, only WASAC has this type of license in urban areas.
- **Water supply infrastructure management license:** The license for water supply infrastructure management is granted to operators that are under or willing to conclude for management contract with the owners of infrastructures. It authorizes the licensee to operate, manage and use appointed water supply infrastructures for supplying water in the service area to customers. There shall be an agreement between asset holder and the operator willing to provide water supply services in a specific area. Before the signature of such agreement, the draft agreement shall be submitted to the Regulatory Authority for advice. The Regulatory Authority shall always keep one copy of the signed agreement for record purposes. Operators under this license are managing water supply system on behalf of districts for water supply system in rural area and the license is valid for 5years renewable.
- **Bulk water supply license:** A license of bulk water supply permits the holder to sell in bulk water to an appointed water utility company, water and sewerage utility or any other operator for the purpose of resale or retail it to customers at eligible premises. Kigali water Limited that constructed Kigali Bulk water supply project in Kanzenze to supply water in Kigali and Bugesera area is the only operator with this type of license.

- ✓ **Other water use permitting**

Other water permitting and license procedures are provided under water user's association law and water law 2018. The use of water resources in different activities and installations susceptible to modify the flow or the level of water or to degrade their quality, or to threaten water related ecosystems, wetlands and the environment are subjected to water use permit. According to this law, the person requesting to be a holder of water use permit, get this permit renewed or transferred pays fees whose amount is determined by a Ministerial Order. Such a Ministerial Order also determines the basis of calculation and amount of annual fees to be paid for water use. A law on water fees is under discussion.

3.3 Institutional arrangement for the environmental management connected to this project

3.3.1 Ministry of Infrastructures (MININFRA)

The missions of the Ministry of Infrastructures include:

- To initiate programs, to develop, rehabilitate and maintain an efficient and integrated national transport infrastructure network, including roads, bridges, airports, railways, and water supply which will contribute towards economic development and regional integration.
- To initiate programs aimed at increasing access to affordable energy, water and sanitation, and transport infrastructure and related services for the population;
- To supervise the implementation of quality standards and norms, cost effectiveness, response to environmental sustainability, safety and cross-cutting issues in infrastructure development;
- To work towards implementation of programs to enhance human resource capacities under the transport, energy, habitat & urbanism, water and sanitation, and meteorology sub-Sectors respectively;
- To supervise activities meant to elaborate, monitor and assess the implementation of national policies and programs on matters relating to habitat and urbanism, transport, energy, water and sanitation.

In this project MININFRA is responsible for overall coordination of water supply to all Rwandans to ensure that the project is implemented in line with the government programs and policies aiming at access to safe drinking water for all.

3.3.2 Ministry of Environment (MoE)

The Ministry of Environment was established to ensure the protection and conservation of the environment and ensure optimal and rational utilization of Water Resources, Lands and Forests for sustainable national development.

The ministry has different responsibilities as stipulated in the Prime Minister's Order Nº 108/03 of 15/10/2020 Determining mission, responsibilities organizational structure, salaries and fringe benefits for employees of the Ministry of Environment.

1. To develop and disseminate the environment and climate change policies, strategies and programs through the following activities:
    a. To develop strategies to promote partnership and enhance capacity of private sector to invest in activities of environment and climate change for sustainable economic development;
    b. To develop laws and regulations to ensure protection of the environment and conservation of natural ecosystems;
    c. To develop institutional and human resources capacities in environment and climate change.
2. To monitor and evaluate the implementation and mainstreaming of environment and climate change policies, strategies and programs across all sectors, especially productive sectors;
3. To oversee and evaluate institutions under its supervision by providing guidance on the implementation of specific programs to be realised by the institutions under its supervision and local government;
4. To mobilise necessary resources for the development, protection and conservation of the environment for the climate change adaptation and mitigation.

The role of the MoE is to ensure that the project of Construction of Karenge Water supply system is implemented in a sustainable manner and in line with the existing environmental protection and conservation policies, laws and other legal requirements.

3.3.3 Water and Sanitation Corporation Limited (WASAC Ltd)

WASAC Ltd is the entity created by the law Nº 87/03 of 16/08/2014 and in order to manage water and sanitation services in Rwanda. The entity was created with the aim to deliver water and sanitation utility

sufficiently focused to deliver new infrastructure; efficient and effective service delivery; build a strong people capability; and meet key national milestones. It is expected to reverse the status quo that includes inadequate planning and investments; inefficient and wasteful operations; inadequate institutional management focus; improve viability and autonomy; and establish a sustainable and customer-centric utility to deliver an important mandate that touches people of all walks of life. The mission of the company is providing quality, reliable and affordable water and sewerage services through continuous innovations and detailed care to customers' needs.

As implementing agency, WASAC Ltd will play a critical role in project implementation but also in the implementation of Environmental and Management Plan as well as conditions of approval to be issued by Rwanda Development Board. WASAC Ltd is also responsible for monitoring of the implementation of mitigation measures and report back to Rwanda Environment Management Authority and JICA.

3.3.4 Rwanda Environment Management Authority (REMA)

REMA was established in 2004 to act as the implementation organ of environment related policies and laws in Rwanda. Under supervision of the Ministry of Natural Resources, from Law N°63/2013 of 27/08/2013 determining the mission, organization and functioning of REMA, it has the legal mandate for national environmental protection, conservation, promotion and overall management, including advisory to the government on all matters pertinent to the environment and climate change. REMA has different key responsibilities where for according to this proposed project, it will:

- Closely monitor and assess development programs to ensure compliance with the laws on environment during their preparation and implementation;
- Participate in the preparation of activities strategies designed to prevent risks and other phenomena which may cause environmental degradation and propose remedial measures;
- Provide, if necessary, advice and technical support to project developer and implementer in terms of natural resources management and environmental conservation.

In this project, REMA will be responsible for overall environmental protection audits and project general overview of project implementation vis a vis the environmental protection and management compliance. REMA will also play key roles in Environmental management Plan of the project implementation as key environmental protection regulator.

3.3.5 Rwanda Water Resources Board (RWB)

Rwanda Water Resources Board (RWB) was established by the law N° 71/2019 of 29/01/2020 with the following responsibilities:

- To implement national policies, laws and strategies related to water resources management;
- To advise the Government on matters related to water resources management;
- To establish strategies aimed at knowledge based on research on water resources knowledge, forecasting on water availability, quality and demand;
- To establish strategies related to the protection of catchments and coordinate the implementation of erosion control plans;
- To establish floods management strategies;
- To establish water storage infrastructure;
- To establish water resources allocation plans;
- To establish water resources quality and quantity preservation strategies;
- To control and enforce water resources use efficiency;
- To examine the preparation of roads, bridges, dams and settlements designs in order to ensure flood mitigation and water storage standards;
- To monitor the implementation of flood mitigation measures and water storage during the implementation of roads, bridges and settlements' plans;
- To cooperate and collaborate with other regional and international institutions with a similar mission.

According to the mission of RWB and the nature of this project, RWB responsibilities will be but not limited to ensuring well managed water resources by the project implementation for sustainable development and will be responsible for issuing water abstraction permit.

3.3.6 Rwanda Land Management and Use Authority (RLMUA)

RLMUA is responsible for putting in place and operationalizing an efficient system of land administration, use and management that secures land ownership, promotes investment in land for socio-economic development and poverty reduction.

Responsibilities of RLMUA are

- Put in place mechanisms which procure security of land tenure for the promotion of investments in land.
- Promote proper allocation of land, and proper use of land resources, according to their potential.
- Avoid the splitting up of plots, and to promote their regrouping in order to bring about optimum production.
- Establish mechanisms which facilitate an optimum exploitation of land, targeting the social-economic development of the country.
- Orient land management towards a more profitable and sustainable production, by making good choices among methods of land development.
- Develop methods that protect land resources from various types of land degradation.
- Establish institutional frameworks which enable land to become more valuable in the economy or at the market.
- Promote research as well as the education of the public on all aspects concerning land tenure, management, and transactions.
- Establish order and discipline in the allocation of land, as well as in land transactions in order to control the pressure on land, inappropriate development, speculation and trafficking of land.
- Involve and sensitize the public at all levels in order to ensure protection of the environment and good management of the land.
- Ensure the sustainable use of wetlands.

The role of RLMUA in the present project implementation will be responsible for the guarantee of the wise use of wetlands located within the project sites and will play key role in land registration located at the project infrastructures as well as the land transfer process between expropriated land and WASAC Ltd.

3.3.7 Rwanda Development Board (RDB)

RDB was created by Organic Law N° 53/2008 of 02/09/2008. It has a mission of improving the well-being of all Rwandans by fast-tracking development, catalysing sustainable economic growth, and creating prosperity for all. This a one stop institution bringing together several government bodies in Rwanda focused at promoting investment. Initially the responsibility for reviewing and approving EIA study reports was entrusted to REMA, this duty has now been transferred to Rwanda Development Board (RDB) where a department of EIA has been created and tasked with review and approvals of all EIA reports for proposed projects and programmes before their implementation. The project of Construction of Masaka WTP requires a conduct of a full EIA, for which RDB has the responsibilities to:

- Receive and register EIA Applications submitted by developer;
- Identify relevant Lead Agencies to review Project Briefs and provide necessary input during screening,
- Review Project Brief and determine project classification at screening stage,
- Transmit Project Brief to relevant Lead Agencies and concerned Local Governments to provide input on Terms of Reference (ToR),
- Publicize Project Brief and collect public comments during development of ToR,
- Receive EIA document submitted by a developer and verify that they are complete,
- Transmit copy of EIA Report to relevant Lead Agencies, Local Governments and Communities to review and make comments,
- Review EIA report and make decision on approval, organize and conduct public hearings, appoint an officer from Authority to chair public hearings, receive public comments and compile public hearing reports,
- Appoint the Technical Committee and its representative to the Technical Committee,
- Forward EIA Document (EIA Report, Environment Monitoring Plan and Public Hearing Report) to the Technical Committee,
- Chair the Executive Committee which makes final decision on approval of a project,
- Communicate decision on whether or not a proposed project is approved,
- Issue to developers EIA Certificate of Authorization if their projects are approved.

RDB will be responsible for approving the EIA study report and ensuing the EIA certificate for the project before implementation.

3.3.8 Rwanda Utility Regulatory Authority (RURA)

Rwanda Utilities Regulatory Authority (RURA) was created by the Law n° 39/2001 of 13/09/2001 with the mission to regulate certain public Utilities, namely: telecommunications network and/or Telecommunications services, electricity, water, removal of waste products from residential or business premises, extraction and distribution of gas and transport of goods and persons. This Law was further reviewed and replaced by Law Nº 09/2013 of 01/03/2013 establishing Rwanda Utilities Regulatory Authority (RURA) and determining its mission, powers, organisation and functioning. This Law gives to RURA the mandate to regulate:

- Telecommunications, information technology, broadcasting and converging electronic technologies including the internet and any other audio-visual information and communication technology;
- Postal services;
- Renewable and non-renewable energy, industrial gases, pipelines and storage facilities;
- Water supply including tariffs;
- Sanitation;
- Transport of persons and goods; and
- Other public utilities, if deemed necessary.

The regulation of water supply activities and other public utilities are among the mandates of RURA which makes it important to this proposed project as it is about the construction of Masaka WTP and transmission & distribution facilities.

3.3.9 Local Governments

Generally, decentralized entities are responsible for the implementation of laws, policies, strategies, objectives and programmes related to protection, conservation and promotion of the environment in Rwanda. Article 61 of environmental law state that in the framework of conservation and protection of the environment, decentralized entities are particularly responsible for:

- ensuring activities related to better management of land, especially controlling soil erosion and tap rain water;
- Afforestation, protection and proper management of forests;
- efficient management of rivers, lakes, sources of water and underground water;
- efficient management and effective use of swamps;
- Protection and proper management of reserved areas, historical sites, endangered animal and plant species.

Under the General Guidelines and Procedure for EIA, Kicukiro district particularly and other Districts of the project intervention with their respective Sectors are tasked to perform the following functions:

- Provide information or advice to developers and EIA Experts when consulted during EIA process,
- At the request of RDB, review EIA reports and provide comments to RDB,
- Assist in organizing public hearings,
- Host public hearings,
- Facilitate in land compensation process
- Gather written comments from public and transmit them to RDB.
- Facilitate the land acquisition process through land bureau office;
- Plan and complaints resolutions.

3.4 International legislative and policy framework

In addition to national environmental legislations, Government of Rwanda is also party to a number of regional and international conventions and protocols on environment. Therefore, the present project of construction of Masaka Water Treatment Plant will be implemented in compliance with international policy and regulations particularly World Bank safeguards Policies and JICA Environmental and Social considerations (project funder).

3.4.1 JICA guidelines on environmental and social consideration

The project of Construction Masaka WTP will be funded by JICA and therefore, it is critical to ensure that the project is implemented in compliance with JICA Environmental and Social Consideration. JICA encourages host country governments, including local governments, borrowers, and project proponents, to implement the appropriate measures for environmental and social considerations when engaging in

cooperation activities. At the same time, JICA provides support for and examinations of environmental and social considerations in accordance with the guidelines.

The guidelines cover five schemes: (1) Loan aid, (2) Grant aid (excluding projects executed through international organizations), (3) Preliminary studies of grant aid undertaken by MOFA, (4) Technical cooperation for development planning, and (5) Technical cooperation projects.

- **Objectives of JICA guidelines**

The objectives of the guidelines are to encourage project proponents to have appropriate consideration for environmental and social impacts, as well as to ensure that JICA's support for an examination of environmental and social considerations are conducted accordingly. The guidelines outline JICA's responsibilities and procedures, along with its requirements for project proponents in order to facilitate the achievement of these objectives. In doing so, JICA endeavours to ensure transparency, predictability, and accountability in its support for an examination of environmental and social consideration.

- **Key principles of JICA guidelines**

Key principles of JICA guidelines on environmental and social considerations can be summarized as follows:

1. Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible planning stage.
2. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan.
3. Examinations must be endeavoured to include an analysis of environmental and social costs and benefits in the most quantitative terms possible, as well as a qualitative analysis. These must be conducted in close harmony with the economic, financial, institutional, social, and technical analyses of projects.
4. The findings of the examination of environmental and social considerations must include alternatives and mitigation measures, and must be recorded as separate documents or as a part of other documents. EIA reports must be produced for projects in which there is a reasonable expectation of particularly large adverse environmental impacts.
5. For projects that have a particularly high potential for adverse impacts or that are highly contentious, a committee of experts may be formed so that JICA may seek their opinions, in order to increase accountability.

- **Responsibility of JICA in EIA process**

While project proponents take the initiative to deal with the environmental and social considerations of projects, JICA provides support for and examinations of the environmental and social considerations for that project proponents in accordance with Sections 2 and 3 of the guidelines and depending on the nature of cooperation projects. Project proponents are required to incorporate the output of environmental and social considerations studies into project planning and decision-making processes. When JICA provides support for and examinations of environmental and social considerations, JICA examines the requirements that must be met.

- **Categorization of projects and JICA guidelines**

JICA classifies projects into four categories according to the extent of environmental and social impacts, taking into account an outline of project, scale, site condition, etc.

Category A: Proposed projects are classified as Category A if they are likely to have significant adverse impacts on the environment and society. Projects with complicated or unprecedented impacts that are difficult to assess, or projects with a wide range of impacts or irreversible impacts, are also classified as Category A. These impacts may affect an area broader than the sites or facilities subject to physical construction. Category A, in principle, includes projects in sensitive sectors, projects that have characteristics that are liable to cause adverse environmental impacts, and projects located in or near sensitive areas.

Category B: Proposed projects are classified as category B if their potential adverse impacts on the environment and society are less adverse than those of category A projects. Generally, they are site-specific; few if any are irreversible; and in most cases, normal mitigation measures can be designed more readily. The project of construction of Masaka Water treatment plant falls under this category B.

Category C: Proposed projects are classified as Category C if they are likely to have minimal or little adverse impact on the environment and society.

Category FI: Proposed projects are classified as Category FI if they satisfy all of the following requirements: JICA's funding of projects is provided to a financial intermediary or executing agency; the selection and appraisal of the sub-projects is substantially undertaken by such an institution only after JICA's approval of the funding, so that the sub-projects cannot be specified prior to JICA's approval of funding (or project appraisal); and those sub-projects are expected to have a potential impact on the environment.

- **Impacts to be assessed**

The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor people, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. Items to be addressed in the specific project are narrowed down to the needed ones through the scoping process.

In addition to the direct and immediate impacts of projects, the derivative, secondary, and cumulative impacts as well as impacts associated with indivisible projects will also be assessed with regard to environmental and social considerations, so far as it is rational. The life cycle impact of a project period is also considered. Various kinds of relevant information are needed in order to assess impacts on the environment and local communities. There are, however, uncertainties in predicting such impacts caused by the incomplete understanding of impact mechanisms and the limited information available. Therefore, if the scale of uncertainty is considered to be large, project proponents provide environmental and social considerations that include preventive measures as much as possible.

3.4.2 World Bank Environmental and Social Framework (ESF)

- ✓ **ESS1: Assessment and management of environmental and social risks and impacts;**

ESS1 sets out the Borrower's responsibilities for assessing, managing and monitoring environmental and social risks and impacts associated with each stage of a project supported by the Bank through Investment Project Financing, in order to achieve environmental and social outcomes consistent with the Environmental and Social Standards (ESSs). Objectives of ESS1 are:

- To identify, evaluate and manage the environment and social risks and impacts of the project in a manner consistent with the ESSs.
- To adopt a mitigation hierarchy approach to: (a) Anticipate and avoid risks and impacts; (b) Where avoidance is not possible, minimize or reduce risks and impacts to acceptable levels; (c) Once risks and impacts have been minimized or reduced, mitigate; and (d) Where significant residual impacts remain, compensate for or offset them, where technically 2 and financially 3 feasible;
- To adopt differentiated measures so that adverse impacts do not fall disproportionately on the disadvantaged or vulnerable, and they are not disadvantaged in sharing development benefits and opportunities resulting from the project;
- To utilize national environmental and social institutions, systems, laws, regulations and procedures in the assessment, development and implementation of projects, whenever appropriate and;
- To promote improved environmental and social performance, in ways which recognize and enhance Borrower capacity.

To comply with the requirement of ESS1, an Environmental and Social Management Framework (ESMF) will be prepared to guide the implementation of proposed project.

- ✓ **ESS2: Labour and working conditions;**

ESS2 recognizes the importance of employment creation and income generation in the pursuit of poverty reduction and inclusive economic growth. Borrowers can promote sound worker-management relationships and enhance the development benefits of a project by treating workers in the project fairly and providing safe and healthy working conditions. The objectives of the ESS2 are:

- To promote safety and health at work;

- To promote the fair treatment, non-discrimination and equal opportunity of project workers;
- To protect project workers, including vulnerable workers such as women, persons with disabilities, children (of working age, in accordance with this ESS) and migrant workers, contracted workers, community workers and primary supply workers, as appropriate.
- To prevent the use of all forms of forced labor and child labor;
- To support the principles of freedom of association and collective bargaining of project workers in a manner consistent with national law; and
- To provide project workers with accessible means to raise workplace concerns.

- ✓ **ESS4: Community health and safety;**

ESS4 addresses the health, safety, and security risks and impacts on project-affected communities and the corresponding responsibility of Borrower to avoid or minimize such risks and impacts, with particular attention to people who, because of their particular circumstances, may be vulnerable. This Standard applies to the proposed project given that schools are constructed within the community and the community will be affected by construction works. The objectives of this standard are:

- To anticipate and avoid adverse impacts on the health and safety of project-affected communities during the project life cycle from both routine and non-routine circumstances;
- To promote quality and safety, and considerations relating to climate change, in the design and construction of infrastructure;
- To avoid or minimize community exposure to project-related traffic and road safety risks, diseases and hazardous materials.
- To have in place effective measures to address emergency events.
- To ensure that the safeguarding of personnel and property is carried out in a manner that avoids or minimizes risks to the project-affected communities.

- ✓ **ESS5: Land acquisition, restrictions on land use and involuntary resettlement**

Objective of ESS5

The objective of Environmental and Social Standard 5 on land acquisition, restriction on land use and involuntary resettlement are:

- To avoid involuntary resettlement or, when unavoidable, minimize involuntary resettlement by exploring project design alternatives.
- To avoid forced eviction.
- To mitigate unavoidable adverse social and economic impacts from land acquisition or restrictions on land use by: (a) providing timely compensation for loss of assets at replacement cost and (b) assisting displaced persons in their efforts to improve, or at least restore, their livelihoods and living standards, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.
- To improve living conditions of poor or vulnerable persons who are physically displaced, through provision of adequate housing, access to services and facilities, and security of tenure.
- To conceive and execute resettlement activities as sustainable development programs, providing sufficient investment resources to enable displaced persons to benefit directly from the project, as the nature of the project may warrant.
- To ensure that resettlement activities are planned and implemented with appropriate disclosure of information, meaningful consultation, and the informed participation of those affected.

- **Scope of application**

The ESS5 applies to all PAPs regardless of the total number affected, the severity of the impact and whether or not they have legal title to the land. Informal or traditional tenure is to be treated in the same manner as formal, legal titles. Therefore, this EIA covers permanent or temporary physical and economic displacement resulting from the following types of land acquisition or restrictions on land use undertaken or imposed in connection with project implementation:

- Land rights or land use rights acquired or restricted through expropriation or other compulsory procedures in accordance with national law;
- Land rights or land use rights acquired or restricted through negotiated settlements with property owners or those with legal rights to the land, if failure to reach settlement would have resulted in expropriation or other compulsory procedures;
- Restrictions on land use and access to natural resources that cause a community or groups within a community to lose access to resource usage where they have traditional or customary tenure, or recognizable usage rights;

- Relocation of people without formal, traditional, or recognizable usage rights, who are occupying or utilizing land prior to a project-specific cut-off date;
- Displacement of people as a result of project impacts that render their land unusable or inaccessible;
- Restriction on access to land or use of other resources including communal property and natural resources such as marine and aquatic resources, timber and non-timber forest products, fresh water, medicinal plants, hunting and gathering grounds and grazing and cropping areas;
- Land rights or claims to land or resources relinquished by individuals or communities without full payment of compensation; and
- Land acquisition or land use restrictions occurring prior to the project, but which were undertaken or initiated in anticipation of, or in preparation for, the project.

- **Compensation measures**

The Standard also requires that resettlement plans are implemented before any project-related impacts on project affected people. Therefore, the land acquisition, displacement or any restriction of access should not occur before necessary measures for resettlement and compensation are in place. For selected sites involving land acquisition, it is further required that these measures include provision of compensation and/or other assistance necessary for relocation, prior to displacement, and preparation and provision of resettlement sites with adequate facilities, where required. In particular, the taking of land and related assets may take place only after compensation has been paid, and where applicable, resettlement sites, related infrastructure and moving allowances have been provided to displaced persons. All activities project activities requiring relocation, loss of shelter or other impacts, the policy requires that measures to assist affected persons are implemented in accordance with the project resettlement plans of action.

- ✓ **ESS6: Biodiversity conservation and sustainable management of living natural resources**

ESS6 recognizes that protecting and conserving biodiversity and sustainably managing living natural resources are fundamental to sustainable development. Biodiversity is defined as the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems. Biodiversity often underpins ecosystem services valued by humans. Impacts on biodiversity can therefore often adversely affect the delivery of ecosystem services. The objectives of ESS6 are:

- To protect and conserve biodiversity and habitats.
- To apply the mitigation hierarchy4 and the pre-cautionary approach in the design and implementation of projects that could have an impact on biodiversity.
- To promote the sustainable management of living natural resources.
- To support livelihoods of local communities, including Indigenous Peoples, and inclusive economic development, through the adoption of practices that integrate conservation needs and development priorities.

- ✓ **ESS510-Stakeholder engagement and information disclosure**

This ESS recognizes the importance of open and transparent engagement between the Borrower and project stakeholders as an essential element of good international practice. Effective stakeholder engagement can improve the environmental and social sustainability of projects, enhance project acceptance, and make a significant contribution to successful project design and implementation. The objectives of stakeholder Engagement and information disclosure are:

- To establish a systematic approach to stakeholder engagement that will help Borrowers identify stakeholders and build and maintain a constructive relationship with them, in particular project-affected parties.
- To assess the level of stakeholder interest and support for the project and to enable stakeholders' views to be taken into account in project design and environmental and social performance;
- To promote and provide means for effective and inclusive engagement with project-affected parties throughout the project life cycle on issues that could potentially affect them;
- To ensure that appropriate project information on environmental and social risks and impacts is disclosed to stakeholders in a timely, understandable, accessible and appropriate manner and format.

3.4.3 Framework convention on climate change

This convention takes into account the fact that climate change has trans-boundary impacts. The basic objective of this convention is to provide for agreed limits on the release of greenhouse gases into the

atmosphere so as to prevent the occurrence of climate change. It also aims to prepare countries to minimize the impact of climate change, should it occur.

3.4.5 Convention on biological diversity

The convention on biological diversity has three goals. These are:

- Conservation of biodiversity;
- Sustainable use of the components of biodiversity; and
- Fair and equitable sharing of the benefits arising from the use of genetic resources. Rwanda has ratified this convention and all project developers are urged to implement the convention during project implementation.

3.5. GAP Analysis between the JICA guidelines and laws of Rwanda

This next table, summarizes gap analysis between national reulation and JICA guidelines for environmental and social consideration

Table 11: GAP Analysis between the JICA Guidelines and Laws of Rwanda

	JICA Guidelines	National Laws	Gaps	Policies/ measures applied to fill the gap
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.	No similar provisions in the Rwandan National Law.	Expropriation of land for public interest is regarded as inevitable and the affected persons shall be given fair and just compensation Article 3 of the expropriation law	Alternative analysis, including no project option and alternatives pipelines is conducted to minimize impacts of involuntary resettlement and loss of means of livelihood.
2	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken.	In the Rwandan National Law on expropriation, compensation of destroyed properties is considered	No gap identified. However, no measures to minimize impact of the displaced people are provided.	Alternative analysis, including no project option, is conducted to minimize impacts of involuntary resettlement and loss of means of livelihood. Compensation will be made for any loss caused by the project based on legislations of the country and JICA guidelines.
3	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be fairly compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels	There are no explicit provisions on livelihood restoration	The Rwandan legislation is silent on this matter.	Compensation will be based on full replacement costs and provided before resettlement. Assistance and supports will be provided to PAPs to restore their livelihood at least at its original level, if not better.
4	Compensation must be based on the full replacement cost as much as possible.	Compensation is calculated considering the size, nature and location and considering the prevailing market prices. (Article 22 of the Expropriation Law)	No gap is identified. Although the word "market price" used in the Expropriation Law actually includes any fees, costs, taxes, etc. hence it is actually the same as "full replacement cost."	Compensation will be based on the full replacement cost, including any fees and costs involved
5	Compensation and other kinds of assistance must be provided prior to displacement.	The Expropriation Law, Article 23 stated that compensation shall be awarded to the expropriated person before he or she relocates.	No gap. Compensation will be provided prior to relocation.	Compensation and other kinds of assistance will be provided prior to displacement.
6	For projects that entail	It is not indicated in the	No gap.	Since this project will not

	JICA Guidelines	National Laws	Gaps	Policies/ measures applied to fill the gap
	large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public	Rwandan National Law, however it is requested by the Rwandan Development Board to be mentioned in the EIA report		trigger a large scale resettlement, an ARAP will be prepared in accordance with Rwandan Laws and JICA guidelines
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance.	The expropriation law governs the specifics of land acquisition. The law provides for public dissemination on the importance of the project to be established and the need for expropriation. (Article 11, 12, 13)	No major gap.	Consultations with PAPs and communities will be conducted through the project preparation and before project implementation and will continue during the ARAP preparation. .
8	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.	The medium of exchange in Rwanda is Kinyarwanda and all Rwandans can hear and speak Kinyarwanda language.	No gap	Kinyarwanda will be used in consultation and Compensation payment agreements with PAPs will be prepared in Kinyarwanda.
9	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.	General Guidelines and Procedure for EIA states public participation in planning and decision making for the project.	There are no specific guidelines for participation of affected people in planning, implementation, and monitoring of RAP.	Consultations during EIA and ARAP preparation will be used as opportunities for public participation in ARAP planning, implementation and monitoring
10	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.	The expropriation law article 26 provides complaints procedures for individuals dissatisfied with the value of their compensation. The law stipulates that the dissatisfied person has a period of 30 days after the project approval decision has been taken to appeal (Article 19)	No gap.	An appropriate and accessible grievance mechanism will be established in the ARAP.
11	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12)	According to the Rwandan expropriation law, the census of the affected people is conducted as well as inventory of their properties at the beginning of the land survey, which is considered the cut-off date. (Article 17)	No gap in terms of conducting inventory and establishment of cut –off date. However, no socio-economic survey is conducted by government funded projects.	An initial baseline survey (including socio-economic survey) will be conducted based on WB OP 4.12 and JICA guidelines. A cut-off date for this project will be then communicated after project approval.
12	Eligibility of benefits includes, the PAPs who have formal legal rights to and (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the	The Rwandan legislation (organic land law 5, 6, 7) defines the eligibility as both formal (legal) and informal (customary) owners of expropriated land. Article 18 of the Expropriation law	There is a gap. The Rwandan legislation does not specifically recognize all users of land to be expropriated while OP 4.12 chapter 14(a),(b),(c) entitles	Follow the OP 4.12 guidelines and principles. Eligibility to benefits includes both formal and informal owners of land and owners of other assets affected by the Project.

	JICA Guidelines	National Laws	Gaps	Policies/ measures applied to fill the gap
	time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	considered in addition to legal documents, a document or testimony of the neighbours confirming ownership for the land as an evidence	those with formal legal rights to land, those with no formal legal rights to land and those who have no recognizable right or claim to the land they are occupying.	
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are Land-based. (WB OP4.12 Para.11)	Article 23 of the expropriation law provides for fair and just compensation and it stipulates that this could be monetary or an alternative land or a building equivalent to the determination of just monetary compensation	No major gap.	Discussion with PAPs will be held to opt for compensation measures either being for full payment compensation or land to land compensation or monetary based compensation.
14	Provide support for the transition period (between displacement and livelihood restoration).(WB OP 4.12 Para.6	There are no explicit support for transition period and livelihood restoration	The Rwandan legislation is silent on this matter.	Since full compensation is envisaged to be by cash transfer payment, there will be no need for support during transition period. It shall be observed that property can only be acquired after PAP has been paid
15	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	No clear provision on the vulnerable groups among those displaced	The Rwandan legislation is silent on this matter.	No vulnerable groups were found in this project areas hence would not applicable
16	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)	No indication in the Rwandan National laws	The Rwandan legislation is silent on this matter	PAPs were fewer than 200 people (only only 9 households were identified) hence the ARAP for the project will be prepared.

CHAPTER IV: BASELINE DATA AND CONSIDERATIONS

This chapter presents physical, biological and socio-economic baseline data of the project area and was made in order to ascertain environmental and socio-economic baseline conditions and then assess the impacts as a result of the proposed project. Data presented are from different sources of information including field survey, literature review, interviews with local population and stakeholders, etc. Despite the pandemic of COVID- 19 that handicapped the formal meeting gathering with local population and residents; different discussions were held during the site visits with the local population and authorities, project affected persons and local government/non-government organisations in formal or informal way and this provided very useful information that are presented in this report. Other sources of information related to line routes of the pipelines, project facilities, size, project designs and locations were collected from the Feasibility Study of the project elaborated by JICA study team.

4.1 Physical environment

4.1.1 Topography

The topography of project area is characterized with by a mixture of plateaus with an altitude varying between 1340 m and 1700 m and undulating hills dominated by varying heights. The relief is also constituted by a succession of low-plateaus with hills and dry valleys. The groundwater influence area is located in a wetland with flat topographical characteristics whereby the altitudes vary between 1480 m (AMSL) and 1350 m (AMSL). The wetland is surrounded by gentle hill with a high elevation of 1540 m (AMSL).

4.1.2 Geology

The project area is situated in the zone of the contact between the quartzite of Nduba and the Musha, Nyabugogo and Birenga formations. Those meta-sedimentary rocks comprise mainly quartzite, sandstones, quartz-phyllites and phyllites of mid – Proterozoic. Towards the West, they have been intruded by the so called Bugesera tin-granite. Besides the folding structures, the area is surrounded and cross-cut by N-S open faults.

The host rocks are schists of Bulimbi formation which often become black shales, quartz- phyllites, medium to coarse-grained sandstones and re-crystallized quartzite of Musha and Nyabugogo formations, hard and massive quartzite of Nduba Formation on the top of which the conglomeratic layers of Rukomo formation. Those meta-sedimentary rocks of mid- Proterozoic age were intruded by two S-types granites (Bugesera and Mugesera) which are likely the source of the mineralizing fluids. The rocks found in the project area are of the middle and upper part of the Rwanda Super group of Mesoproterozoic age. The details of the stratigraphic units are described below, from the oldest to the youngest formation.

- **Rukira formation:** Comprises metapelite - dominated packages of thinly stratified and laminated layers of schists with locally black shales: tourmaline chlorite schists and whitish to dark beige sericite schists underlying dark, ferruginous and silicified schist, fine-grained sandstones and siltstones.
- **Kibaya formation:** Comprises 10m to 200m thick of continuous sandstones and hard layers of quartzite appearing along several outcrops. These latter are whitish in colour, well sorted medium to coarse grained and show sedimentary structures such as ripple marks, cross-stratification and oblique laminated beds.
- **Ndamira formation:** Contains zoned clayish schists, siltstones and alternation of isolated lenses of schists, fine to coarse grained sandstones and lithic conglomerates.
- **Kibungo formation:** sparsely distributed small outcrops of quartzite or medium to coarse grained sandstones have been identified further west of Rwinkwavu anticline on the left side of the main road Kayonza-Kibungo-Rusumo-Tanzania
- **Birenga formation:** the silt-schist-dominated formation of Birenga with some quartzite is not found in the direct environment of Rwinkwavu anticline and overlies the formation of Kibungo. The outcrops of Birenga formation are rare and mostly found on the right side of the road Kayonza-Kibungo-Rusumo-Tanzania in the vicinity of Kabarondo.
- **Quaternary:** represented by undifferentiated Holocene and Pleistocene with several tens of meters of recent alluvial sediments deposited by rivers and/or erosion.

4.1.3 Weather conditions in project area

The Masaka Water Treatment Plant area as well as the rest of the area of intervention enjoys four seasons: two rainy seasons and two dry seasons spread out as follows: - short dry season: December, January, and February; - long rainy season: March, April, May; - long dry season: June, July, August, September; -

short rainy season: October, November. These four seasons are the common characteristics of the climate across the country. As these seasons are often irregular due to climate changes, lower or higher limits of each season cannot be determined accurately. The rainy season may drag on into the dry season and the other way round. Average temperature is 22°C for a rainfall varying between 900 and 1150 mm of annual rain.

According to the EIA results for Kanzenze Water treatment plant located in the vicinities of Masaka WTP, the rainfall data collected from a group of 44 rainfall stations closer to the study area and from the Rwanda Meteorological Agency and .by using the Gumbel distribution in the project catchment, the extreme rainfall events and their return periods for the catchment are given in the table below:

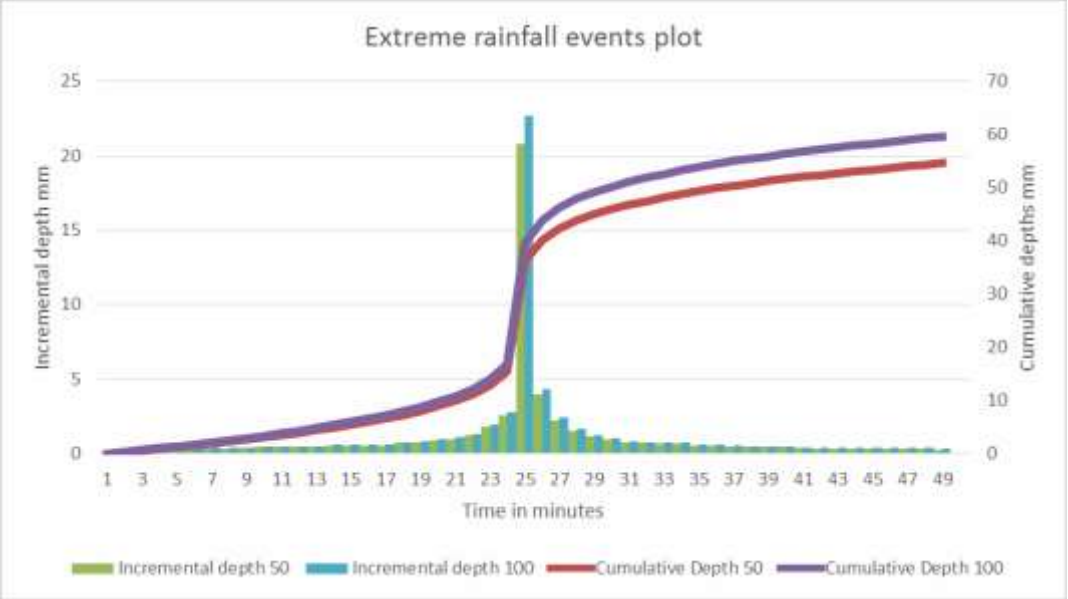
Table 12: Extreme rainfall events in the catchment of interest

Return Periods T=1/(1-PL)	PL	Y	Rainfall events
50	0.98	3.901938658	54.6
100	0.99	4.600149227	59.6

Source: EIA Kanzenze WTP,2018

The resulting extreme rainfall events in the catchment of the project area, with a temporal resolution of 30 minutes, are provided in figure below with their respective return periods.

Figure 16: Extreme rainfall events of the catchment of interest



Source: EIA, Kanzenze WTP,2018

4.1.4 Air pollution in project area

The Masaka WTP site is located in the neighbourhoods with similar characteristics of rural areas where the ambient air is relatively not polluted based on the surrounding activities and daily human business. Even if no measurement related to air quality have been conducted in the project area, it is expected that the implementation of this project may cause air pollution in its surroundings and impact on environment and people's health.

The main sources of air pollution may result from combustion fuels via transportation of construction materials and workers, use of machinery, excavation works, and construction activities. The mitigation measure to avoid air pollutions and related impacts were provided in this report highlighting mitigation measure of identified impacts.

4.1.5 Characteristics the catchment of the project area

According the National Water Resources Master Plan (2014), the present project is located in the Upper Akagera catchment. The Upper Akagera catchment commences at the confluence of the Lower Nyabarongo and the Akanyaru Rivers and belongs to the Nile basin. The first half of the catchment is located within Rwanda but after Lake Rweru, the Akagera River forms the boundary between Rwanda and Burundi. The principle tributaries cum lakes of the Upper Akagera catchment are Lake Mugesera and

Rweru, the Nyabarongo River, and finally the Ruvubu River which takes its water exclusively from Burundi and Tanzania and enters the Akagera just upstream of Rusumo falls. The upper Akagera catchment is characterized by the following hydrological data:

Table 13: Summary of hydrological data of upper Akagera catchment

Catchment name	Surface area (km^2)	Renewable resources (000 m^3)	Potable water supply use (000 m^3)	Irrigation water use (000 m^3)	Total water use in (000m^3)	Av. annual rainfall(mm/yr)	Av. annual evaporation (water balance) [mm/yr]	Av. annual surface water runoff [mm/yr]	Av. annual ground water recharge [mm/yr]	Ground water volume storage [MCM]
Upper Akagera	2,939	504,000	9,776	16,034	25,809	925	760	165	115	3580

Source: Rwanda Water Master Plan, 2014

The Project of construction of Masaka Water Treatment Plant will be carried out in the Upper Akagera catchment at almost 5km downstream the New Constructed Kanzenze Water Treatment Plant. There is no any other river or stream that confluences the Akagera before reaching the project site. the surrounding catchment is used for rice plantation of the side of Bugesera district and the other side of Kicukiro District is dominated by papyrus plantations.

4.1.6 Water quality of the project area

Considering the fact that no water quality information for the surface water and ground water at Masaka, water quality surveys have been conducted and the results are summarized in next table.

Table 14: Summary of Water Quality Survey at Masaka

No.	Sampling No.	Unit	Dry Season		Rainy Season		RDWQS [1]	WHO (2017)
	Sampling Date		2019/09/12	2020/11/10	2021/02/19	2019/09/12		
	Sampling Type		Nyabarongo River	Ground Water	Nyabarongo River	Ground Water		
1	pH	-	7.09	7.51	7.17	6.61	6.5-8.5	-
2	Turbidity	NTU	512 [2]	21	1,650	18	5	5
3	Electrical Conductivity		-	292	-	257	1,500	-
4	BOD_5	mg/L	10.8	-	16.65	22 (COD)	-	-
5	Ammonia nitrogen (NH_4-N)	mg/L	0.23	0.73	0.502	0.279	0.5	-
6	Nitrate nitrogen (NO_3^--N)	mg/L	0.16	1.03	1.244	1.425	10	11.3
7	Nitrite nitrogen (NO_2^--N)	mg/L	<0.002	0.07	0.054	0.013	0.001	0.9
8	Fluoride (F^-)	mg/L	0.32	0.49	0.13	0.80	1	1.5
9	Manganese (Mn)	mg/L	0.015	3.12	0.150	3.037	0.1	0.4
10	Iron (Fe)	mg/L	0.16	2.91	1.91	6.70	0.3	0.3
11	Zinc (Zn)	mg/L	0.18	-	0.24	-	-	-
12	Calcium (Ca)	mg/L	5.6	15.62	9.74	18.10	150	-
13	Magnesium (Mg)	mg/L	8.3	11.46	9.21	14.13	100	-
14	Chloride (Cl^-)	mg/L	-	22.2	-	14.2	-	-
15	Standard plate count bacteria	cfu/ml	5×10^4	8.5×10^4	1.4×10^6	3.2×10^5	100	-
16	E. coli	cfu/ 100ml	4×10^1	1.9×10^1	1×10^5	8×10^3	-	-
17	Cyanide (CN^-) [3]	mg/L	<0.001	-	<0.001	-	0.01	0.5
18	Chromium (Cr^{6+}) [3]	mg/L	<0.005	-	0.014[4]	-	0.05	0.05
19	Cadmium (Cd) [3]	mg/L	<0.0003	-	<0.0003	-	0.003	0.003
20	Lead (Pb) [3]	mg/L	0.007	-	0.018	0.002	0.01	0.01
21	Mercury (Hg) [3]	mg/L	<0.00005	-	0.00008	-	0.001	0.006
22	Arsenic (As) [3]	mg/L	-	0.003		0.006	0.01	0.01

Source: JST , 2021

1) RDWQS: Rwanda Drinking Water Quality Standard
2) 512 means the value exceeding Rwanda Drinking Water Quality Standard
3) Items analyzed in Japan.
4) Total Chromium

Based on the results of above table, the target treatment compounds have been identified and their treatment methods are also studied as shown in below table.

Table 15: Summary of target water quality compounds and their treatment methods

No.	Target Compounds	Pollution Level	Unit Treatment Process	Remark
1	Turbidity	Low (18-21)	Coagulation-sedimentation, filtration, membrane	
2	Ammonia nitrogen (NH_4-N)	Low-Middle (0.28-0.73)	Aeration, biologic treatment, chlorination	
3	Nitrite nitrogen (NO_2^--N)	Low (0.01-0.07)	Aeration, biologic treatment, membrane	
4	Iron (Fe)	Middle-High (2.91-6.70)	Coagulation-sedimentation, biologic treatment, chlorination, contact oxidation	
5	Manganese (Mn)	High (3.04-3.12)	Coagulation-sedimentation, biologic treatment, chlorination, contact oxidation	
6	Bacteria	Middle (10^4-10^5)	Coagulation-sedimentation, filtration, O_3, UV, chlorination, membrane	

Source: JST 1) Microscope observation, but no Species and quantitative analysis

4.1.7 Potential source of Pollution in Project area and on-going mitigations

The Project will use raw water from Akagera River ground water recharge and the project is located downstream of Kigali City. The Nyabarongo river which receives other inflows stream located upstream the project site and passing near Kigali City may also contribute to the site pollution via channelling the municipal, industrial and domestic waste to the Project site. These streams include Nyabugogo river which receives other inflows streams like Mwange, Rusine and Marenge on its upstream and later on the Nyabugogo river is joined by others inflows streams that cross the Kigali city urban area namely Rwanzekuma, Ruganwa, Mpazi and Yanze. The main source of pollution of these stream include agricultural activities, industrial activities, mining activities (in Rulindo and Gasabo District) and other handcraft activities such as garages etc.

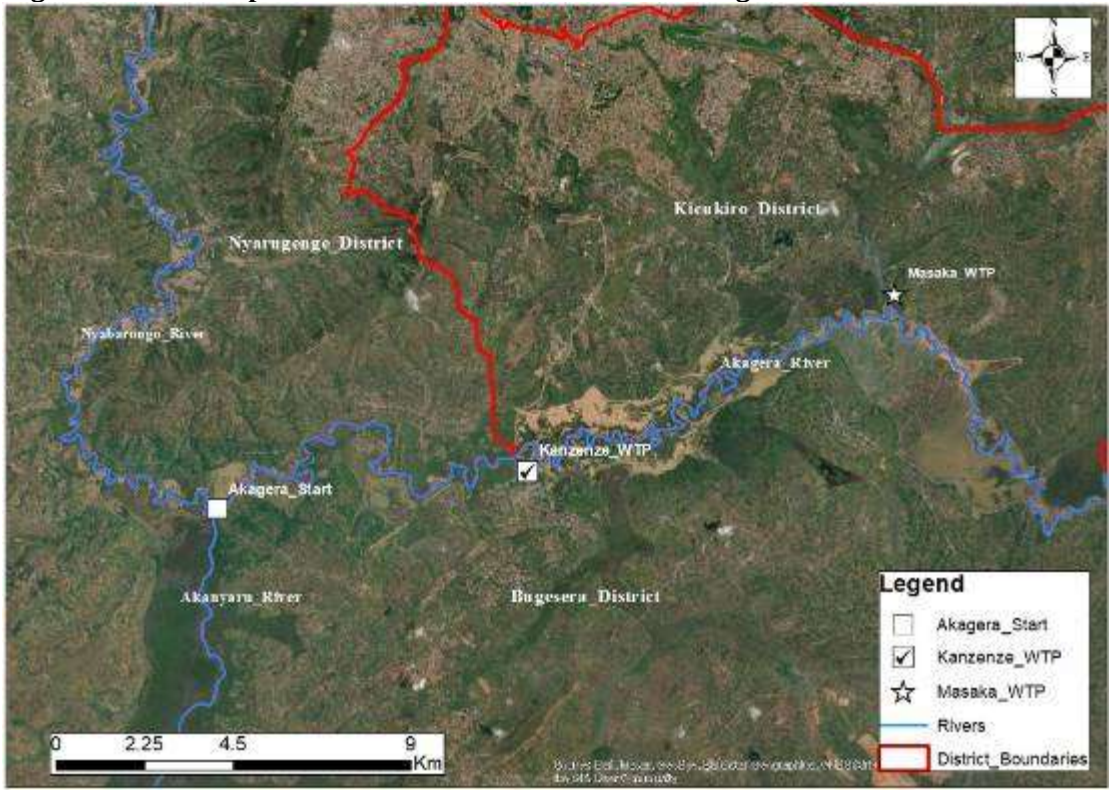
To this extent, some initiatives to combat water pollution within the tributaries of Akagera River have been developed by the GoR and Kigali City and are under implementation. Among them include:

- Relocation of Gikondo Industrial Park to Kigali Special Economic Zone (KSEZ) located in Masoro Sector, Gasabo District.
- Relocation of Nyabugogo garages from Nyabugogo Swamp to the new locations in Gatsata Sector
- Rehabilitation of the Nyabugogo Swamp
- Trees plantation and erosion control around the tributaries of Nyabarongo River
- Establishment of 10 m buffer away from all stream from rivers.

4.1.8 Land use and activities in the project area and its surroundings

The project area (WTP location) and its surrounds is used mostly dominated by agricultural activities. The rest is made of wetland that remains unexploited and dominated by papyrus plantations. There is no human settlement around the project site despite being noted that the area is dedicated to residential areas as per the zoning plans of the Kigali Master Plan 2050. The other notable activity located upstream of the project site is Kanzenze Water treatment Plant as described in the previous sections. There is also intensive cultivation of some sugar cane done longest the Nyabarongo River. The figure bellow illustrates the project site and its surroundings.

Figure 17: Aerial photo for land use and activities in ground water area of influence



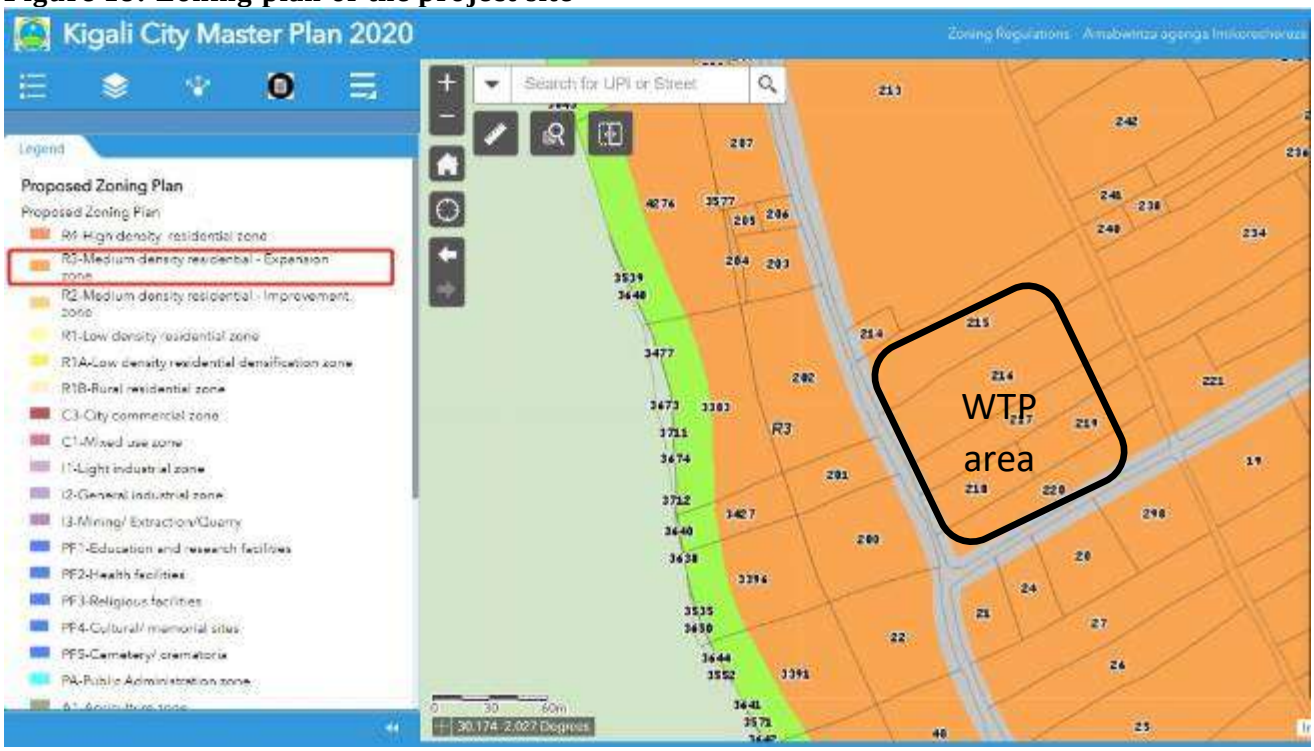
Source: Google Map, adapted by BESST Ltd, June 2021

4.1.9 Zoning plan of the project area

As per the new Kigali land Use Master Plan 2050 the project site is zoned in the expansion zone for Medium Density Residential (R3). The Medium Density Residential - Expansion Zone (R3) is established to allow for intensification and redevelopment of peri-urban and green field areas through extensive housing strategies to provide variety of housing solutions. This zone is expected to stimulate development of low-cost incremental housing in special redevelopment or greenfield areas. The purpose of R3 zone is to facilitate the provision of housing dedicated to the low-income segment of the population, by providing low-rise, higher-intensity developments in green field sites of the City. To ensure mix of use and mix of income, several housing solutions are allowed. Implementation mechanisms shall be identified by CoK and Government Agencies to allow for the creation of economies of scale in the development of this Zone.

However considering that Masaka WTP is planned to be on a small surface area and considering the hall zoned area for residential; as well as taking into consideration the importance of having the present project in the area as discussed in the chapter of alternatives, it is recommended that WASAC Ltd, City of Kigali together with other involved institutions have to agree and issuing a special authorization permit to allow the construction of Masaka WTP at the area. It is no doubt that the plant will also supply the clean water to the rest of the households of the project area. The figure below illustrates the zoning plan of the project site.

Figure 18: Zoning plan of the project site



Source: Kigali City Master Plan 2050

4.1.10 Environmental flow

Environmental flow assessment is an assessment of how much of the original flow regime of a river should continue to flow down it and onto its floodplains in order to maintain specified, valued features of the ecosystem hydrological regimes for the rivers, the environmental flow requirements, each linked to a predetermined objective in terms of the ecosystem's future condition. In general, the minimum flow is that which is required downstream for agriculture, water adduction for drinking water and industry, dilution of pollution, and the sustainability of aquatic life. There are different methodologies to calculate environmental flows and these include:

- Hydrological methods;
- Hydraulic rating methods;
- Habitat rating method, and
- Holistic methods.

Each method has advantages and disadvantages and the choice of the method must take into account the environmental concerns to be addressed and the specific characteristics of the river being studied.

- **Approach for determining environmental flow**

The Tennant (or Montana) method has been retained for determining the environmental flow. This is a hydrological method and it has been adopted because the slope of the river in the short-circuited stretch of the river is more than 1%, creating hydraulics conditions where it is not possible to conduct safe bathymetric surveys that are necessary to apply other methods. Hydrological methodologies use flow duration or mean discharge to scale down the natural flow regime and the Tennant (or Montana) method (1976), is the most common method applied worldwide. Since the flow affects many important environmental conditions as depths, velocities, wet perimeter, etc. it is used to describe the general conditions of the environment. The percentage of mean annual flow is assumed to roughly describe aquatic habitat conditions. For example, Tenant suggests the following interpretation:

Table 16: Tennant (Montana) method for environmental flow estimation

General condition of flow	Recommend flow regime (%of MAF*) October to March	Recommend flow regime (% of MAF*) April to September
Flushing or maximum	200%	200%
Optimum range	60-100%	60-100%
Outstanding	40%	60%
Excellent	30%	50%
Good	20%	40%
Fair or degrading	10%	30%

The study area is near the hydrological stations of Kanzenze 70004, Ruliba 70005 and Ngaru 70008. Hydrological data for those three stations allow a better understanding of surface and groundwater

variation. The study area is also included in the NAKU catchment according to the delineation from the recent concluded Integrated Water Resources Master Plan. The station 70004 collects the runoff from the Nyabarongo and the Akanyaru rivers.

The hydrometric station named Kanzenze station located near the Bugesera Bridge represent all the upstream runoff contribution coming from the Nyabarongo Upstream, Nyabarongo downstream and Mukungwa catchments. From the available time series of the Kanzenze station, a daily average flow was estimated in order to understand the upstream area contribution in the area of interest. The runoff coming from upstream catchments flows through the area of interest which a very flat wetland around the Bugesera Bridge and therefore contributing to flooding the wetland and replenishing the groundwater in the area of interest. It is clear from figure 5 that the peak flows are mostly located in the end of the month of May with flow rates of around 600 cubic m per second. Low flows are located in the end of August with flow rates of around 20 cubic meters per second.
At the project area, Kanzenze gauging station (1973-1913) the monthly flow rates are summarized as follows:

- Average mean annual flow rate is 193.3 m^3/s;
- Average maximum annual flow rate is 620.3 m^3/s
- Average minimum annual flow rate is 20.1 m^3/s

- **Adopted minimum environmental flow**

A minimum water flow of 19.3 m^3 /s is proposed. This flow represents 10% of the average flow (for the period 1973 – 2013) of the river. This minimum flow should allow fair conditions for maintaining the environmental conditions according to the Tennant (or Montana) method. The adoption of the 19.3 m^3/s is supported by the fact that:

- The Akagera River behaves as a temperate river (and not a tropical river) and the minimum environmental flow for temperate rivers is in general 10%
- The flow of the river is already regularized by the upstream marshes so it is not necessary to have different minimum river flows for dry season and wet seasons;

The adoption of 10% is considered to be largely sufficient to maintain the environmental conditions to an acceptable level. It may be possible to reduce the minimum environmental flow in order to increase power production. It's worth to note that 40,000m^3 /d represent approximately 2% of dry flow.

4.1.11 Ground water assessment

The hydro-geological study focused on assessment of groundwater resources at well field location. According to the Paster Plan for water resources, the study area is located in upper Akagera catchment which is sub-divided into:

- **The quartzite aquifers:** the quartzite aquifer has an intermediate storage and provides access to groundwater.
- **The schist-aquifers:** the central part of the basin is dominated by schists with low storage.
- **The alluvial aquifers:** the alluvial aquifers mainly have an organic matrix; their use for groundwater abstraction is difficult due to water quality issues (low oxygen content, mobility of metals). The alluvial aquifer acts as storage for the catchments downstream.

As described in Table 12 and as per the Water Resources Master Plan, Masaka WTP is located in the NAKU catchment with the average annual surface water runoff of 165 mm/yr, the Av. annual ground water recharge of 115 mm/ year and 3580 MCM of groundwater volume storage.

4.1.12 Water availability and impact of water abstraction in the project area

The availability of groundwater resources at the project areas of intervention is on one hand confirmed by the geology of the area and by the data from Kanzenze gauging station
The assessment of flows indicates that there is plenty of water in the Akagera River to meet projected demands in Kigali, and that abstractions would be very unlikely to have significant impacts on downstream users.

According the data recorded by MINIRENA, 2012 and 2013; the maximum daily discharge of 196 m^3/s was observed at the station. . For the year 2012 the minimum daily discharge observed was of 62.4 m3/s and that the mean discharge of 2013 was significantly much larger than normal and the maximum of 329 m3/s was observed According to AQUASAT 2005, the natural renewable water resources for Akagera catchment, for the year 2000 were estimated to be 6.3 km^3/yr, compared to 5 km^3/yr for 1993, a marked increase in the resource. Per capita annual renewable water resources also increased from 638.2

m^3/person/yr in 1993 to 815 m^3/person/yr in 2000. In light of population increase and subsequent increase in withdrawals over the years, other factors such as the long rainy season and increased inflow from outside the country could explain these increases.

The reduction of total annual withdrawals from 0.768 km^3/yr in 1993 to 0.15 km^3/yr in 2000 even with the increase in the total renewable resources indicates a reduced capacity to utilize the available water resources within the catchment. The amount of available water increased in 2000 but less was used, even though the population had increased, as compared to 1993 where the amount available was less. As a result of this reduction in water withdrawals and population increase from 1993 to 2000 the per capita annual withdrawals falls from 141 to 17.4 m^3/person/yr in that period (AQUASAT, 2005).

4.2 Biological and ecological data

4.2.1 Methodology

During the conduct of the present study, the ecological survey followed three main steps. The first step consisted of desktop work. During this phase, a literature review was undertaken. Species lists, species databases, existing documents, and previous studies and assessments for Rwanda (with much focus on the study area) were consulted. As output, a list of species that occur, or could occur, in the study area based upon their habitat affinities and ranges were established. The second step consisted of field survey where data on species and diversity were collected based on standards survey methods as per animal taxa and plant species; and were recorded on pre-designed datasheets. The last step included data entry, processing, analysis and report writing.

4.2.2 Setting up sampling units

The project area was divided into 3 components: Water Treatment Area, Water Intake Area and Pipeline and Storage Area. The 3 components were considered independently as separate sampling units. ***The Water Treatment Area*** was defined as the water treatment plant and its surrounding area within 1-kilometer radius. ***The Intake Area*** or the wellfield was defined as the location of the wellfield and its surrounding swamp which includes Akagaera River. Lastly the ***Pipeline and Storage Area*** was the area around 100-meters around pipeline and planned water reservoirs. This exclude the part of the water pipeline from the wellfield to the water treatment plant since it is covered under Intake area.

Two reconnaissance routes were established. One was established within the Water Treatment Area, while another was established within the swamp along Akagaera River. For the pipeline and storage area, the area was divided into 3 segments: the central segment covering Muyumbu Sector, the eastern covering Gahengeri Sector and the western segment covering Nyakaliro Sector. For each segment, we selected area for sampling using satellite imagery and we ensured that sampling area was most representative of the whole segment in terms of physical and ecological conditions. For each selected area, we walked along the proposed pipeline area recording plant and animal species diversity.

4.2.3 Data collection on Fauna

✓ **Birds**

Two (2) methods were used for data collection on birds. The first method consisted of **point counts**, where observation points were established at an interval of 200 meters along the reconnaissance route. At each point the observer waited for three (3) minutes to allow birds to settle down and then record all sightings and calls of birds for a period of 10 minutes (Sutherland, W. 2000). The observers then moved on to the next point and repeated this same process. The second approach consisted of opportunistic sampling where all bird species seen or heard were recorded. For bird species identification, we used the identification keys provided by Stevenson & Fanshawe (2002).

✓ **Amphibians and reptiles**

Visual Encounter Sampling (VES) approach was used. According to this approach, each amphibian reptile encountered along the reconnaissance route was recorded. In case the species was not identified at place, a description of the species was made and photographs were taken for further identification.

✓ **Fishes**

We relied on information provided by local community members, especially those involved in fishing in Akagaera River. We asked them the vernacular names of fish species living in Akagaera River. Vernacular names of species were then cross-checked to find their equivalent in English and their species names from different reports and fish database in Rwanda.

✓ **Other species**

For other species taxa, mainly mammals, data were recorded along established reconnaissance routes. All signs including animal sighting, animal voices and other signs including dung, footprint or spoor, hairs, digging and nests were recorded. In addition, we relied on local community knowledge about species occurring in the area.

4.2.4 Data collection on Flora

For surveying flora, 2 methods were used. The first method consisted of recording all plant species in a 10x10 meter plot that were established in both the Water Treatment Plant Area and the Intake Area (swamp around Akagaera River). The plots were established in a most representative area of the study area in terms of physical and ecological conditions. The second method consisted of recording any new plant species encountered along the reconnaissance routes that were established during fauna survey. For the pipeline area, data was collected along the proposed pipeline location, while for the storage Area, data was collected in a 100-meters radius around the area proposed for water reservoir construction. These both methods helped in maximizing the number of plant species to be recorded. All plant species encountered were recorded. '**Flore du Rwanda**' in 4 volumes (Troupin 1978, 1983, 1985, 1988) were used as the main source for plant species identification. The circumscription of plant families followed APG (2009).

4.2.5 Assessing conservation status of species

For assessing the conservation status of each species, the IUCN Red List of Threatened Species, version 2020-2 (IUCN, 2020) was used. In addition, the ministerial order No 007/2008 of 15/08/2008 establishing the list of protected animal and plant species was consulted to identify plant and animal species protected in Rwanda. Birds were given a special attention since Nyabarongo is located in the "Important Bird Area" (IBA). Any endangered or listed species on IUCN red list or any species protected in Rwanda were highlighted and brought to the client's attention.

4.2.6 Data processing and analysis

All collected data were entered in Excel sheets and analyzed. Species lists along with species conservation status and their occurrence location were produced.

4.2.7 Survey findings

The overall Project Area, including Wellfield area , Water Treatment Plant Area and Pipeline and Reservoir Area is characterized by the following main habitat types: (i) anthropic landscape dominated by agriculture and human settlement, (ii) swamp and aquatic vegetation around Akagaera River.

A total of 56 plant species were recorded in the project area. These are divided into 20 orders and 28 families. Details on plant species are provided in the annex. The sections below provide details on the flora composition per each project components.

✓ **Water intake area**

The Water Intake Area consists of the Akagaera River and its surrounding swamp. The swamp in the project area has been affected by human activities. It is dominated by sugarcane plantation (***Saccharum officinarum***) at the large extent and some Napier grass (***Pennisetum purpureum***). Other natural plant community are dominated by Papyrus Sedge ***Cyperus papyrus***, Giant Reedmace ***Typha latifolia***, ***Vossia cuspidal, Echinochloetum pyramidalis*** and woody shrubs of ***Mimosa pigra***. The other swamp and aquatic plant species included ***Polygonum pensylvanicum***, ***Phragmites mauritianus, Salvia nilotica, Sesbania sesban,*** etc. The most common floating aquatic vegetation recorded was the non-native invasive species commonly known as Water Hyacinth (***Eichhornia crassipes***).

✓ **Water treatment plant area**

The Water Treatment Plant Area is located in the within the anthropic landscape which is dominated by the cow farms and agriculture land. The cow farms consist of several natural plant species including: ***Haplocoelum foliolosum, Sapium ellipticum, Grewia similis, Hypericum revolutum, Euphorbia candelabrum, Markhamia lutea, etc.*** The side close to the swamp is dominated by seasonal food crops including beans, maize, sorghum and others

✓ **Pipeline and Reservoir Area**

A small section of the proposed pipeline area is located in the intake area (in the swamp) and will consist of pipes that will carry water from the wellfield to the Water Treatment Plant. The largest section of the pipeline and Reservoir Area are located in the in the anthropic landscape dominated by agriculture and human settlement. Dominant species include banana plantation with scattered ***Markhamia lutea*** trees and forest woodlots dominated by ***Eucalyptus, Grevillea robusta,*** and ***Pinus spatula.*** Bush thickets around the

road and in several areas are dominated by ***Lantana camara, Vernonia amygdalina*** and several other species. Crops include seasonal crops such as beans, maize, potatoes, sorghum, cassava, etc.

Figure 19: Flora of the project area

Haplocoelum foliolosum

Hypericum revolutum

Erythrina abyssinica

Cyperus papyrus

Phragmites mauritianus

Agave sisalana

Acacia kirkii

Triumfetta sp.

Saccharum officinarum

Mimosa pigra

Lantana camara

Source: Field survey, 2021

✓ **Birds**

During the field survey, a total of 17 bird species were recorded. These belong to 7 orders and 15 families. Passeriformes were the most represented among these 7 bird species found in all project locations: Water Treatment Plant area (WTP), Pipeline and Storage Area (PSA) and Intake Area (IA), while 5 species were found in two project locations (WTP, PSA). In addition, 4 bird species were recorded only in the swamp (IA).

The most common species recorded in the WTP and PSA included Slender-Billed weaver ***Ploceus pelzelni***, African-Pied Wagtail ***Motacilla aguimp*** and Common Grey-Headed Sparrow ***Passer griseus.*** Other species recorded included Red-winged blackbird ***Agelaius phoeniceus***, Cape sparrow ***Passer melanurus***, Blue cheeked Bee-eater ***Merops persicus***, etc. In the Nyabarongo swamp (IA), the most recorded species included: Cattle Egret **Bubulcus ibis** and Black-Headed Heron ***Ardea melanocephala***, which are considered as water birds. The birds recorded in the projet areas are given in the table below:

Table 17: Bird species in project area

No.	Location - Project component*	Order	Family	Scientific Name	Common Name	Vernacular Name	IUCN Redlist Status**
1	IA, WTP, PSA	Passeriformes	Ploceidae	*Ploceus pelzelni*	Slender-Billed weaver	Isandi	-
2	WTP, PSA	Passeriformes	Passeridae	*Passer griseus*	Common Grey-Headed Sparrow	Igishwi	LC
3	WTP, PSA	Passeriformes	Motacillidae	*Motacilla aguimp*	African-Pied Wagtail	Inyamanza	LC
4	IA, WTP, PSA	Passeriformes	Laniidae	*Lanius excubitoroides*	Grey-Backed Fiscal	Rubamba	LC
5	IA, WTP, PSA	Passeriformes	Icteridae	*Agelaius phoeniceus*	Red-winged blackbird	Makote	LC
6	IA, WTP, PSA	Passeriformes	Passeridae	*Passer melanurus*	Cape sparrow	Uruhuri	LC
7	IA	Pelecaniformes	Ardeidae	*Bubulcus ibis #*	Cattle Egret	Inyange	LC
8	WTP, PSA	Passeriformes	Estrildidae	*Lagonosticta rubricata*	African Firefinch	Ifundi	LC
9	WTP, PSA	Accipitriformes	Accipitridae	*Milvus migrans*	Black kite	Sakabaka	LC
10	WTP, PSA	Passeriformes	Corvidae	*Corvus albus*	Pied Crow	Icyiyoni	LC
11	IA, WTP, PSA	Coliiformes	Coliidae	*Colius striatus*	Spickled	Umusure	LC

No.	Location - Project component*	Order	Family	Scientific Name	Common Name	Vernacular Name	IUCN Redlist Status**
					Mousebird		
12	IA	Passeriformes	Nectariinidae	*Hedydipna collaris* #	Collared sunbird	Umununi	LC
13	IA, WTP, PSA	Accipitriformes	Accipitridae	*Accipiter melanoleucus*	Great sparrowhawk	Agaca	LC
14	IA	Charadriiformes	Charadriidae	*Ardea melanocephala* #	Black-Headed Heron	Uruyongoyongo	LC
15	IA	Columbiformes	Columbidae	*Streptopelia semitorquata*	Red-eyed dove	Inuma (intunguru)	LC
16	IA, WTP	Coraciiformes	Coraciidae	*Coracias caudatus*	Lilac-breasted roller		LC
17	IA, WTP, PSA	Coraciiformes	Meropidae	*Merops persicus* #	Blue cheeked Bee-eater	Umusamanzuki	LC

*** Location - Project component| IA =Intake Area, WTP = Water Treatment Plant, PSA = Pipeline and Storage Area**

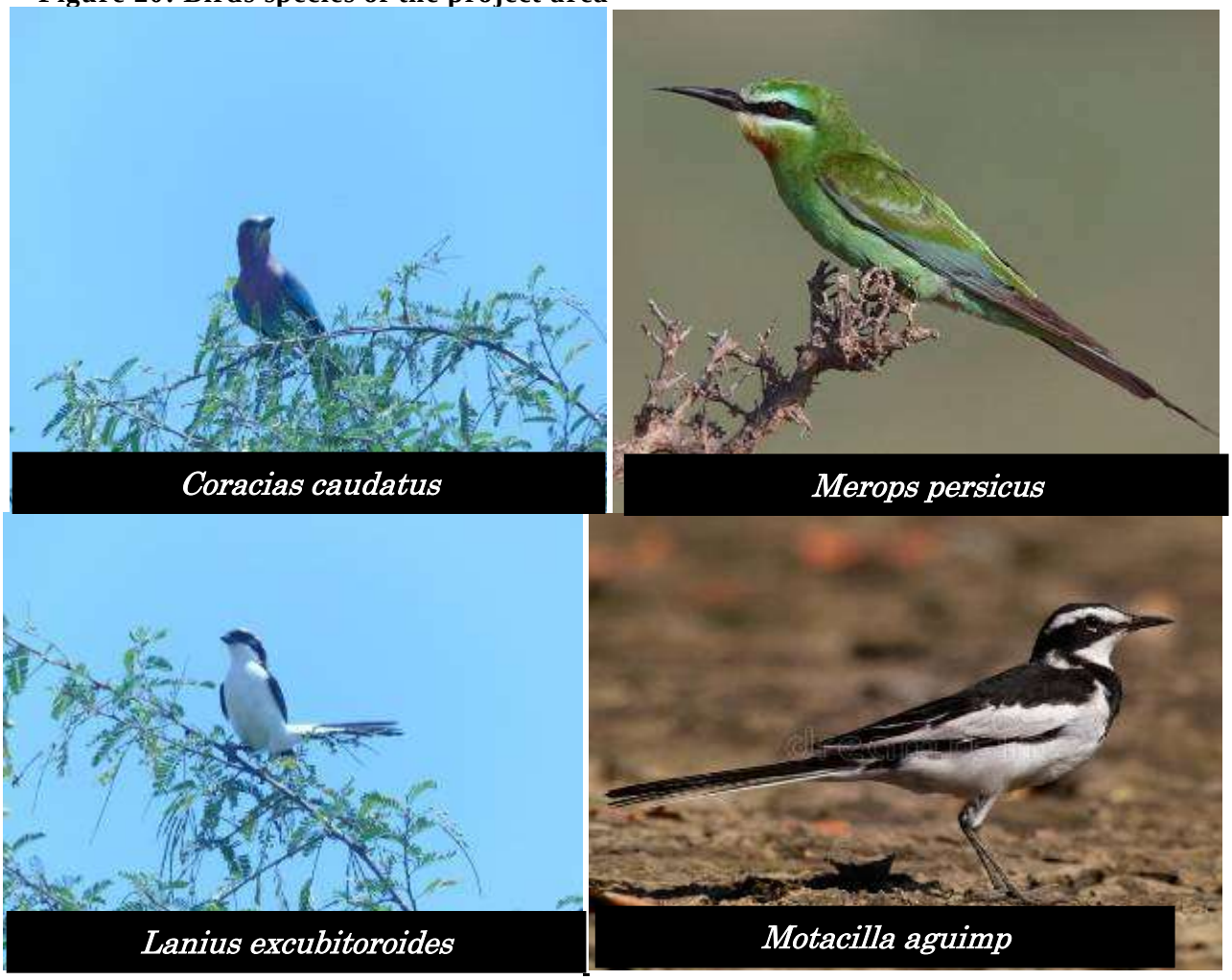
**** IUCN Redlist status| LC = Least Concern, - = not currently assessed by the IUCN Redlist**

 # Protected species by the Ministerial Order N°007/2008 of 15/08/2008

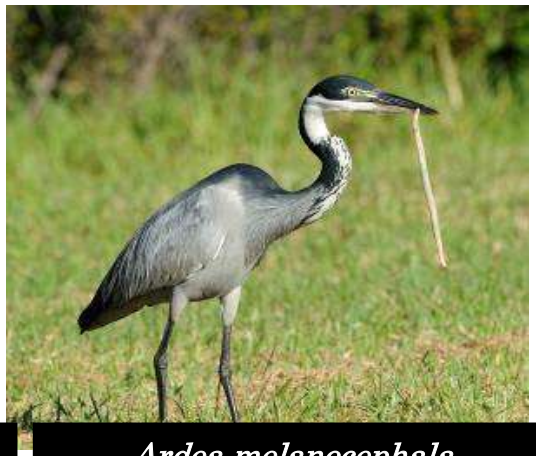
Source: Field Survey, BESST LTD 2021

The figures below show the pictures of birds species identified in the project areas

Figure 20: Birds species of the project area



Bubulcus ibis



Ardea melanocephala

Source: Field survey, 2021

✓ **Bird species that could occur based on literature review from previous assessments**

Masaka Water Treatment Plant is located within Nyabarongo wetland. Nyabarongo wetland is a protected area in Rwanda covering 142.62 km². It is located in the South-East of the country and South-East of Kigali. It includes swamps and marshes in part of the flood plain of the Akagaera River, the longest river in Rwanda. Nyabarongo wetland has a nomination of the Important Bird Area (IBA). These are places of international significance for the conservation of birds and other biodiversity. According to Bird Life International (2021), a total of 50 bird species are found in Nyabarongo wetland These species have been confirmed by another assessment that was conducted in the area by the Association pour la Conservation de la Nature au Rwanda (ACNR, 2004). Among species recorded included 8 species are called trigger species (those for which the site has been selected):

i. Papyrus Gonolek ***Laniarius mufumbiri***;
ii. Carruthers's Cisticola ***Cisticola carruthersi***
iii. Papyrus Yellow Warbler ***Calamonastides gracilirostris*** (**Chloropeta gracilirostris**);
iv. White-winged Swamp-warbler ***Bradypterus carpalis***;
v. Black-lored Babbler ***Turdoides sharpei***;
vi. Northern Brown-throated Weaver ***Ploceus castanops***;
vii. White-collared Oliveback ***Nesocharis ansorgei***; and
viii. Papyrus Canary ***Crithagra koliensis***.

✓ **Amphibians**

During the field data collection, two species of amphibian were encountered and recorded in the Water Intake Area. These included the African common toad (***Sclerophrys regularis***) and the Natal dwarf puddle frog (***Phrynobatrachus natalensis***). In addition, a description of the species that local community members provided converged to the description of these 2 species.

It is important to mention that several other studies conducted in the same area and other surrounding wetland areas recorded 10 amphibian species (Table 2-2). For that, these species could occur in the area.

Table 18: Amphibian species that could occur in the area based on different literature

No.	Species	Family	IUCN Redlist Status*	Endemic Status**	Habitat affinity***
1	Sclerophrys regularis	Bufoniadae	LC	W	AL
2	Hyperolius kivuensis	Hyperoliidae	LC	W	AS
3	Hyperolius viridiflavus	Hyperoliidae	LC	W	AS
4	Hyperolius nasutus	Hyperoliidae	LC	W	AS
5	Kassina senegalensis	Hyperoliidae	LC	W	AL, AS
6	Phrynobatrachus mababiensis	Phrynobatrachidae	LC	GL	AS
7	Phrynobatrachus natalensis	Phrynobatrachidae	LC	W	AL, AS
8	Ptychadena anchietae	Ptychadenidae	LC	W	AL, AS
9	Ptychadena mascareniensis	Ptychadenidae	LC	W	AL, AS
10	Ptychadena porosissima	Ptychadenidae	LC	W	AL, AS

*** IUCN Redlist status| LC = Least Concern**

**** Endemic status|W = widespread in Africa, GL = regional endemic of the Great Lake region.**

***** Habitat affinity| AL = anthropic landscape dominated by agriculture and human settlement, AS = aquatic and swamp area**

The Photos below show the amphibians species that were recorded in the project areas

Figure 21: Amphibians of the project area

Sclerophrys regularis

Phrynobatrachus natalensis

Source: BESST field Survey, 2021

✓ **Reptiles**

No reptile species was encountered during the field survey. We relied on information provided by local community members in the area. They reported that the most reptile species encountered is Black-bellied Hinged Terrapin (***Pelusios subniger***). These are recorded in the wetland and surrounding areas. Other most encountered species included African Green Snake (***Philothamnus heterolepidotus***) and the Nile crocodile (***Crocodylus niloticus***) and other 3 species (Table 2-3).

Table 19: Reptile species reported to be found in the area by community members

No.	Species	Vernacular name	Order	Family	IUCN Redlist Status*	Endemic Status **	Habitat affinity ***
1	Nile crocodile *Crocodylus niloticus #*	Ingona	Crocodilia	Crocodylidae	LC	W	AS
2	Black-bellied Hinged Terrapin *Pelusios subniger #*	Akanyamasyo	Testudines	Pelomedusidae	LC	W	AS
3	African green snake *Philothamnus heterolepidotus*	Incarwatsi	Squamata	Colubridae	-	W	AL, AS
4	Spitting cobra *Naja nigricollis*	Incira	Squamata	Elapidae	-	W	AL
5	Puff adder *Bitis arietans #*	Impiri	Squamata	Viperiade	-	W	AL
6	Striped sand snake *Psammophis sibilans*	Imbarabara	Squamata	Lamprophiidae	LC	W	AL

*** IUCN Redlist status| LC = Least Concern, - = not currently assessed by the IUCN Redlist**

**** Endemic status|W = widespread in Africa, GL = regional endemic of the Great Lake region.**
***** Habitat affinity| AL = anthropic landscape dominated by agriculture and human settlement, AS = aquatic and swamp area**
 # Protected species by the Ministerial Order N°007/2008 of 15/08/2008

✓ **Fishes**

Three fish species are found in Akagaera River according to the information obtained from local communities of the target area. These include Lungfish ***Protopterusaethiopicus*** (locally known as Imamba), African Catfish ***Clariasgariepinus*** (locally known as Inkube) and the Common carp ***Cyprinuscarpio***.

✓ **Mammals**

During the field survey, no mammal species was observed or sign recorded. According to the information provided by local communities, the hippos ***Hippopotamus amphibius*** are found in Akagaera River and sometimes they roam around the River. They reported also 2 primate species - the Blue monkey (***Cercopithecus mitis***) and the Velvet monkeys ***Chlorocebus pygerythrus***. Other species associated to the swamp habitat included the Marsh Mongoose ***Atilax paludinosus***, Dwarf Mongoose ***Helogale parvula***, and Sitatunga ***Tragelaphus spekii***. However, they reported that Sitatunga have not been seen for a long time. Other species that are commonly found in the anthropic landscape include African civet and Serval cat, etc. They also reported the presence of leopard (***Panthera pardus***) though this information needs to be verified and confirmed.

Table 20: Mammal species diversity found in the project area

No.	Class	Order	Family	Species	Common name	Local Name	IUCN Redlist Status*	Habitat affinity**
1	Mammal	Artiodactyla	Hippopotamidae	Hippopotamus amphibius #	Hippopotamus	Imvubu	VU	AS
2	Mammal	Primate	Cercopithecidae	Cercopithecus mitis	Blue monkey	Inkima	LC	AL
3	Mammal	Primate	Cercopithecidae	Chlorocebus pygerythrus	Vervet monkey	Inkende	LC	AL
4	Mammal	Carnivore	Herpestidae	Atilax paludinosus	Marsh Mongoose	Inzibyi	LC	AS
5	Mammal	Carnivore	Herpestidae	Helogale parvula #	Dwarf Mongoose	Umukara	LC	AS
6	Mammal	Artiodactyla	Bovidae	Tragelaphus spekii #	Sitatunga	Inzobe	LC	AS
7	Mammal	Carnivore	Felidae	Panthera pardus #	Leopard	Ingwe	VU	AL
8	Mammal	Carnivore	Mustelidae	Aonyx congicus	Congo clawless otter	Igihura	NT	AS
9	Mammal	Carnivore	Felidae	Leptailurus serval #	Serval cat	Imondo	LC	AL
10	Mammal	Carnivore	Viverridae"	Civettictis civetta	African civet	Impimbi	LC	AL

*** IUCN Redlist status| VU = Vulnerable, LC = Least Concern, - = not currently assessed by the IUCN Redlist**

**** Habitat affinity| AL = anthropic landscape dominated by agriculture and human settlement, AS = aquatic and swamp area**

 # Protected species by the Ministerial Order N°007/2008 of 15/08/2008

Source: Community member and document review , 2021

4.2.8. Threatened species (IUCN Red List) and locally-protected species

✓ **Plant species**

No species was found on the IUCN Redlist. However, 2 species were found on the list of protected species in Rwanda (Ministerial Order N°007/2008 of 15/08/2008). These are ***Erythrina abyssinica*** locally known as Umuko and ***Ficus thonningii*** locally known as Umuvumu.

✓ **Bird species**

No species recorded during the survey was found on the threatened species Redlist of IUCN. However, one Endangered species – the Grey crowned-crane ***Balearica regulorum*** are sometimes sighted during the long rainy season though it was not recorded during the survey. Five species are found on the list of protected species in Rwanda. These are the Black-headed heron ***Ardea melanocephala***, Cattle Egret ***Bubulcus ibis***, Collared sunbird ***Hedydipna collaris*** , Blue cheeked Bee-eater ***Merops persicus*** and the Hammerkop ***Scopus umbrette***.

For other species that have been recorded in Nyabarongo wetland which may occur in the target area, 3 species are on the IUCN Redlist. These include 1 specie in the category of Endangered (Madagascar Sqacco Heron ***Ardeola idea***), 1 species in the category of Vulnerable (Papyrus Yellow Warbler ***Calamonastides gracilirostris***) and 1 specie in the category of Near Threatened (Papyrus Gonolek ***Laniarius mufumbiri***). In addition, 4 species are listed on the CITES list. These include Little Egret ***Egretta garzetta***, Hadada Ibis ***Bostrychia hagedash***, Sacred ibis ***Threskiornis aethiopica*** and Egyptian goose ***Alopochen aegyptiacus***.

✓ **Reptiles**

Three (3) species are on the list of protected species in Rwanda. These are: the Nile crocodile ***Crocodylus niloticus***, Black-bellied Hinged Terrapin (***Pelusios subniger***) and Puff Adder viper ***(Bitis arietans)***.

✓ **Mammals**

Two (2) species are categorized as Vulnerable on the IUCN Redlist: Hippopotamus ***Hippopotamus amphibius*** and Leopard ***Panthera pardus***, while 1 specie is categorized as Near Threatened: Congo clawless otter ***Aonyx congicus***. In addition, four species are protected by Rwandan law. These in addition Hippopotamus and Leopard include Sitatunga ***Tragelaphus spekii*** and Serval cat ***Leptailurus serval***.

4.3 Socio economic baseline data

This section describes the socio economic development characteristics of sampled (200) households in Kicukiro district. Data were collected using questionnaire. From total households of Kicukiro 314,644 (NISR, 2014) a sample of 200 households were selected using purposive sampling. The sample size was determined using Slovin's formula of sample size where

$n = \frac{N}{1+N*(e)^2} = \frac{314,644}{1+314,644*(0.07)^2} \approx 200$ (Yesudhas, 2017). The assessmnet was into different parts such as households characteristics, health aspect, education of households members, housing characteristics, Migration/displacement, Finance characteristics (income and expenses), Access to water, Sanitation and Environment aspects, Access to Energy/ Electricty and energy for Cooking etc.

4.3.1 Households' characteristics

- ✓ **General overview**

In 2014, NISR has enumerated 314,655 residents in Kicukiro district, which represents 28.4% of the total population of Kigali City (1,132,686 residents). The population of Kicukiro district is predominantly male: 163,445 are men corresponding to 51.3% of the total population. Females are predominant in Masaka (50.6%) and Gahanga (50.2%) sectors. Gatenga, Kanombe, Kigarama, Nyarugunga and Masaka are the most populated sectors with more than 39 thousands residents each. Kagarama and Gikondo are the last populated sectors in Kicukiro district (14,385 and 17,146 inhabitants respectively).

- ✓ **Sex ration**

households characteristic were defined based on sex of respondent, relation of respondent to head of household, are of location for sampled household sex of the household head, age of respondent and age of household head, marital status of head of household, religion of household head, education level of respondent and that of household head, socio-economic category of household, benefit of household in 1st Ubudehe socio-economic category and mean size of persons living in the sampled household. Here below are details of findings:

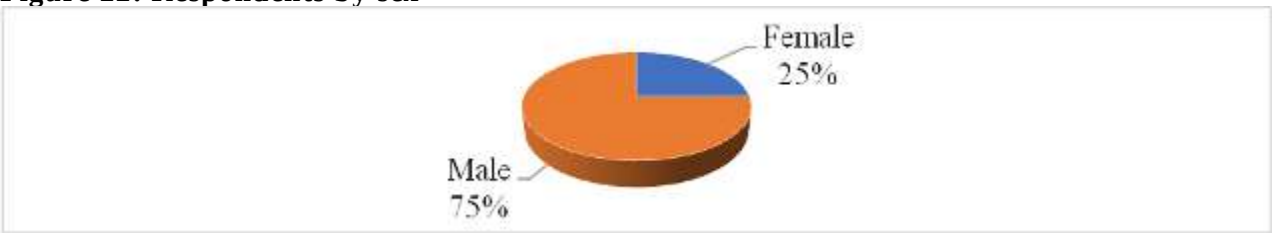
Table 21: Area of residence for sampled households

Area of residence	Frequency	Percent
Urban	200	100
Total	**200**	**100.0**

Source: Socio-economic survey, 2021

As seen from table above, from 200 sampled households in Kicukiro District, 100% are in urban area. Urban areas were considered based on the village's classification made by NISR, 2012.

Figure 22: Respondents by sex



Source: Socio-economic survey, 2021

As seen from figure above, findings show that, from 200 sampled households in Kicukiro district 75% of respondents were males and 25% were females.

- ✓ **Age of respondents**

Table 22: Ages of respondents (not households heads) (years)

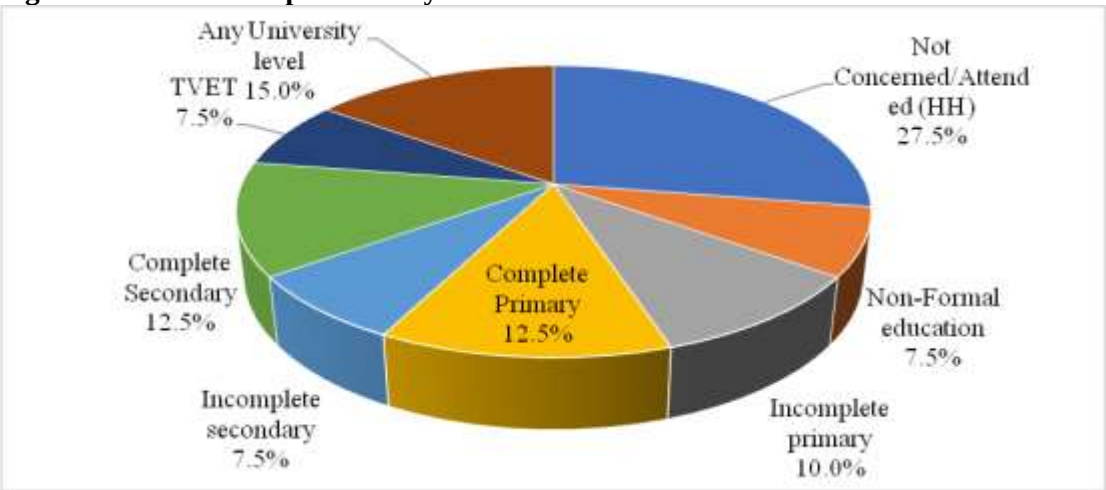
Ages of respondent (if he/she is not the HH head) (Unit: Years)	Frequency	Percent
16-24	25	12.5
25-33	25	12.5
34-42	25	12.5
43-60	70	35.0
Not Concerned	55	27.5
Total	**200**	**100**

Source: Socio-economic survey, 2021

As seen from table **above.....**, from 200 sampled households in Kicukiro District, average age of respondents (households head excluded) was around 38 years. From 200 respondents 55 were households' heads and were not concerned with this question. From 200 respondents 35% were aged between 43-60 years old, 12.5% aged between 16-24 years, 12.5% between 25-33 years and 12.5% aged between 34-42 years

✓ **Education level**

Figure 23: Share of respondents by education characteristics



Source: Socio-economic survey, 2021

As seen from figure above from 200 sampled households in Kicukiro district 10% of respondents have not completed primary education, 12.5% were completed primary level of education, 7.5% were not completed secondary education, 7.5% have no formal education, 12.5% were completed secondary education, 7.5% attended and completed TVET and 15% attended or completed any university level. for this question 27.5% or 55 respondents were not concerned by this question as they were head of households

✓ **Ubudehe[2] category**

Figure 24: Share of households by ubudehe socio-economic categories

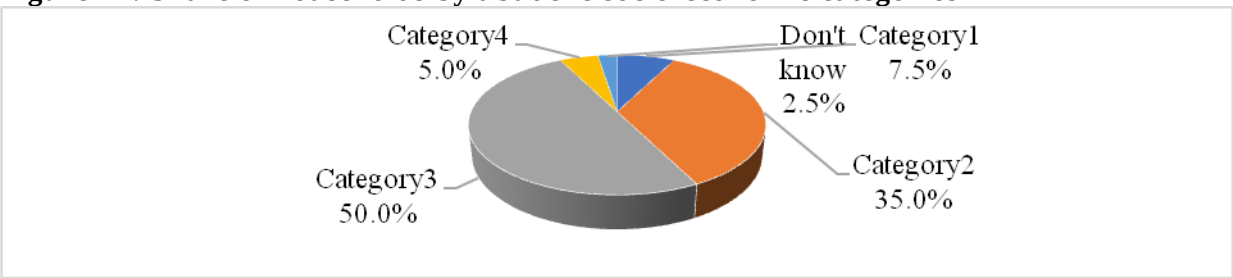


Figure .23 above shows that, from 200 sampled households in Kicukiro district 50% are classified in the 3rd category of Ubudehe socio-economic development, 35% were in 2nd category, 7.5% in 1st category, 5% in 5th category and 2.5% were do not know their category of Ubudehe Socio-Economic Development

✓ **Health insurance**

Table 23: Health insurance of head of household

Health Insurance of the head of household	Frequency	Percent
RAMA	30	15.0
Mutual insurance	140	70.0
MMI	25	12.5
Other (Britam)	1	0.5
Other (Not specified)	4	2.0
Total	**200**	**100.0**

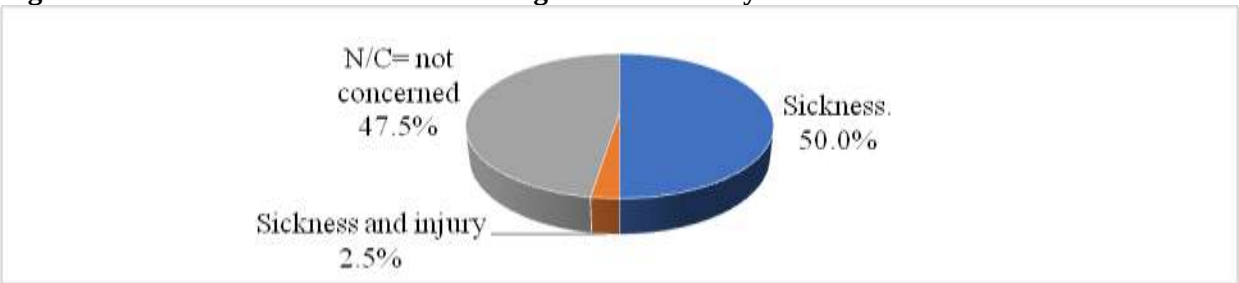
Source: Socio-economic survey, 2021

Table 22 above shows that, from 200 sampled households in Kicukiro district 70% head of households are beneficiary of mutual health insurance, 12.5% with MMI, 15% with RAMA (RSSB), 0.5% Britam and 2% have other insurance (not specified).

[2] Ubudehe is national categoraation of households based on their income and standards of living

✓ **Visiting health facility.**

Figure 25: Households member visiting health facility.



Source: Socio-economic survey, 2021

From 200 sampled households 50% are with members suffered sickness in 4 weeks before the survey, 2.5% households have members went to health facility for Sickness injury and 47.5% were not concerned by this case (none of household member visited health facility 4 weeks before the interview). For the cases of sickness, here below are details:

Table 24: Sickness status by households' members in 4 weeks before the survey date.

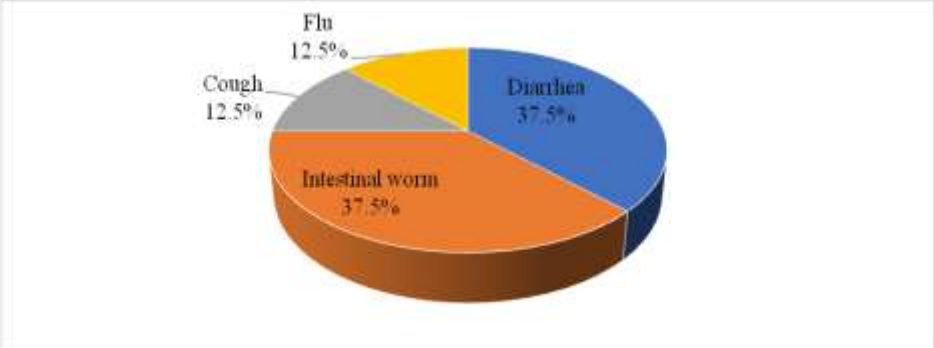
Nature of sickens suffered by household member	Frequency	Percent
N/C= not concerned	**95**	**47.5**
Malaria	15	7.5
Abdominal Pain	10	5.0
Respiratory infections	20	10.0
Eye infection	5	2.5
STDs/STIs/HIV/AIDs	5	2.5
Other (Specify)	**50**	**25.0**
Cough	*5*	*2.5*
Diabetes	*10*	*5.0*
Flu	*5*	*2.5*
Goiter	*5*	*2.5*
Nilves (imitsi)	*5*	*2.5*
Skin disease	*5*	*2.5*
Stomach pain	*5*	*2.5*
Wound	*5*	*2.5*
Total	**200**	**100.0**

Source: Socio-economic survey, 2021

As presented in above table, among 200 households sampled 105 are with household members who suffered sickness in 4 weeks before the date of survey. Thus, the sickness suffered are as follows: malaria (7.5% of 200 sampled households in Kicukiro), abdominal (5%), respiratory infections (10%), eye infection (2.5%), STDs/STIs/HIV/AIDs (2.5%) while other sickness (25%) detailed 2.5% cough, 5% diabetes, 2.5% flu, 2.5% Goiter, 2.5% Nilves (imitsi), 2.5% skin disease, 2.5% stomach pain and 2.5% wound.

✓ **Sickness type related to poor water quality**

Figure 26: Sickness resulting from poor water quality

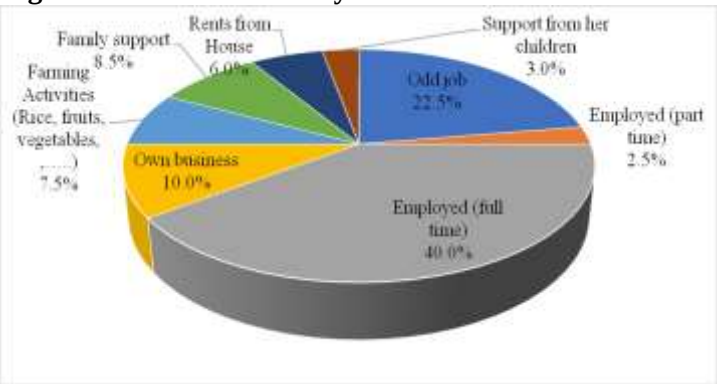


Source: Socio-economic survey, 2021

Figure above shows that, from 200 assessed households in Kicukiro District with any member suffered with poor water quality sickness, 37.5% was suffered intestinal worm, 37.5% suffered Diarrhea, 12.5% suffered Cough and 12.5% was suffered Flu.

✓ **Main source of income**

Figure 27: Households by main source of income activities



Source: Socio-economic survey, 2021

The above figure, shows that from 200 sampled households in Kicukiro District 40% are with employment (full time) as main income source, 22.5% are with odd job as main income generating activity, 10% depend on own business, 8.5% depends on family support, 7.5% depends on farming activities (rice, fruits, vegetables, …) as main income generating activity, 6% depends on income from house renting, 3% depends on support got from children and 2.5% depends on part time job employment.

Table 25: Distribution of households by second income generating activities.

Second household income generating activity	Frequency	Percent
Own business	20	10.0
Farming Activities (Rice, fruits, vegetables, etc.)	10	5.0
Livestock	5	2.5
Pension	5	2.5
Renting house	10	5.0
Sewing	5	2.5
Sub-Total	**55**	**27.5**
Not Attended	145	72.5
Total	**200**	**100.0**

Source: Socio-economic survey, 2021

The above table shows that from 200 sampled households in Kicukiro district only 27.5% identified their second or alternative source of income. In the other case from 200 sampled households 10% are considering own business as second income generating activity for the household, 5% farming Activities (Rice, fruits, vegetables...), 5% renting house, 2.5% livestock, 2.5% pension and 2.5% sewing.

Table 26: Distribution of households with other income source

Monthly income paid by other donors (Rwfs)	Frequency	Percent
10,000	5	2.5
45,000	5	2.5
80,000	10	5.0
Sub-Total	**20**	**10.0**
Not Concerned	180	90.0
Total	200	100.0

Source: Socio-economic survey, 2021

The bove Table shows that from 200 identified households which have any other source of income out of economic activity done by the household members (example gift, Gvt subsidies, etc..). Thus from 200 households with that opportunity 25% get 10,000 Frw per month from other non-economic income source, 25% earn 45,00 Frws and 50% earn 80,000 Frw per month. 2.5% get additional income from house rent, 2.5% from rent house and 5% did not specified where exactly they get additional income out of economic income sources generated by economic activities of Households heads or household members.

Table 27: Distribution of households by average household monthly expenses (in Frw)

Average household monthly Expense	Frequency	Percent
1,000-10,000	10	5.0
10,000-50,000	90	45.0
50,000-100,000	55	27.5
100,000-300,000	40	20.0
Not Attended	5	2.5
Total	**200**	**100**

Source: Socio-economic survey, 2021

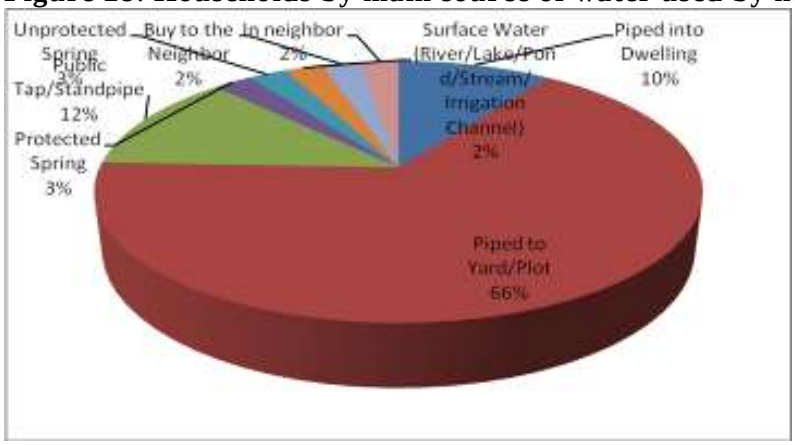
The above table shows that from 200 sampled households in Kicukiro District, 45% are spending monthly expenses between 10,000 to 50,000 Frws, 27.5% between 50,000 to 100,000 Frws, 20% between 100,000

to 300,000 Frws, 5% spending 1,000 to 10,000 Frws and 2.5% were not specified their household monthly expenses.

4.3.2 Water availability and access

Water component assessment was done based on the main source of water for domestic households use, distance between water source and household, source of drinking water for household, distance between household and drinking water source, source of drinking water used by the household, waiting period at the domestic household water source, waiting time at drinking water source, home water availability in last 7 days before survey date, costs of water in case water is unavailable, water transport cost, period it takes to fetch water from the nearest source in case drinking water is unavailable, water used every day (quantity) for drinking, quantity of domestic water used by household, the last bill of WASAC, rain water management,. The results of the survey are presented below:

Figure 28: **Households by main source of water used by household.**



Source: Socio-economic survey, 2021

The above figure shows that from 200 sampled households in Kicukiro district 2.4% use surface water (River/Lake/Pond/Stream/ Irrigation Channel) for domestic use, 2.4% use unprotected spring, 2.4% use protected spring, 12.2% use public tap/ standpipe, 65.9% use piped to yard/plot, 2.4% use from neighbors, 9.8% use piped into dwelling, and 2.4% buy water from neighbours

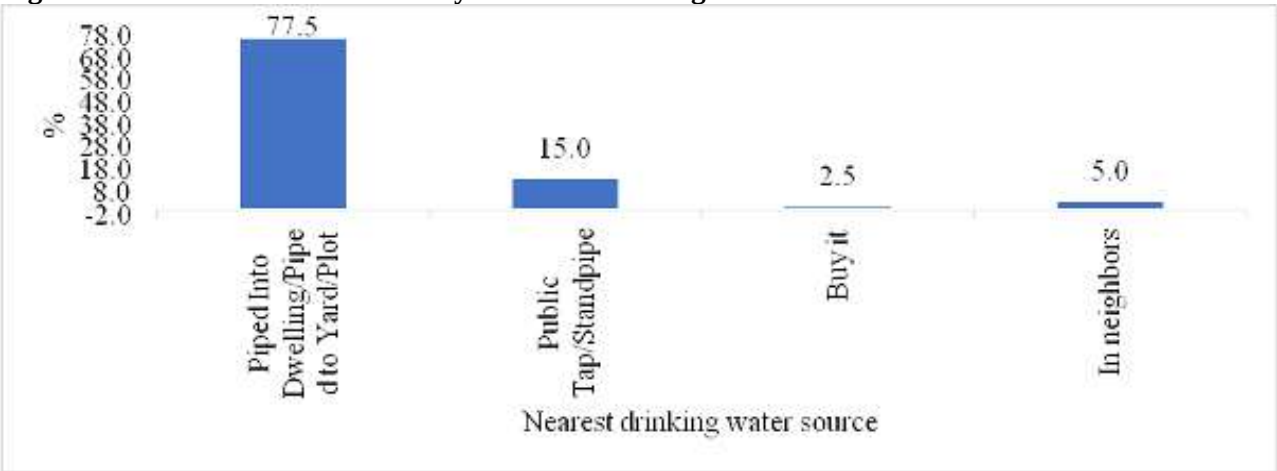
Table 28: Households by distance between domestic water source and household

Distance between domestic water source and household (in meters)	Frequency	Percent
0-10	165	82.5
10-30	5	2.5
30-90	5	2.5
90-1,000	25	12.5
Total	**200**	**100.0**

Source: Primary data, 2021

Table above table shows that, from 200 sampled households in Kicukiro district 82.5% are used to travel distance between 0 m to 10 m from household to domestic water source, 12.5% use distance between 90 m to 1,000 m, 2.5% use between 10 m to 30 m, and 2.5% use 30 m

Figure 29: Share of households by nearest drinking water source



As seen from the above figure, from 200 sampled households in Kicukiro district 77.5% are with Piped into Dwelling/Piped to Yard/Plot as nearest drinking water source, 15% public tap/ standpipe, 2.5% buy drinking water, and 5% get water from neighbors.

Table 29: Distribution of households by number of daily waters uses

Number of jerrican (1 Jerrican=20 litres)	Frequency	Percent
1	5	2.5
2	25	12.5
3	35	17.5
4	40	20.0
5	35	17.5
6	15	7.5
7	5	2.5
8	10	5.0
10	30	15.0
Total	**200**	**100.0**

Source: Socio-economic survey, 2021

Table above table shows that from 200 sampled households in Kicukiro district 20% use 4 jerricans for domestic activities, 17.5% use 4 jerricans per day, 17.5% use 3 jerricans per day, 15% use 10 jerrican sper day, 12.5% use 2 jerricans per day, 7.5% use 6 jerricans per day, 5% use 8 jerricans per day, 2.5% use 7 jerricans per day, and 2.5% use 1 jerrican per day

Table 30: Households by distance travelled to nearest drinking water source.

Distance in meters	Frequency	Percent
0-20	180	90.0
20-100	15	7.5
100-700	5	2.5
Total	**200**	**100.0**

Source: Socio-economic survey, 2021

The above table shows that from 200 sampled households in Kicukiro District 90% travel distance between 0-20 m from nearest drinking water source to their household, 7.5% use 20-100 m, and 2.5% use 100-700 m.

Table 31:Household by waiting time at domestic use water source (in minutes)

Time in minutes	Frequency	Percent
1-30	25	12.5
31-60	20	10.0
300	5	2.5
Sub-Total	**50**	**25.0**
Not concerned/ Attended	150	75.0
Total	**200**	**100.0**

Source: Socio-economic survey, 2021

The above table shows that from 200 sampled households in Kicukiro district 12.5% wait around 1-30 minutes at domestic water source, 10% wait 31-60 min and 2.5% wait 300 min to get water at domestic use water source.

Table 32: Households by waiting period in minutes at drinking water source.

Time in minutes	Frequency	Percent
1-30	45	22.5
31-60	10	5.0
300	5	2.5
Sub-Total	**60**	**30.0**
Not concerned/ Attended	140	70.0
Total	**200**	**100**

Source: Socio-economic survey, 2021

The above table shows that from 200 sampled households in Kicukiro District 22.5% wait around 1-30 min at drinking water source, 5% wait 31-60 min, and 2.5%% wait 300 min at drinking water source (to get water drinking water).

Table 33: Household by water fluctuation encounted last 7 days before survey day.

Number of water fluctuation	Frequency	Percent
1	5	2.5
2	10	5.0
3	15	7.5
4	25	12.5
5	10	5.0
6	35	17.5
7	60	30.0
Sub-Total	**160**	**82.5**
Not Concerned	40	20.0
Total	**200**	**100.0**

Source: Socio-economic survey, 2021

The above table shows that from 200 sampled households in Kicukiro district 82.5% have water in their homes (including these getting water from homes of neighbours). From them 3.1% were missed water 1 times in last 7 days counted before the date of visit 7 days, 6.3% 2 times, 9.4% 3 times, 15.6% 4 times, 6.3% 5 times, 21.9% 6 times and 37.5% 7 times.

Table 34: Price paid for water per 20 liters once water unavailable from the nearest source

Price of water/ 20 liters	Frequency	Percent	Valid Percent
20-50 Rwf	15	7.5	8.6
50-100 Rwf	95	47.5	54.3
100-150 Rwf	10	5.0	5.7
150- 200 Rwf.	15	7.5	8.6
More than 200 Rwf	40	20.0	22.9
Sub-Total	**175**	**87.5**	**100.0**
Not Concerned	25	12.5	
Total	**200**	**100.0**	

Source: Socio-economic survey, 2021

As shown in the above table, when ther is no water in usual source, households spend around 20 to 50 Rwfs per 20 liters (7.5%), 47.5% pay between 50 to 100 Rwfs, 5% pay between 100 to 150 Rwfs per 20 liters, 7.5% pay between 150-200 Frws, and 20% pay more than 200 Frws per a jerrican of 20 liters. Rates were counted from 200 sampled households in Kicukiro district where 62.6% were not concerned by this case.

Table 35: Water transport cost in case water unavailability at nearest source per month.

Water transport costs	Frequency	Percent	Valid Percent
Less than 5,000Rwf	75	37.5	50.0
5,000-10,000 Rwf	30	15.0	20.0
10,000-15,000 Rwf	15	7.5	10.0
25,000-30,000 Rwf	10	5.0	6.7
More than 30,000 Rwf.	15	7.5	10.0
HH members fetch water themselves	5	2.5	3.3
Sub-Total	**150**	**75.0**	**100.0**
Not Concerned	50	25.0	
Total	**200**	**100.0**	

Source: Socio-economic survey, 2021

The above table indicates that from 200 sampled households in Kicukiro district 37.5% pay less than 5,000 Frws water transport cost per month for fetching water once both drinking or domestic use water

unavailable at nearest source, 15% pay between 10,000-15,000 Frw 7.5% pay between 5,000-10,000 Frw, 5% pay between 20,000-25,000 Frws, 7.5% pay between 25,000-30,000 Frw and 2.5% pay more than 30,000 Frw per month for water transport.

Table 36: Time used to fetch water in case unavailable from the nearest source.

Time in minutes	Frequency	Percent
2-10	50	25.0
11-30	50	25.0
31-120	80	40.0
121-300	5	2.5
Sub-Total	**185**	**92.5**
Not Concerned	15	7.5
Total	**200**	**100**

Source: Socio-economic survey, 2021

The above Table shows that to go and come back while household fetch water from alternative water source in case unavailable from the nearest water source for both drinking and domestic use, 25% use time between 2-10 minutes, 25% use time between 11-30 minutes, 40% use time between 31-120 minutes, and 2.5% use time between 121-300 minutes.

Table 37:Average mount money paid by households for water

Water Bill for water supply company (WASAC in Rwfs) per month	Frequency	Percent
1,400-5,000	45	22.5
5,000-10,000	40	20.0
10,00-20,000	20	10.0
Sub-Total	**105**	**52.5**
Not Concerned	95	47.5
Total	**200**	**100.0**

Source: Socio-economic survey, 2021

The above table shows that from 200 sampled households in Kicukiro district, 22.5% have paid an average amount counted from several months to water supply company in Rwanda (WASAC) ranged between 1,400-5,000 Frws, 20% paid average water costs ranged between 5,000 – 10,00-Frws and 10% were paid average water costs ranged between 10,000-20,000Frws per month.

Table 38: A**lternative solutions when there is no water or money to purchase water**

Alternative solutions when water unavailable and money to buy water	Frequency	Percent	Valid Percent
Go for river water/ lake	120	60.0	68.6
Borrow money to buy	25	12.5	14.3
Get water from neighbors	30	15.0	17.1
Sub-Total	**175**	**87.5**	**100.0**
Not Attended	25	12.5	
Total	**200**	**100.0**	

Source: Socio-economic survey, 2021

The above Table shows that from 200 sampled households in Kicukiro District, 60% went to river or lake to find water once water unavailable form nearest source and there is no money to buy water from other sources, 12.5% borrow money to buy water, and 15% get water from neighbours.

Table 39: Responsibility to fetch water

Household member who fetches water	Frequency	Percent
Wife	15	7.5
Husband	5	2.5
Daughter	5	2.5
Son	20	10.0
All families	30	15.0
Sellers	30	15.0
House keepers	65	32.5
Children	30	15.0
Total	**200**	**100.0**

Source: Socio-economic survey, 2021

From above table, 200 sampled households in Kicukiro District water are fetched by 7.5% wife, 15% children, 15% all family members, 2.5% by husband, 2.5% by daughter, 10% by son, 15% sellers, and 32.5% house maid (housekeepers

4.3.3 Access to Sanitation facilities

In sanitation component, the survey results are based on type of toilette used by the household and methods used by the households for waste management. Here below are details:

Table 40:Distribution of households by type of toilette facility used by the household.

Type of toilette used by the household	Frequency	Percent
Flush toilet	70	35.0
Pit Latrine with constructed floor slab	120	60.0
Pit latrine without slab	10	5.0
Total	200	100.0

Source: Socio-economic survey, 2021

The above table shows that from 200 sampled households in Kicukiro district 35% use Flush toilet, 60 use pit latrines with constructed floor slab toilette facility and 5% use pit latrine without slab

Table 41: Distribution of households by domestic wastewater management methods.

Domestic wastewater management methods	Frequency	Percent
Fosses accumulating water	180	90.0
There is no canal created	20	10.0
Total	**200**	**100.0**

Source: Socio-economic survey, 2021

The above Table shows that from 200 sampled households in Kicukiro District 90% are using fosses accumulating wastewater from domestic use and 10% have no canal created for domestic wastewater management.

Table 42 :Distribution of households by rubbish/garbage disposal method.

Rubbish/garbage disposal method	Frequency	Percent
Publicly managed refuse area	5	2.5
Rubbish collection Service	150	75.0
Thrown in the household's fields or bushes	25	12.5
Burnt	5	2.5
Compost heap on own property	15	7.5
Total	**200**	**100.0**

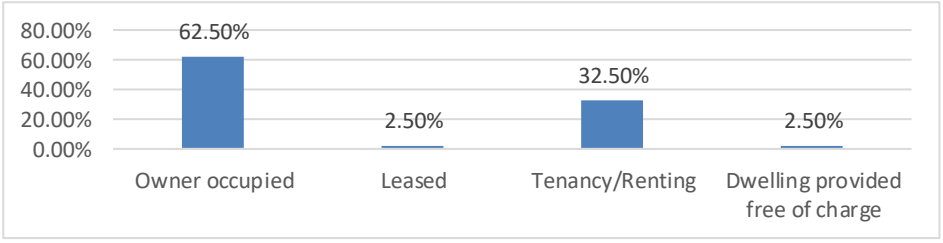
Source: Socio-economic survey, 2021

Table 42 shows that from 200 sampled households in Kicukiro District 75% use Rubbish collection services as method of domestic rubbish/garbage disposal, 12.5% use thrown in the household's field or bushes, 7.5% use compost heap on own property, 2.5% use publicly managed refuse area and 2.5% use burnt

4.3.4 Land ownership in the project area

In Rwanda all plots have been registered and given a Unique Personnel Identification (UPI) that shows the land owner. In some instance the land owner may lease his land to someone else for a given period. There also people who are using the government land especially in marshlands. The collected information during the study survey show that more than 62.5 % own land in the study area.

Figure 30: Distribution of households according to house ownership



Source: Socio-economic survey, 2021

CHAPTER V: PROJECT NEED AND ALTERNATIVES

5.1 Justification and overview

The conduct of the EIA requires the analysis of alternatives with the main purpose to select the best among all possible project options. During the analysis of project alternatives, different options were examined and discussed with the aim of designing the proposed project and identify other alternatives, which would achieve the same objective with maximum efforts to minimize and avoid project socio and environmental adverse impacts .The analysis of alternatives was then conducted in a bid to privilege positive impacts and attenuate/ avoid negative impacts of the project implementations.

The "no project" alternative was also assessed to demonstrate environmental and social conditions without the project implementation. Other alternatives consideration includes the projects sites, project designs, construction techniques, phasing and schedule, operating and maintenance procedures. Alternatives were compared in terms of potential environmental and social impacts; suitability under local conditions; and institutional, and monitoring requirements.

5.2 No-Project Alternative

The project of construction of Masaka WTP is aiming at access to clean water, health improvement, and hygiene standards with provision of improved water supply services. The implementation of the present project will deliver sufficient clean water with new infrastructures and facilities and will as well help the country to meet key national targets and ambitions of supplying reliable, efficient and effective clean water to the local population. The project is expected to reverse the status quo of lack of clean and sufficient water in the targeted water supply areas and this will improve the living condition of the supplied population.

In the case of no project option, this means that the construction of Masaka WTP and its related facilities is not undertaken. Therefore, this will result to leaving the population of the targeted water supply areas and those getting water from Karenge WTP in the same present and existing conditions and this option is not desirable considering the increasing of water demand associated to population growth and country development initiatives and programs. Besides, there are many significant and specific benefits that would not be achieved if the proposed project is not to be implemented. It is expected that the proposed WTP will produce 20,000m^3/day that will be additional water to that supplied in Kigali City on daily basis.

5.2.1 Benefits of No-Project Option

The benefits of No-Project alternative are described below:

- The existing groundwater balance along Akagera River will be maintained
- The impacts related to water abstraction from the project area will not exist
- The compensation cost related to project implementation will not occur
- Possible water contamination associated to human activities within the project area nearby project site and Akagera River would not exist
- The loss of land to local population for WTP and other project infrastructures would not exist
- Short term impacts caused by construction activities e.g. noise, dust generation, vibrations, etc, would not exist.
- Temporary inconvenience caused by construction activities e.g. temporary road closure for pipeline crossings, would not exist.
- Possible loss of vegetation associated to the project activities would not exist.
- Possible work accident and other socio impacts connected to the project implementation would not occur.
- Biodiversity loss and disturbance in and around the project site would be avoided

5.2.2 Negative Effects of No-Project Option

The negative effects of No-Project Option are:

- The growing population of the City of Kigali and the entire targeted Water Supply Area will continue to suffer from serious water shortage caused by inadequate existing water supply system and infrastructures, and large percentage of the population would continue having no access to safe drinking water.
- The ambitions and targets set by Rwanda to have access to clean water to all population will not be achieved within the fixed period.

- Occurrence of diseases caused by consumption of untreated drinking water would continue to be high in the area of project intervention as described in details in the next chapters.
- Employment opportunities connected to the project implementation would not be available.
- Economic development of the area expected as a result of the Project would also be absent.

For the above reasons the consultant could not recommend No-Option alternative. Instead, the consultant is recommending the implementation of the proposed project with appropriate mitigation measures.

5.3 Sites Alternatives

5.3.1 Alternatives for water treatment plant site and wellfield

The selected new site for Water Treatment Plant and wellfield have been assessed and found to be more suitable and most reliable for the project. This was done based on the topography and environmental concern. Other criteria were also taken into consideration during the sites selection and among them include:

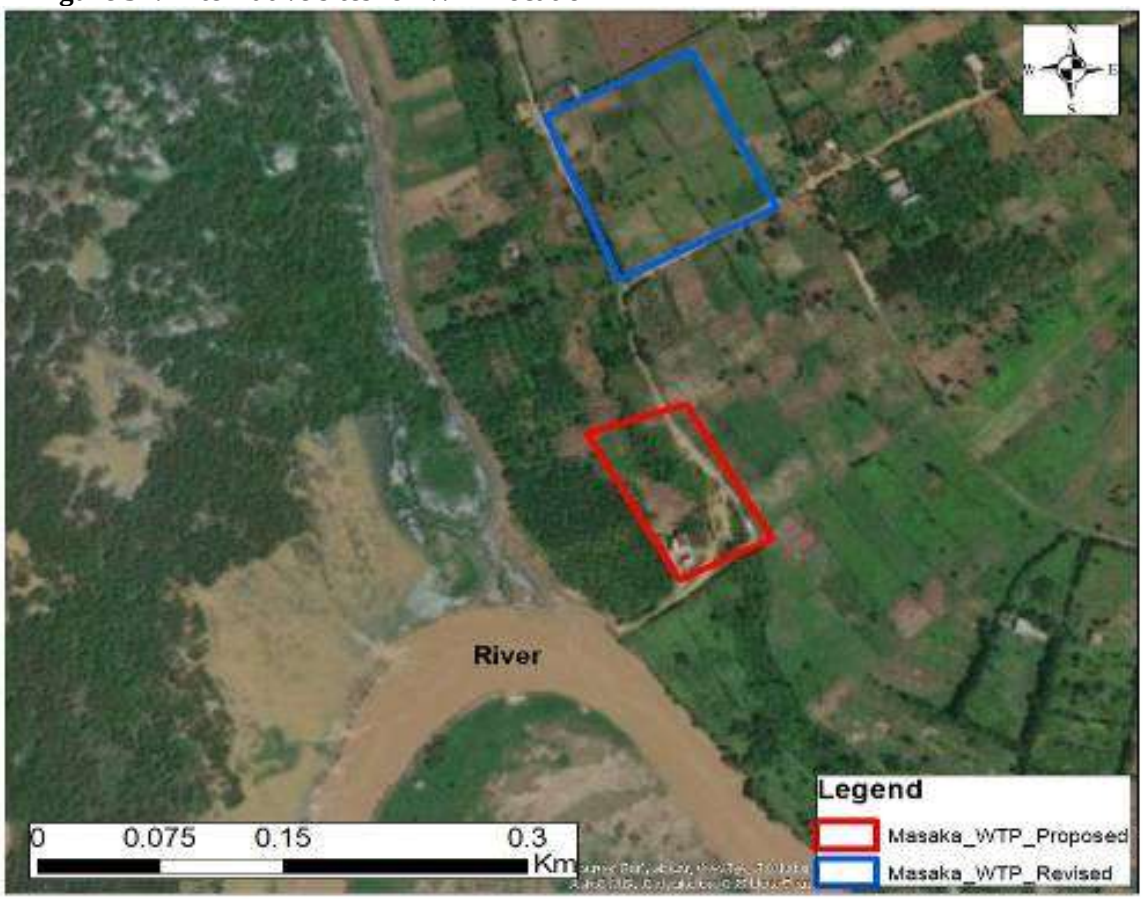
- **Easy access**

The sites for WTP and Wellfield identified are easily accessible and were selected based on the technical requirements in water supply mechanisms and were done to facilitate construction activities including easy accessibility of construction materials and with maximum efforts to avoid environmental pollution and degradation such as the creation of new access roads and associated impacts.

- **Environmental considerations**

The selected site for new WTP is proposed to be in the area mainly used for agriculture activities where is no severe environmental degradation expected. Akagera River becomes more flooded during the rainy season, but the WTP will be constructed at an elevated place from the river to avoid flood risks and other environmental challenges. This was done after assessing the initially proposed location for the WTP and found the area to be closer to the Akagera River and susceptible to flooding as it was noted during our field visit and assessment done on March 2021. The figure below illustrates the new proposed alternative site for WTP.

Figure 31: Alternative sites for WTP location

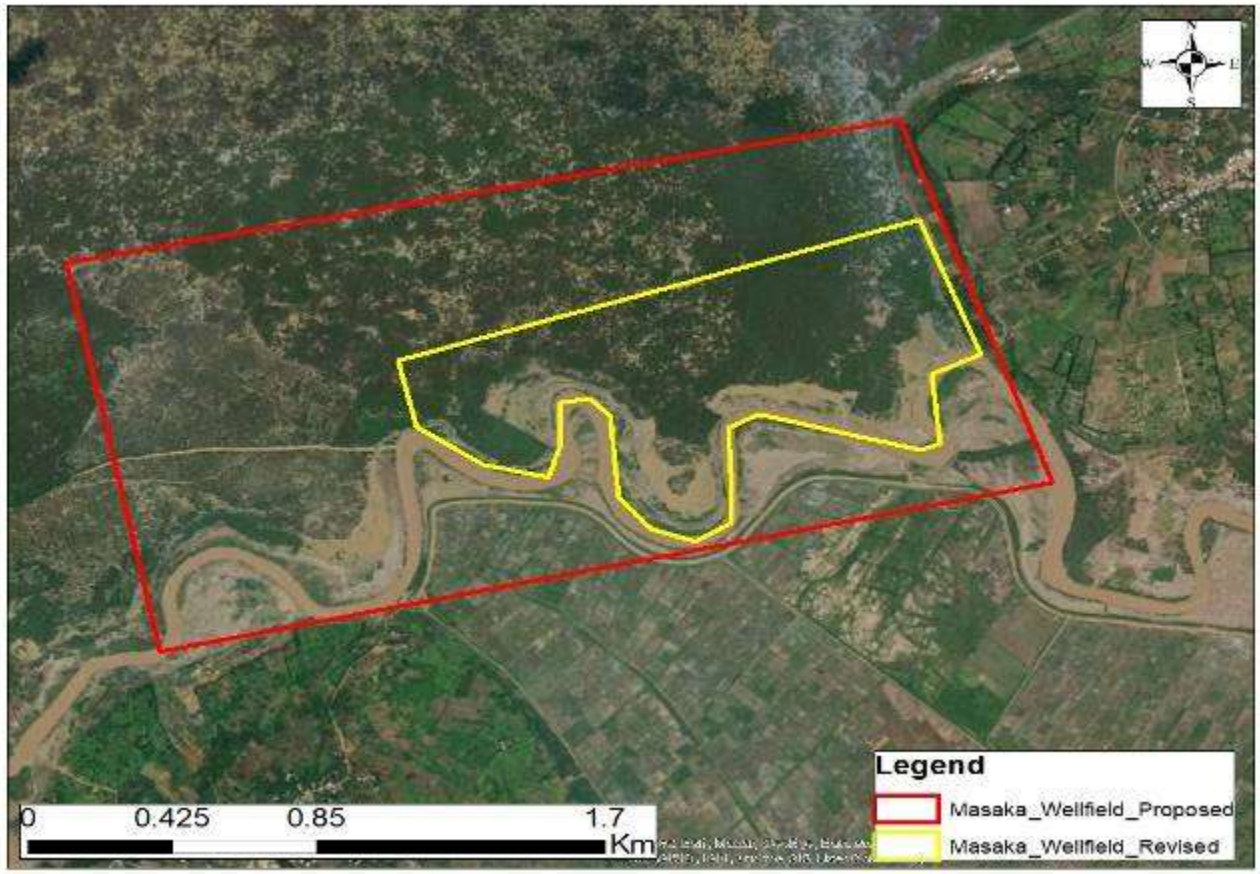


Source: Google Map and FS adapted by BESST Ltd

For the Wellfield, the initial proposed site has been reduced to a smaller place to cover 20 boreholes which will occupy the maximum length of 1.9 km located in a distance of 30m from the river banks. The distance

between boreholes is recommended to be from 50m to 100m if possible. In other to reduce the risks of environmental damage to the wellfield by creating different access ways depending on the season, an access road of 6m width and approximately 1400m length will be traced to ease the transport of construction materials and other works after project completion. The map below shows the alternative well filed location zones.

Figure 32: Alternatives for the location of well field zones



Source: Google Map and FS adapted by BESST Ltd

- **Land acquisition and resettlement**

The land acquisition is necessary for both Water Treatment Plant and access road to the wellfield. The existing status of those lands is private owned or public land used for agriculture. Except for the initially proposed location of WTP where is privately owned land with house in the plot. Therefore, there is no resettlement expected in this project in case the revised locations of WTP and Wellfield is considered. The table below shows the potential structures to be affected considering both alternatives

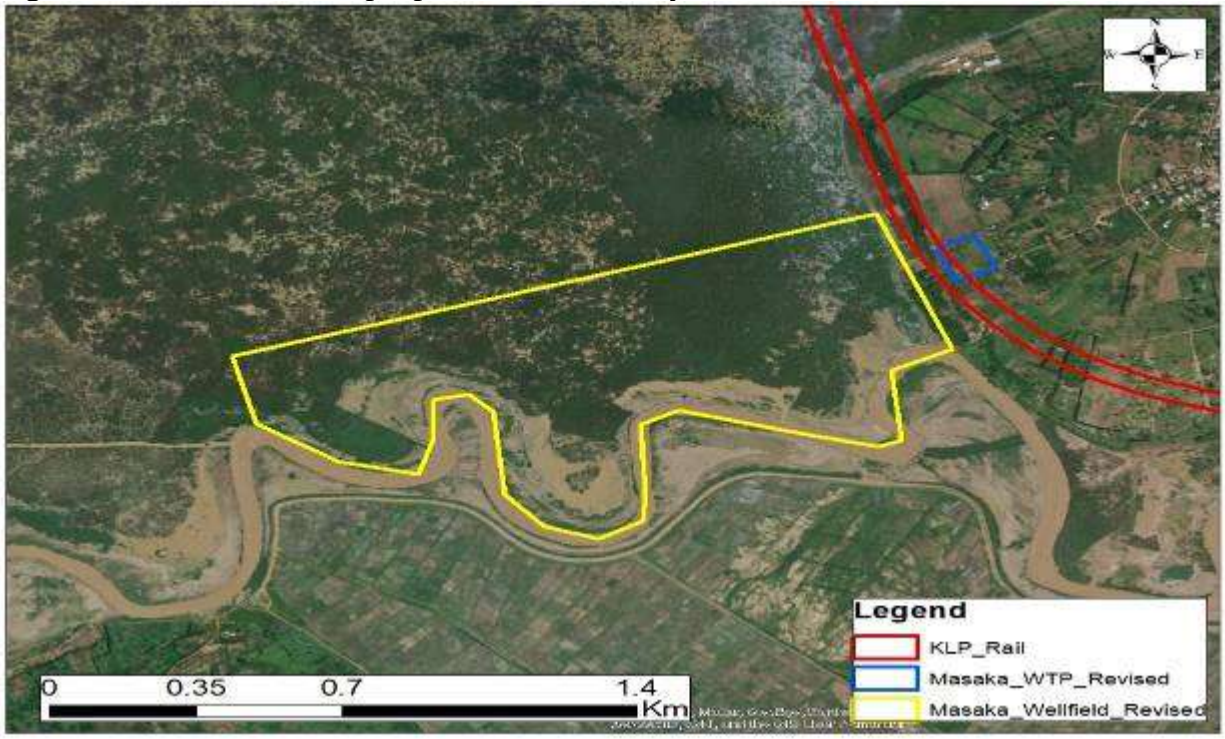
Table 43: Project structures to be affected

Alternatives	Physical Resettlement (House hlds)	Land Acquisition (number of plots)	Area (m^2)
Water Treatment Plant			
WTP initially Proposed site	1	6	6,829
WTP_Revised	0	6	12,236
Wellfield			
Wellfield initially Proposed zone	0	76	3,483,773
Wellfield_Revised	0	30	93,8475

- **National land use development master plan, 2020-2050**

Since Rwanda is landlocked country, land transportation remains the paramount mode. In other words, to achieve its socio-economic development objectives, the GoR is committed to connecting Rwanda to the region through railways construction. Two regional railways are currently in the pipelines and one of them (Dar es salaam-Isaka-Kigali with 139km from Rusumo to Kigali passing Kirehe, Ngoma, Bugesera to Kigali with a branch to the airport in Bugesera) will pass through the area proposed for the construction of new Masaka WTP in Kigali at the Kigali Logistics Platform area (KLP) as shown on the map below.

Figure 33: Location of the proposed KLP Railway vis a s vis the WTP location



Source: Google Map and FS adapted by BESST Ltd

5.3.2 Alternatives on water transmission pipelines and reservoirs

The selected areas for pipelines and reservoirs have been assessed and found more suitable and reliable for the project. These sites selections were done based on the project topography and environmental concern. The water pipelines and reservoirs locations were chosen based on the topography and existing settlements patterns and futures plans of the city of Kigali (settlement sites, residential areas, etc). However, the designed pipelines route will affect 9 structures as shown on map below, and the best way to avoid such loss and resettlement, is to follow the existing road networks and place the pipelines in the buffer of road. And there will be 10 reservoirs with 3main reservoirs and 7 blocks reservoirs to help the distribution of water in the water supply area.

Figure 33: Location of the households susceptible to be affected by pipelines

Source: Google Map and FS adapted by BESST Ltd

5.4 Conclusion on alternatives analysis

Following the increase of population of the City of Kigali especially in the east and southern part, there is a crucial need of sustainable and clean water supply system in the targeted Water supply area of this project. The existing water supply system is not sufficient as the area is supplied by Karenge Water Treatment

Plant (Karenge 1) which is old and operates beyond its designed production capacity to serve the population of Eastern Province and City of Kigali as well. For these reasons, the No-project alternative is not recommended, as it would leave the population in poor and unimproved conditions in terms of water supply and sanitation.

The alternative that considers the relocation of Water Treatment Plant and Wellfield to the revised locations as well as the alignment of pipelines along the existing roads remain the best option, also by complying with the National Land Use and Development Master Plan especially in land transport by moving the revised WTP upwards on the planned railway side.

Though, these options still may cause some environment and social impacts on the receiving environment and local community. Those impacts can be minimised and compensated by implementing appropriate mitigation measures. The EIA team recommends the following:

- Land use changes need to be requested for wellfiled from conservation area to industrial development to allow water abstraction. This also goes for water treatment Plant land which is currently zoned foe medium density residential area
- The design should explorer under ground transmission pipilene for raw water under the Isaka-Kigali Railway
- Before construction, land, crops, trees and other assets valuation should be conducted prior to project implementation and provide the compensation to any land taken
- The environmental management plan should be implemented together with construction activities
- The project activities should be implemented considering all national and international requirements related to the project
- The project should be implemented in compliance and close collaboration with other planned projects in the area

CHAPTER VI: PUBLIC CONSULTATION AND STAKEHOLDERS ENGAGEMENT

6.1. Overview

Public consultation and stakeholder engagement is the basis for building strong, constructive, and responsive relationships that are essential for the successful management of a project's environmental and social impacts. Members of the public and stakeholders are supposed to participate and get involved in decision making concerning development projects because they affect them. The role of public consultation and involvement in EIA process is to assure the quality, comprehensiveness and effectiveness of the assessment and ensure that the public views are adequately taken into consideration in decision making process. Stakeholder engagement is an on-going process that involves the following elements; stakeholder analysis and planning, disclosure and dissemination of information, consultation and participation, grievance mechanism and on-going reporting to affected communities.

In our case consultations were held at the project sites with local community, PAPs and local authorities and were as well as held at key stakeholders' offices. However, due to restrictions imposed by COVID-19, public gathering were not allowed. Site visits to the project sites, visits to the institutional offices and interview phone calls were the major consultation approaches that were used. This were as well managed while respecting the measures to avoid the spread of covi-19 including social distancing, proper hand washing and use of hand sanitizer and proper wearing of protective musk.

6.2. Purpose

The purposes of conducting the consultation were:

- To build a trusting relationship with the affected communities and other stakeholders based on a transparent and timely supply of information and open dialogue.
- To inform local community the project implementation and prepare them on potential impacts that could be caused by the project and can affect them.
- To ensure effective engagement with local communities and key stakeholders throughout all phases of the project.
- To actively build and maintain productive working relationships, based on principles of transparency, accountability, accuracy, trust, respect and mutual interests with affected communities and other stakeholders.
- To collected relevant and trustable information that shall be based on to formulate project impacts as well their mitigation measures.

6.3. Public participation – methods and process

Due to restrictions imposed by COVID-19, where by general public gathering were not allowed; one to one interviews with locals while respecting social distancing were the best approaches used during the consultations. However other techniques including phones call to targeted key informant s were also used.

6.3.1. Consultation with local population and PAPs

During the project consultations, efforts were made to consult with the decision-making officials at local level as well as a number of local communities and Project Affected Persons (PAPs). The level of their opinions, thoughts, suggestions and level of project's impacts were assessed and discussed and the feedbacks were of use during the process of conducting this study. Local communities especially nearby residents of the project areas who will be positively or negatively affected by the project implementation were also consulted to give them the opportunity to express their views and concerns about the project implementation. As part of the process, they were also provided with relevant and sufficient information on the project prior to its start - up.

6.3.2. Consultation with Stakeholders

In addition to the public consultation meeting, the consultant team conducted interviews with different official to discuss the projects and collect their views, concern and recommendations. Consultation conducted allowed to collect different data and information related to the projects like existing laws, standards and policies that are connected to the project implementation. Visits to stakeholder's offices were also organized and conducted. Where visits to offices were not conducted, phone calls were used as means of data and information collection from key stakeholders. In addition to that, the collection of relevant information was also gained via comments that were provided through the client (at inception level). The process of consultation with key stakeholders is a continuous process throughout the study. Information and data are always being collected during the study period. Key findings of the stakeholder

consultation are summarized in the table below and the list of key stakeholders and authorities with whom consultations was made is provided in annexes of the report.

Table 44: Outcome of consultation with stakeholders at central and Local Level

Stakeholder	Summary of discussion	Findings
WASAC Ltd	- Need and importance of having Masaka Treatment Plant. - Operation capacity and requirements. - Water issues and availability within Kigali City and its environs. - Labor and work force and working conditions at The new Plant - Land availability/ ownership and expropriation issues - Use of chemical at the plant - Waste generation and management through the project implementation	- The construction of Masaka WTP is a necessity to meet the fixed target and existing policies and programs objectives to supply 100% of clan water to all Rwandans by 2014. - The land for the project will be acquired via the existing laws related to the expropriation/ compensation in public interests. Fair compensation will be made. - The operation capacity of the plant would be designed taking into consideration future expansion and population increase. - The work force is available in the project area and willing to support. New jobs will be created and manpower is available in the project area. - Chemicals are to be used at the plant such as chlorine for the treatment of raw water. Special attention will be made to their handling, storage and use in order to avoid any associated impact as to their misuses. - Different types of waste are generated at the plant either solid or liquid. The plant will develop a waste management plan that will be followed with maximum effort to protect the environment. .
MoE	- Environmental protection through the implementation of the project. - Existing laws and regulation related to environmental protection - Akagera River wetland protection	- The project will be implemented in line with the existing environmental protection laws and regulations to protect the environment. - Akagera River wetland where the project is located would be protected. Mitigation measure to the identified impacts have to be implemented and regular monitoring will be conducted
RWB	- Water permitting issues - Impact of project implementation on Akagera River. - Water allocation and uses issues in the project areas. - Possible any other ongoing or planned projects within the project area - Water availability/ quantity and quality. - Water pollution issues	- WASAC ltd will be required to apply for water abstraction permit before project implementation. - Project will cause impacts on the surrounding environment Mitigation measures of the identified impacts would be implemented as a prerequisite to project the environment. Regular monitoring will be conducted by competent authorities. - Future projects development will occur in the project catchment. Even though no projects are currently not yet identified, these may include agriculture projects. Further studies would be conducted to determine the level of those in terms of water availability and before their approval. - Some impacts were discussed including water pollution, siltation, turbidity etc. The proposed mitigation measures were incorporated in this report. - Studies including the Kigali Water Supply Master Plan showed enough water to sustain the project.
RURA	- Water tariffs and regulations	- Implementation of construction of Masaka Water treatment Plant would not be considered as a standalone plant which would have its own water tariffs. RURA, the regulator will play its role in terms of water tariffs as required.
RLMUA	- Land issues and ownership and zoning plans	- The project will be implemented in consideration of the existing laws related to land use , land management, land allocation, land ownership and land acquiring/ compensation issues
REMA	- Potential source of pollution within project area - Impacts of the project implementation	- Main potential source of water pollution would be associated to human activities within the project area. Compensation meauses of the identified impacts would be developed anad implemented. However efforts have to be made to refuse and avoid those identified impacts.

	- Any useful information to be used in the EIA	- Different impacts of project implementation were discussed and incorporated in this report.Monitoring will be undertaken on regular basis to avoid potential environmental pollution.
Sector and District officials	- Impact of project implementation in the project area - Water tariffs - Other water uses in the project area (navigation, fishing, agriculture etc - Ecosystem Services of the wetland - Land ownership and availability for project implementation - Challenges and impacts associated to the project implementation - Labor and work force - Compensation of affected land and private assets etc.	- The project is of high importance since it will contribute to the development, sanitation increases, availability and reliable clean water in the project areas, etc. Project implementation would be beneficial to the local population and where possible RURA should intervene in terms of water tariff fixing. - Fair compensation would be done by the project developer and in accordance with the existing laws and regulation related to fair compensation in terms of public interests. - Different project positive and negative impacts were discussed and incorporated in this report.

6.3.3. Consultation at community level

Even though, no general public meetings were allowed due to the established measure to fight against the spread of covid-19 pandemic, local consultations were held with local community in form of discussion and question-answer method. Where possible, the consultation was held in a group of not more than 5 people while respecting the preventive measures of fighting the spread of Covid- 19. This method has been taken up as an integral part of social and environmental assessment process of the project. Consultation was used as a tool to inform project affected people, beneficiaries and stakeholders about the proposed activities both before and after the development decisions are made. It assisted in identification of the problems associated with the project as well as the needs of the population likely to be impacted. This participatory process helped in reducing the public resistance to change and enabled the participation of the local people in the decision-making process. Key findings of the consultation with local community are presented in the table below:

Table 45: Key outcomes of consultation at community level

No	Question/comments	Answers provided by consultant team
1	The project will no doubt affect land and crops . How these will be compensated and by who?	The implementation of the project will rewire land for construction of project infrastructures. Some of those infatsrtucres will be permanenet and others may be temporally. Some crops and other structure amay also be affected by the project. Fain compensation will be done. And these will be conducted following the requirements of the expropriation law in public interests. Those having land other properties to be damaged will have a key role in land compensation measures as they will be some compensation committees that would be created for the good conduct of the compensation process and conflict resolution if any. Compensation will be done by WASAC Ltd via the National Ordinary Budget
2	Who is going to fix the amount of money for compensation	The valuation will be done to allow fair compensation. As per the existing expropriation, valuations of assets will be done by an independent valuer who will be hired by WASAC Ltd in collaboration with the District. This will be conducted to allow fair compensation and will be done in accordance with the existing laws.
3	When will the project be implemented to plan ahead of time	The project is of good and human well being. The sooner the better. However, considering the all requirement for the project to be implemented some of the activities started and thse include, preliminary project designs, fund mobilization etc. It is expected that in case everything goes well including tendering process, the project construction works are expected to start early 2024 and ending 2026.

No	Question/comments	Answers provided by consultant team
4	Will be there new connections to the water network as a result of project implementation?	For sure. As the project stands to increase the accessibility to clean water new connections will be made even in remote areas of the project to increase water availability.
6	What kind of compensation will you give us?	Fair compensation will be provided in cash. Measures to establish the compensation will be based on eligibility criteria and the nature of impact and the compensation will include only monetary compensation. There is no land for land compensation that is expected.
7	It was noted sometimes that s the fees paid by WASAC Ltd as compensation is not enough to buy another land. How WASAC ltd is planning to address this issue?	WASAC Ltd together Kicukiro District will hire and independent valuer to provide the replacement cost. For the person who disagrees with the value assigned to his/her properties; appealing measures are provided by the expropriation law in Public interests. Prior to the valuation exercise, the law and procedures of appealing to address issues related to compensation will be available to public and explained to the PAPs.
8	Will be there job creation by the new project.	For sure that jobs will be created and local population will benefits for employment connected to the project. Even though some activities will require the use of machines, knowledge and expertise to manipulate them; other works will be performed by people and affected persons will be given priority. However jobs will not be given and limited to the affected people but more personnel will be recruited to work on and for the project. These include manpower, masonry, machine operators, guards etc.
9	Will some pipelines destroy our houses.?	Maximum efforts were made to local the pipelines longest the existing roads. No houses destruction are expected to be caused by the project . however were not possible, some structures may be affected by the pipeline construction works. Where possible The land used for pipelines will continue to be used by the land owner. As the pipes will be buried in more than 1m depth this may not affect or handicap the normal use of that land and especially for agriculture purposes. Some restriction wills be imposed e and people will be regularly sensitized to protect the installed infrastructure. The other land for reservoirs will be taken permanently and fair compensation will be done before project implementation. .

CHAPTER VII: IMPACTS PREDICTION, ANALYSIS AND MITIGATION MEASURES

The implementation of the present project of Construction of Masaka Water Treatment Plant in Masaka Sector will have both positive and negative impacts. The environmental impact herewith described in this EIA report refers to the changes of existing conditions of any area or environment caused by human activities or any internal or external influence, which may be positive or negative. Project activities that are likely to cause impacts include construction works and related activities such as site levelling, soil excavation, site clearing, vegetation cutting, water abstraction and treatment, construction of water pipelines and water storage, water treatment and distribution etc.

7.1. Identification and evaluation of potential impacts

7.1.1. Impact identification

In order to identify the potential impacts of the project, impact matrix was designed and used for the assessment of impacts associated with almost any type of development project. Its main strength is a checklist that incorporates qualitative information on cause-and-effect relationships. The used matrix is provided in the table below:

Table 46: Risks/Impacts Matrix associated with the construction of Masaka WTP

Environmental components			**Physical impacts (Land-Water-Air)**								**Biological impacts**				**Socio-economic impacts**										
			Geology	Soil		Water			Air	Visual	Flora		Fauna		Resettlement						Quality of life				
Project activities			**Geological formation**	**Soil pollution**	**Soil erosion**	**Water Pollution**	**Runoff and infiltration**	**Underground water pollution**	**Air quality**	**Visual impacts**	**Loss of Flora species**	**Flora Succession**	**Loss of Fauna species**	**Disturbance of Fauna Habitat**	**Loss and disturbance of**	**Loss of Crops**	**Loss of private land**	**Loss of public land**	**Loss of income**	**Infrastructure and public**	**Occupational health and safety**	**Employment**	**Skills transfer**	**Injuries and work accident**	**Noise and vibration**
Project Phase	#	Main Activity																							
Design and Planning	1	Preliminary Survey and detailed design of project components													+	+				+	+	+	+	+	
Construction	2	Excavation and Installation works	+	+	+	+	+	+	+		+		+	+		+	+	+	+	+	+	+	+	+	+
	3	Installation of wellfileds	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+		+	+	+	+	+
	4	Excavation and installation of raw water transmission pipes	+	+	+	+	+	+	+		+	+	+	+		+	+	+	+	+	+	+	+	+	+
	5	Construction of receiving raw water basins	+	+	+	+	+	+	+		+	+	+	+		+	+	+	+		+	+	+	+	+
	6	Construction of Coagulation-Flocculation and sedimentation basins	+	+	+	+	+	+	+	+	+	+	+	+		+	+		+		+	+	+	+	+
	7	Construction of water reservoirs	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+
	8	Excavation and construction of water transmission pipes	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	9	Construction of administrative building and other buildings	+	+	+	+	+	+	+		+	+	+	+		+	+		+		+	+	+	+	+
	10	Construction of sludge drying beds	+	+	+	+	+	+	+		+	+	+	+		+	+		+		+	+	+	+	+
	11	Excavation and transport of construction materials		+	+				+											+	+	+	+	+	+

Environmental components			Physical impacts (Land-Water-Air)								Biological impacts				Socio-economic impacts										
			Geology	Soil		Water			Air	Visual	Flora		Fauna		Resettlement						Quality of life				
Project activities			Geological formation	Soil pollution	Soil erosion	Water Pollution	Runoff and infiltration	Underground water pollution	Air quality	Visual impacts	Loss of Flora species	Flora Succession	Loss of Fauna species	Disturbance of Fauna Habitat	Loss and disturbance of	Loss of Crops	Loss of private land	Loss of public land	Loss of income	Infrastructure and public	Occupational health and safety	Employment	Skills transfer	Injuries and work accident	Noise and vibration
	12	Transportation of other project materials and personnel		+					+	+										+	+	+	+	+	+
Operation phase	13	Raw water treatment process		+		+		+													+	+	+	+	
	14	Sludge wash out		+	+	+	+														+	+		+	
	15	Operation and maintenance works		+		+	+				+		+						+		+	+	+	+	+
Decommissioning	16	Site closure	+	+	+	+	+	+	+	+	+	+	+	+		+			+	+	+	+	+	+	+
	17	Decommissioning	+	+	+	+	+	+	+	+	+	+	+	+		+			+		+	+	+	+	+

+= Occurrence of potential Risk/negative impacts

7.1.2. Impact analysis

Impact analysis was done through conducting risk assessment, risk evaluation and risk management (relating directly to applicable mitigation measures to be implemented. The findings are presented in the impact analysis matrix below:

Table 47: Impact analysis matrix of the project

Nature or Status of the Impact: The type of effect the activity would have on the environment		
Status		Description
Positive:		a benefit to the holistic environment
Negative:		a cost to the holistic environment
Neutral:		no cost or benefit
Duration of the Impact: The lifetime of the impact		
Score	Duration	Description
1	Short term	Less than 2 years
2	Short to medium term	2 – 5 years
3	Medium term	6 – 25 years
4	Long term	26 – 45 years
5	Permanent	46 years or more
Extent or Scale of the Impact: The distance from source that impacts may be experienced		
Score	Extent	Description
1	Site specific	Within the site boundary
2	Local	Affects immediate surrounding areas
3	Regional	Extends substantially beyond the site boundary
4	National	Affects country
5	International	Across international borders.
Reversibility of the Impact: To what degree its influence on the relevant environment can be negative.		
Score	Reversibility	Description
1	Completely reversible	Reverses with minimal rehabilitation & negligible residual affects
3	Reversible	Requires mitigation and rehabilitation to ensure reversibility
5	Irreversible	Cannot be rehabilitated completely/rehabilitation is not viable
Intensity or Magnitude of the Impact: Severity of the negative and magnitude of positive impacts		

Score	Severe/beneficial effect	Description
1	Low	Little effect - negligible disturbance/benefit
2	Low to moderate	Effects observable - environmental impacts reversible with time
3	Moderate	Effects observable - impacts reversible with rehabilitation
4	Moderate to high	Extensive effects - irreversible alteration to the environment
5	High	Extensive permanent effects with irreversible alteration

The Probability of the Impact: Describes the likelihood of the impact actually occurring		
Score	Rating	Description
1	Unlikely	Less than 15% sure of an impact occurring
2	Possible	Between 15% and 40% sure of an impact occurring
3	Probable	Between 40% and 60% sure that the impact will occur
4	Highly Probable	Between 60% and 85% sure that the impact will occur
5	Definite	Over 85% sure that the impact will occur
The Consequence (C)		= Magnitude/Intensity (M/I) + Extent (E) + Duration (D) + Reversibility (R).
The Significance (S)		= Consequence (C) x Probability (P)

After assessment of an impact in accordance to the criteria described above, the significance of an impact can be determined. The various ratings as indicated above are accorded to these criteria. These ratings are then used to calculate a significance (S) rating and are formulated by adding the sum of ratings given to the extent (E), duration (D), Reversibility (R) and intensity (I) and then multiplying the sum with the probability (P) of an impact as follows:

Significance (S) = (E+D+R+I) X P

The significance rating is described as follows:

Score out of 100	Significance
1 to 20	Low
21 to 39	Moderate to Low
40 to 60	Moderate
61 to 79	Moderate to high
80 to 100	High

The following table summarizes the evaluation of impacts associated with the proposed project of Construction of Masaka Water treatment Plant and shows identified impacts and their significance during different project phases.

Table 48: Summary of impacts evaluation

Project Phases	Main Activity	Positive/ Negative/ Neutral Impact	Magnitude (M/I)	Extent (E)	Duration (D)	Reversibility (R)	Probability (P)	Significance (S)	Mitigation
Design and Planning	Job Creation		5	1	1	1	4	32	No
	Risk of accidents and diseases contamination		3	1	1	5	1	10	Yes
	Income generation		3	5	1	5	4	56	No
	Skills transfer		3	4	1	5	3	39	No
	Gender considerations		2	4	1	5	3	36	No
Construction phase	Job Creation		5	5	2	5	5	85	No
	Loss of land and other structures		4	2	1	5	4	48	Yes
	Loss of houses		4	2	1	5	1	12	Yes
	Loss of income		4	2	1	5	2	24	Yes
	Loss of crops		4	1	1	5	5	55	Yes
	Soil erosion		2	1	2	3	2	16	Yes
	Surface and ground water pollution		3	2	1	5	2	22	Yes
	Dust emission and air pollution		4	1	1	5	4	44	Yes
	Noise pollution		3	1	1	3	3	24	Yes

		Positive/ Negative/ Neutral	Magnitude (M/I)	Extent (E)	Duration (D)	Reversibility (R)	Probability (P)	Significance (S)	Mitigation
	Loss of fauna and flora		5	1	1	3	5	50	Yes
	Possible disease contamination between workers		4	2	1	5	2	24	Yes
	Solid waste generation		4	1	2	3	5	50	Yes
	Gender based violence and sexual harassment		3	2	1	3	1	9	Yes
	Vandalism		2	2	1	3	1	8	Yes
Operation phase	Surface water pollution		3	3	3	5	3	42	Yes
	Generation of sludge		4	1	3	5	5	65	Yes
	Work accidents		4	1	2	3	3	30	Yes
	Possible conflicts with local community		2	2	1	1	1	6	Yes
	Generation of solid wastes		4	1	3	3	5	55	Yes
	Income generation		5	3	4	5	5	85	No
	Job creation		5	4	5	5	5	95	No
	Vandalism		2	1	1	1	1	5	Yes
Decommissioning	Soil contamination		3	3	1	5	2	24	Yes
	Water and air pollution		2	3	1	5	3	33	Yes
	Job Creation		2	1	1	5	5	45	No
	Site restoration and improvement		4	1	5	1	4	44	No
	Water supply availability		5	4	5	5	5	95	No

7.2. Positive impacts of the project

Different potential positive impacts were identified to be caused by the project implementation and based on the methodology described above; they are discussed in the following paragraphs.

7.2.1. Positive impact during of the planning and design phases

Based on the conducted scoping exercise, it is noted that there will be no considerable environmental impacts in the preliminary planning and design phases of the project. Among key positive impacts identified include:

i. Employment opportunities and job creation

During the planning and design period, new jobs will be created in the form of skilled and unskilled labor in the local community to conduct topographical surveys and work force. A majority of unskilled labour will be sourced from the local residents. Indirect employment will be in the form of suppliers and other forms of sub-contracted works that will be required for planning and design of project components.

ii. Income generation

The employments connected to project implementation will generate income to local population who will be directly or indirectly employed by the project. This will contribute to their income generation in terms of salary income or other form of income.

iii. Increased savings for the local employees

The increase of the project's local work force and employee's revenue will lead to the possibility of savings in local banks such as SACCO and local micro-finances of the project area.

iv. Skills transfer

In the process of planning and design, the local technical work force will work with the experts in different domain. This process of working together will transfer design and planning tools and other useful guidelines, which are used in similar topographical conditions countrywide.

v. Gender considerations

During the implementation of the present project women will equally benefit as men in terms of employment benefits. As also in Rwandan culture, the collection of water is the responsibility of a woman and girls, these are mostly vulnerable during water shortages and sacristy. . Therefore, the proposed project will be highly beneficial to women and girls and will enhance the gender balance considerations. .

7.2.2. Positive impact during construction phase of the project

i. Employment opportunities

During the construction phase of the present project, different people with different skills will be employed and among them including local population within and in the surroundings of the project area. Other people may include experts from different field in water treatment plant constructions. This ensures that they will economically benefit from the project and as expected, the project will provide up to more than 100 employment opportunities over its entire lifetime including permanent and temporally workers at the plant. The use of local labourers and skilled workers will improve the skill resource base in Rwanda through the implementation of training and development programmes. These are both positive outcomes of the project and for the local population.

ii. Knowledge transfer

Technical and planning skills will also be gained by the Rwandese people that will be employed by the project and this is likely to contribute to the capacity building. Among them include local civil engineers who will be working with other civil experts with different expertise, machines operators, and water treatment engineers. There will be also the knowledge of technology transfer among project employees.

iii. Increase to public revenue and local socio-economy

All works connected to the project will provide a positive increase to the local and national economy in general This will fully contribute to the increase of human socio-economy benefits within and around the project area. The implementation of the project will also increase revenue and taxes for both the central (Rwanda Revenue Authority) and local authorities. The project will fully participate in increased payments of taxes from suppliers of construction materials and other stuffs required necessary for the project implementation.

iv. Rational exploitation of Rwandan natural resources

The project will contribute to the wise-use of water resources, with among the aims to serve as a model and inspiration for the future attempts for similar projects in region. The project is also committed to ensuring that local companies, local raw materials will be utilized as much as possible for successful completion of the project. It is expected that the demand for the supply and production of local building materials as well as provision of services will contribute to providing a positive increase to various sectors related to the construction industry.

v. Gender balance enhancement

It is expected that during the project implementation women will also equally benefit as men in terms of employment benefits. This will contribute to the government vision of fighting against gender inequality and ensuring that women are given equal opportunity in terms of employment.

7.2.3. Positive impacts during the operation phase of the project

i. Access to potable water and reliability of water supply system

The Construction of Masaka WTP will add more 20,000 m^3/d of water to the existing water supply system within Kigali City. This will contribute to the increase of number of people with access to clean water and therefore increasing their well being. This will enable greater responsiveness to the demand, increasing also the reliability of the operating system. The reliability of the system will allow adequate planning for water supplies.

ii. Economic diversification and improved local socio-economy

All works related to the project will provide a positive increase to the local and national economy. In general this will contribute to the socio economic benefits within and around the project areas of intervention. The economic expansion will enable alternative businesses and economic activities to be developed in the project areas. Also, increased earnings by staff will most likely be spent locally further supporting already established businesses in the area, as well as potential new businesses that may emerge and connected to the project.

iii. Healthcare for employees

Employees and their families will be provided with basic healthcare. This will benefit the overall health of the local population. HIV/AIDS, COVID -19 and other information related to the prevention of contaminated diseases will be dispersed to employees to prevent the spread of such diseases amongst the project employees and their families.

iv. New jobs creation

As the project will supply water in different areas of Kigali City, new emerging public water kiosks for water vendors may arise from the implementation of the project. This will therefore contribute to the new creation of new jobs in different areas of the project and therefore fighting the unemployment.

v. Improved health and sanitation

The project will significantly contribute to improvement of sanitation within its areas of intervention and therefore improvement of living conditions of Rwandan population.

7.3. Potential adverse impacts and their mitigation measures

The construction of Masaka WTP is a vital, positive and necessary intervention project. However its implementation has identified some negative impacts as described below. The mitigation measures were also proposed to each of the identified impact. .

7.3.1. Potential negative impacts during planning and construction Phase

7.3.1.1. Negative socio-economic impacts

i. High jobs expectation by local community

During the conduct of stakeholder consultation, it was noted that local population are expecting more jobs from the project implementation. Indeed, although the project will create employment opportunities, the jobs will be limited and it is therefore important that the procurement processes is clear and fair. It is expected that creation of not enough jobs will create frustration on part of the local people and conflicts can occur or be generated in relation to the project implementation

✓ **Mitigation measures**

- Local and affected project persons should be prioritized when allocating jobs
- Recruitment should be done a clear and fair process.
- Establish recruitment committees prior to job commencement
- Women should equally benefits from job recruitments

ii. Resettlement implications

The implementation of the present project will require land to accommodate the project infrastructures. These include the land for the entire WTP and land for transmission and distribution pipes. The land for the proposed plant location is currently privately. Fortunately there are no households or other structures that will be affected at the plant location. Only trees and crops will be affected and removed to pave the way the project activities.

✓ **Mitigation measures**

- The project design should take into consideration the land issues and scarcity in the project area and designs to be done when minimizing the use of land.
- The required land for the project has to be purchased/ compensated before project implementation. .
- Crops and trees to be affected will be also compensated before project implementation.
- All compensations should be done prior to the project implementation and in accordance with the existing laws and regulations related to the expropriation in public interests.

iii. High expectations of getting great compensation in cases of resettlement

It is no doubt that some people will lose their land or infrastructure or business due to the project implementation. Some of them may have a bad behaviour of highly benefitting from the project implementation while expecting more form the compensation.

✓ **Mitigation measures**

- Valuation of damaged assets should be done with the certified independent valuer as per the existing regulations and laws.
- Full replacement cost should be used so as to provide fair compensation and the application of market and value of money to be applied.
- The compensation exercise has to involve different project partners including WASAC, Local population and local leaders, PAPS, district etc.

iv. Conflicts among workers and the local population

Though it is anticipated that the project will make an effort to employee local population, projects involving major works include, often, the potential for the occurrence of social conflicts between workers who temporarily settle in the local and community residents. Such behaviours are generally related to socially unacceptable behaviour according to local social standards and can be seen, for example, cases of drunkenness and disregard/lack of respect for local customs. This impact should be considered even though an important part of the manpower to be recruited is locally.

✓ **Mitigation measures**

- Where possible maximum efforts should be made to recruitment of local population who returns to their homes after work.
- Elaborate and enforce the code of conduct to all project workers

v. Injuries or fatalities from project activities

The most common injuries or illnesses as a result of manual handling are musculoskeletal disorders in various parts of the body (back, neck, shoulders, or other) and include from sprains and strains to damage to muscles, joints and vessels. Other injuries include cuts, bruises, lacerations and fractures due to unexpected events such as accidents caused by manual handling.

Mitigation measures:

- Health and safety measures to be implemented at the project site.
- provision of Personnel Protective Equipment (PPE) to all employees,
- Provide permanent First aid kit at the work site,
- Provide health insurance as means of health affordability
- Working conditions should respect the requirement of the Law n° 66/2018 of 30/08/2018 regulating labour in Rwanda.
- Measures are taken to oblige workers to wear safety boots and helmets and to manage waste properly, in order to prevent accidents during the construction works
- The safety plan will be prepared and enforced at the project site.
- Basic trainings on safety measure to be conducted to the project workers.
- Provide sign boards at the project site in order to prevent accidents and troubles involving site workers at the construction site.

vi. Work related health issues

Health related issues are mainly resulted from emission of dust, noise and vibration which can result in possible respiratory irritation, discomfort, or illness to workers and local communities.

✓ **Mitigation measures**

In addition to the safety measures mentioned above, the following additional measures should be implemented:

- PPE should be provided to workers who are exposed to dust, noise and vibration for a prolonged period.
- Regularly watering the project site when necessary to suppress dust during construction, use of gas masks and goggles for dusty sections is strongly recommended;
- Enforce the acquiring of medical insurance “mituelle de sante” for all workers as a means of affordability of treatment.
- The safety and sanitation plan will be prepared and implemented and regular safety education will conducted, in consultation with a district work safety inspector.

vii. Possible increases of HIV/AIDS and other communicable diseases such Covid -19

Risk of increase of HIV/AIDS and other Sexually Transmitted Diseases (STD) as well as the increase of contaminating diseases such as Covid-19 due to the increase of people from outside of the project zone may arise among workers.

- ✓ **Mitigation measures**

- Regular sensitization on ways of HIV/AIDS prevention,
- Regularly enforce the measures of hygiene and workers should be sensitized on the prevention of such diseases.
- Wearing protective masks should be mandatory and disciplinary measures should be implied.
- The contractor is requested to arrange a health and hygiene training for workers in cooperation with health centre near the construction site, in order to prevent infectious diseases

viii. Project impacts on public utilities/ infrastructures

During construction of the pipelines some social infrastructure like water point, road crossing and water supply infrastructure may be affected.

Mitigation measures

- Rehabilitation of affected structures and infrastructures as soon as possible after project works;
- Inform local population about the inconvenient and this prior to the works.

ix. Child labour, forced labour , discrimination and abusive dismissal

The implementation of the present project should be done in compliance with national and international standards in terms of child labour forced labour and discrimination.

Mitigation Measures

- Protect workers' rights and provide contract to each employee
- Establish, maintain, and improve the employee–employer relationship;
- Promote compliance with national legal requirements and provide supplemental due diligence requirements where national laws are silent;
- Comply with international Labour Organization, and the UNICEF Convention on the Rights of the Child, where national laws do not provide equivalent protection;
- Protect the workforce from inequality, social exclusion, child labour, and forced labour

7.3.1.2. Negative Impact on Physical Environment

The topography of the project area is characterized with a plain zone with a relative flat site with no major steps slops. The location of the plant is also relatively flat. Secondly, the construction activities will contribute to the loss of the topsoil in some areas and combined with soil compaction during site preparation and levelling will result in reduced capacity of the ground to retain water and increase surface water run-off during periods of rainfall. The construction around and within Akagera River will also cause water and soil pollution from drilling muds, borrow pits and quarries; as well as disturbance/loss of vegetation. The identified physical impacts to the project implementation are described above and their proposed mitigation measures:

i. Conflict between the railway project and Masaka WTP

As described in the section 5.3.1 and shown on figure 35 of this report, Masaka WTP is subject to be constructed in the same buffer of the Kigali - Dar e Salam railway. This is a project of GoR under pipeline to be connect the country with the rest of The East Africa. Considering the presence of this rwail in the project sites this may cause several impacts on both. Considering that both projects are at the feasibility stages , following are the mitigation measures to overcome any impacts tat may be raized during the project implamantation;

- ✓ **Mitigation measures**

- Consultation between WASAC ltd and RTDA are recommended for proper way forward before final stuides of both projects (MWTP and kigali Dar e Salam railway)
- The final techcnical designs for Masaka WTP have to consider the presense of railwayin the project area and the railway crossings by the pipelines to be designed in accordance with the project.

- All final desings for both projects habe to be done in close colaboration for project complementatarity.
- Joint collaboration and consultation between all involved Institutions is required before final designs of both projects.

ii. Changes of landscape - Visual impact

Impacts on the physical environment will consist of landscape transformation causing visual impacts. The construction of the plant and water pipe lines will alter slightly the landscape at their areas of interventions. These impacts will remain during operational phase and disappear after the project implementation. Temporary physical impacts will occur during the construction period at places selected to store construction materials and at accommodation places for workers. However, those sites will be decommissioned after the construction phase; the visual impact is restricted to the construction period.

✓ **Mitigation measures**

- To clear only the area demarcated for construction activities;
- Rehabilitation of construction sites.
- Re-vegetate the damaged species through trees planting

iii. Water pollution

The construction works at the project sites would impact the water quality of Akagera river. The use of machinery in the nearby would also spill away some liquid or solid wastes generated from the construction works which will cause adverse effect in the project environment.

✓ **Mitigation measures**

- Before starting to use heavy equipment near the river, the soils of the river banks have to be protected with strong materials in order to prevent it from falling into the river especially during the excavation works.
- No activities shall be allowed within the buffer zone of the Akagera River
- Properly planning for the intended activities to avoid unnecessary waste generation around the river
- The construction period should be done during dry season in order to avoid soil and sediment run off into water bodies;
- Project designs to consider the buffer zones of the river and restrict any activity within the buffer zone.

iv. Soil pollution and erosion

Soil excavation, trenches excavation, construction works and vegetation clearance will expose soils in the project affected areas leaving them vulnerable to erosion by surface run-off or by wind. Other activities exposing soil include the movement of machines, trucking, and to some extent the felling of trees during excavation works. Soil erosion depends not only on soil damage but also soil type, rainfall, and angle and length of slope. Soil erosion is mostly expected at high slops of pipelines and without adequate water management on site, soil erosion will persist and result in loss of soil and sedimentation and affecting the downstream of the project areas. However the impacts of soil erosion are mostly expected to happen during rain seasons.

The contamination of soil may also occur from the spillage of oils and lubricants during construction works and operation activities. Degradation of the surrounding soil will affect flora and fauna and may restrict the future land use.

✓ **Mitigation measure**

- Properly monitor areas of exposed soil so as to implement sediment dispersal measures as appropriate.
- Only clear areas earmarked for construction works.
- Construction of soil erosion barriers at the project sites.
- Limit areas subject to excavation works.

v. Generation of effluent from plant washouts

The treatment of surface water for potable supplies involves coagulation, flocculation, sedimentation and filtration processes for removing colloidal as well as suspended solids from raw water as explained in the previous chapters. All the water treatment processes produce waste/residue known as water treatment

sludge (WTS) during the purification of raw water. Depending of the chemicals to be used at the plant, the produced sludge may present different physical and chemical characteristics that may contain fine sand silica, ferric oxide and lime and others. The direct disposal of the produced sludge into the environment is not an environment friendly disposal option .

✓ **Mitigation measures**

- Conduct further chemical analysis of the produced sludge and determine their final uses/ destination before they are discharged in the environment.
- Enforce the mechanism of waste water management at the project site..
- Develop suitable sludge management strategies at Masaka WTP.
- The sustainable and profitable disposal through recycling and reuse is recommended such use as fertilizers, bricks making or as substitute to building materials. However, further studies are recommended before the choice is made and the recycling in building and construction industry could be a safe disposal option.

vi. Dust generation and air pollution

Exposed surface with loosened topsoil will increase dust raised in the area especially during initial levelling and preparation required under each phase of the project. Dust will also be raised by haulage vehicles delivering materials to and from the sites of the project. The dust raised during construction can pose a nuisance to workers although the impact of this is considered relatively small and localized. This situation will be worse during the dry season and during the afternoons when the winds are most prevalent. Air borne particulates may pose a hazard to site workers or downwind of the construction sites that suffer from upper respiratory tract problems.

✓ **Mitigation**

- Access roads and exposed ground should be regularly wetted in a manner that effectively keeps down the dust.
- Exposed construction sites will be fenced with wind brokers to avoid dust emissions to neighbouring areas especially at the pipelines construction areas
- Workers on the site should be issued with dust masks during dry and windy conditions.
- Most of the emissions are expected to come from vehicles, tractors and machines to be used. The contractor will be required to present technical control certificate for all vehicles, machines and trucks. Those certificates are issued by National police and are issued only when the vehicle emission is below the maximum permissible limit.
- A regular monitoring on ambient air will be conducted to check the level of air pollution. In the case the level exceeds the minimum permissible air pollution level, the developer will be required to reduce his emissions

vii. Impacts on noise and vibrations

Noise will be caused by construction traffic transporting construction materials/workers to and from the site and from the construction sites. These would be also generated by the operation of heavy machines, heavy trucks, right of way preparation, soil stripping, trenching, pipe stringing, welding and laying and backfilling activities. However, the impacts are limited as the construction works will be for a short period and only to be done during normal working hours.

Mitigation measures include the:

- Limitation of heavy works in daytime 7am to 5pm;
- Provision of PPE to workers;
- If necessary, local residents should be given notice of intended noisy activities so as to reduce degree of annoyances especially at the pipelines construction sites.
- Workers operating equipment that generates noise should be equipped with noise protection gear.
- A regular monitoring of noise will be conducted as to check the compliance of noise pollution with permissible level.
- As most of the expected noise is from vehicles, truck and machines, the contractor will be requested to use equipment in good condition and certificate of technical control will be required
- Equipment with heavy noise and vibration will be restricted on normal working hours, from 7am to5 pm,
- Facing sites should be mandatory to limit noise emitted.

viii. Generation of solid waste

Solid waste generated during site preparations and construction works would include several types of solids wastes including off cut vegetation, typical construction waste, soil, metals, and papers. These wastes would negatively impact the site and surrounding environment if not properly managed and disposed of at an approved dumpsite.

✓ **Mitigation-**

- A site waste management plan should be prepared by the contractor prior to commencement of construction works. This should include designation of appropriate waste storage areas, collection and removal schedule, identification of approved disposal site, and a system for supervision and monitoring.
- Onsite temporally waste deposit area should be clearly designated and marked. Workers on site will be clearly briefed on proper solid waste disposal.
  Waste recycling is also an option whereby construction recycled soil and concrete debris can be used as road bed materials in different areas of the project interventions.

ix. Oil spillages

During the construction activities it is expected that machinery including trucks, bulldozer and other equipments that require re-fuelling, maintenance works and repair works, which in effect result in oil spillage. At point sources, contamination of soils and run-off ending in the receiving bodies could cause water quality degradation.

✓ **Mitigation Measures**

- Re-fuelling, oil change, maintenance works, repair works shall be allocated at a restricted area and far from water body and marshland and preferably positioned in an area that have no adverse effects if degraded.
- The area allocated for fuels shall need to have a cemented floor and a sand stock for use in the absorption of spilled oil.
- Water quality will be regularly monitored so as to compare the baseline and monitoring results. If during monitoring process water is contaminated, then additional measures will be taken.

x. Impacts on quarries and burrow pits

It is anticipated that the project will need construction material such as sand and stones. Therefore, it is appropriate to give consideration to the environmental implications in selection of quarry sources since poorly run operations create dust problems, contribute to noise pollution or environmental degradation in general.

✓ **Mitigation measure**

- All construction materials have to be sourced from approved and licensed quarries.
- Burrow pits areas shall preferably be selected from high land and/or waste land. Although locations of the borrow areas are negotiated between contractor and landowners. The excavation and restoration of the burrow areas and their surroundings, in an environmentally sound manner to the satisfaction of the Supervising Engineer, is required before final acceptance and payment under the terms of the contract.

7.3.1.3. Negative impact on biological environment

i. Loss of flora and fauna

Some crops and trees established in the project area will have to be destroyed and removed especially at the water treatment plant and at the pipelines locations.

✓ **Mitigation**

- Compensation of trees and land to be affected should be done prior to the project implementation to avoid further complaints at the project site.
- The site clearance should be only done on an area demarcated for construction activities.
- The landscaping through rehabilitation and re-planting of affected trees is recommended after project construction works.

ii. Disturbance of ecosystems habitats

The clearing of vegetation during excavation works will result in the complete loss of associated ecological habitats and their fauna within the project areas. Noise, vibrations, and intrusive activities related to construction works will tend to scare away some animals species remaining on the site after vegetation clearance.

✓ **Mitigation**

- Clearing and construction activity should be restricted within the area of the project development.
- Construction works should be limited at only project areas
- Construction works to be done only at day time

7.3.2. Potential impacts during the operation phase

Environmental impacts related to the operation phase of Masaka water Treatment Plant and associated forward infrastructure are manly associated with water abstraction and treatment. Key anticipated impacts during this phase and proposed mitigation measures are presented in the following sections:

(i) Dusturbance of water balance

During the operation phase, groundwater will be day to day exploited from the nearest river bank of Nyabarongo River at a rate of 20,000m 3 /day in phase 1. Even if, as described above, the area has enough quantity of groundwater and it is no doubt that the extraction will compulsory contribute to the variation of the groundwater table within the project region and downstream. Considering the available water discharge in the area, the project will have minor variation of ground water table taking into consideration the Nyabarongo river input, the abundant rainfall and other climatic patterns. It is also noted that the groundwater abstraction will be limited to the fixed rate and regular monitoring is recommended.

✓ **Mitigation**

- There will be no use of surface water during the operation of the plant and hence no impact is expected on the surface water.
- To maintain the ecological system, the average safe yield for each well should be set between 40 to 60 m3/h for keeping the minimum drawdown in each operating well as recommended by hydro-geological study.
- Regular monitoring of water level and water table should be conducted as to maintain the minimum ecological flow especially in dry season(June, July and august. Bases on the monitoring result, the system operator will decide on the amount of water to be extracted.

(ii)Water pollution

During the operation phases some chemicals will be used and it is with no doubt that the plant will produce some sludge.

✓ **Mitigation**

- It is proposed to remove this sludge by dewatering m/c to be constructed at the Treatment plant area.
- All chemical sludge will be properly handled on site and brought to Ntarama landfill and this one will be monitored continuously. It is recommended that there not be any sludge disposal into Nyabarongo River to preserve it normal quality.

(iii) **Sludge handling and disposal**

During the operational phase two kind of waste is expected including sludge and waste water. If not well handled, this waste may contribute to water pollution and environmental degradation. Therefore, a proper handling and disposal plan is required in order to avoid any pollution or environmental degradation.

✓ **Proposed sludge handling and disposal**

- Backwash thickeners and belt press filtrate will be recycled to the inlet of the plant and Sludge will be thickened.
- **Dewatering** aims to reduce the water content further so that the solids content of the sludge is about 20 % (equivalent to 1 kg dry sludge with 4 L of water). The sludge can then be handled like a solid. Dewatering can be done mechanically using a filter press (employing pressure or vacuum), or a centrifuge.
- **Sludge reuse:** the sludge can be reused for different use including in agriculture or in bricks making. The expected sludge will have less biological component and there may be a presence of pathogens in the sludge in high numbers which make the use in agriculture unsatisfactory. Therefore the plausible opportunity of sludge reuse would be in bricks making around the project area there people who are involved in making bricks and Kigali Water Limited will consult with bricks maker in order to explorer this opportunity.

- **Final or ultimate disposal of sludge, which cannot be reused**, is by land filling or incineration. Since sludge for land filling usually contains heavy metals or toxic chemicals, lining of the landfill with clay or plastic liner may be required to prevent contamination of groundwater.
- Sludge disposal should be done in appropriate landfill approved by District authority and in accordance to the Land Use Master Plan.

The appropriate landfill should be ready and approved by relevant authority before the completion of construction works.

(iv) Wastewater treatment

Dewatering the sludge will release wastewater and if no well handle it may have adverse impact on environment and on human health as the water treatment plant is located not far from the wetlands. Environmental pollution by wastewater or consumption of wastewater contaminated water might lead to eruption water-borne diseases i.e. cholera, diarrhoea, dysentery and typhoid. Problems associated with the unmanaged increased wastewater could last during the whole project life.

✓ **Mitigation measures:**

- The filtrate water which is generated from sludge dewatering will be recycled to the water treatment plan
- Wastewater from sanitary sewage which is generated from administration building, guard room, workshop will be treated in septic tanks.

(v) **Vandalism of water supply infrastructure**

With the coming of the project, a number of infrastructures will be made from metal, steel and concrete some people may be involved in vandalism of that equipment's.

- **Impact Significance**

The impact could be of low significance in terms of magnitude. With community policing encouraged in Rwanda and existing security organ in the project area, such an impact might be of short term scattered periods of vandalism.

✓ **Mitigation Measure(s)**

- Sensitization of local communities to ensure project ownership and use community policing as a means of ascertaining security, will collectively avoid vandalism.
- Regulations on penalties to perpetrators convicted of vandalism are necessary. Punitive actions towards perpetrators by the authorities will facilitate compliance by the locals thereby avoiding vandalism.

(vi) **Loss of biodiversity due to ground water over-abstraction:**

During operational phase, over-abstraction of ground water has a negative impact on living organisms including flora and fauna. When the groundwater withdrawals exceed recharge, there is a falling of water table and living organism does not have enough water. Therefore any project that need ground water should consider the minimum ecological flow to sustain the living organism.

✓ **Mitigation measure:**

- The hydrological study has evaluated proposed well field and evaluated the aquifer response due to expected daily abstraction (20,000m3/d) under different operating scenarios. To maintain the ecological system, the hydro-geological study recommended the average safe yield for each well to be set between 40 to 60 m3/h for keeping the minimum drawdown in each operating well.
- Regular monitoring of water level and water table should be conducted as to maintain the minimum ecological flow especially in dry season(June, July and august. Bases on the monitoring result, the system operator will decide on the amount of water to be extracted.

Table 49: Summary of mitigation measures compared with after consideration case

Impacts	**Positive impact**	**With No mitigation measures**	**With mitigation measures**		
Positive impacts			**High**	**Medium**	**Low**
Employment opportunity and income generation	+				
Skills transfer	+				
Increased saving for local employee	+				
Gender balance enhancement	+				
Increased public revenue and local	+				

Impacts	Positive impact	With No mitigation measures	With mitigation measures		
socioeconomic					
Rational exploitation of Rwandan natural resources	+				
Access to potable water and reliability of water supply system	+				
Economic diversification and improved local socio economy	+				
Gender balance	+				
Improved health and sanitation	+				
Improved living condition due to availability of clean water	+				
Negative impacts					
High job expectations by local community		-			-
Resettlement implications		---		--	
High expectations of getting great compensation		---		--	
Conflicts among workers and local population		--			-
Injuries or fatality of workers		---		--	
Possible increase of HIV and other communicable diseases.		--			-
Child labor and forced labor		--			-
Change of landscapes		-			-
Mugesera lake Water pollution		---		--	
Soil erosion and contamination		---		--	
Generation of effluent from washouts		---		--	
Dust release and nuisance		--			-
Noise and vibrations		-			-
Solid waste generation		-			-
Disturbance of ecosystem habitat		--			-
Water use conflicts		--			-
River buffer encroachment		---		--	
Floods risks		---		--	
Sludge generation and hanling		---		--	

+	Positive environmental and Social Impacts
-	Low significance
--	Medium significance
---	High significance impacts

7.4. Cumulative impacts

Cumulative impacts are the environmental and social effects of a project in combination with the effects of other existing projects and/or projects that are being carried out, or are reasonably foreseeable, in respect of specific components of the environment and social conditions. The assessment is carried out to ensure that the cumulative impacts are identified and evaluated in an integrated manner at the catchment basin level. The assessment considered the effects of projects that may interact cumulatively with those of the proposed Project based on available existing information. Projects to be particularly encompassed by the assessment include hydroelectric power generation Nyabarongo I and Nyabarongo II located at upstream of the proposed project location.

7.4.1. Nyabarongo I hydroelectric project

Nyabarongo I is a run of the river power plant with a design capacity of 27.5 MW (two 14 MW Francis turbine) and an estimated cost of US$97.7 million. The project is financed by a line of credit with Exim Bank of India and the balance is financed by the Government of Rwanda. Located on Bijyojyo Hill, in Ngororero District, Western Province, the construction of the power plant began in May 2009 and was commissioned in April 2015. It has become the largest domestic hydropower project of Rwanda. Since the project is a run of the river type of hydroelectric project, it will not modify the hydrology of the river and in contrary will regulate water flow should become better with less maximum. However, the sedimentation in the reservoir may reduce the suspended solid in the water discharged from the reservoir. In addition to that the Nyabarongo River is joined with two rivers before it reach the project area, Akanyaru and

Nyabugogo and this increase the availability of water in the project area.

7.4.2 Nyabarongo II hydroelectric project

Nyabarongo II is a multipurpose project in addition to the production of hydro-electricity; the project will supply water and power to Kigali and for irrigated perimeter. The project is at feasibility studies stage and the final location not yet determined but the proposed one is located not far from Kigali City. The project involves diversion from the river from the dam/intake to the powerhouse over some 8 kilometres and the projected energy cost from the project is relatively high, with the firm energy cost estimated as 15 cents/kWh.

The Nyabarongo II project was originally intended to develop 8,152 ha of land in the region of Bugesera. But in 2009 in an evaluation report by the AfDB (Integrated Rural Development Project of the Natural Region of Bugesera (Rwanda-Burundi), advocated instead a project of 1,500 ha. At the time, domestic and industrial water needs were estimated at 15 cubic metres per second, or a total corresponding to 6% of the flow of the Kagera. By reducing the amount of water in the Nyabarongo River, this project may have an impact on the river hydrological regime. However, predictions of climate change for the East Africa indicate a trend of increased precipitation and flow which may counterbalance the effect. In addition, the planned studies for Nyabarongo II should consider the existing and planned projects downstream in order to avoid any impacts.

The consulting team is the view that the two projects Nyabarongo I and Nyabarongo II do not have any significant impact on the proposed project. However, the proposed mitigation in EIA of the three projects should be implemented.

7.4.3 Nzove water treatment plant and Kanzenze Water Treatment

Other water treatment plants are constructed on Nyabarongo/Akagera river and other are planned on the same rever. These include:

- ✓ **Nzove Water Treatment Plant**

The Nzove I Water Treatment Plant which has been pumping 40,000 cubic meters per day,was upgraded to produce 65,000 while Nzove II was upgraded from 25,000 to 40,000 cubic meters per day.

- ✓ **Kigali Bulk Water Supply Project:**

The Project will have the capacity of 40,000 m3/day and row water will be extracted near the Nyabarongo River near Kanzenze Bridge located on the floodplain in the valley of the Nyabarongo River. The project main components include Kanzenze Well Field and Kanzenze Water Treatment Plant (40,000 m3/day) that will be constructed by KWL.

Both Water Treatment Plants abstract ground water from Nyabarongo/Akagera river. Fortunately the currecnt water balance as decribed in Chapter 4, remain sufficient for current and future development. However, all future development should conduct cumulative impact assesment to confirm that water are still avialable for all projects.

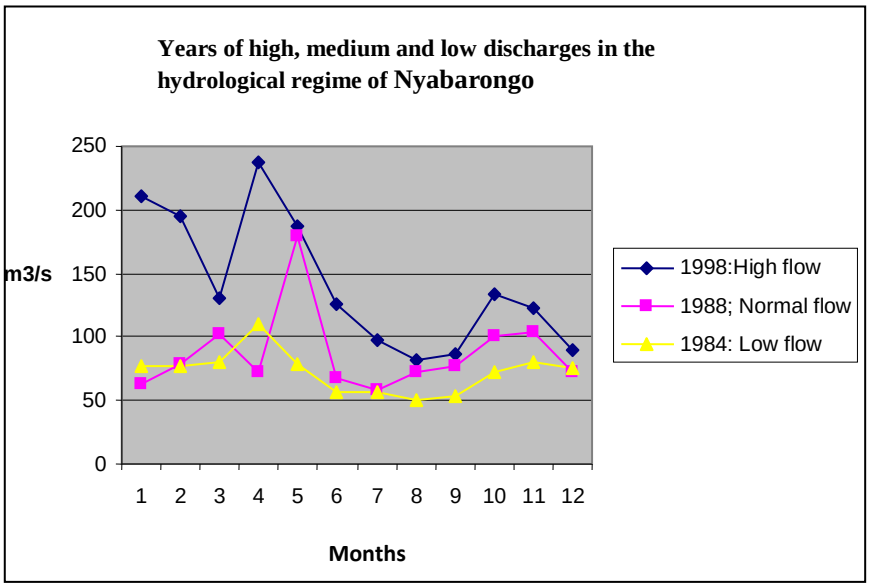
7.5. Climate change impact of the proposed project

In order to evaluate the impact of climate change on water resources of Nyabarongo the watershed of the Nyabarongo river at Kanzenze area has been selected in order to apply simulation techniques of the hydrological balance of our rivers and determine the total quantity of runoff and infiltration water, as well as the water resources available for domestic, industrial, farming, and for ecosystems use. The simulation technique applied to this study is the WATBAL model (Spatial lumped conceptual integrated catchments Water Balance model). This model has two components: a hydrologic balance, representing the flow of water at the entrance and at the exit of the watershed and an estimation of the potential evapo-transpiration.

To apply this model, the hydrographic basin of Nyabarongo river basin, of an area of 8,900 km^2 was chosen. For this study, average temperatures and rainfalls of Ruhengeri Byimana, Gikongoro (Nyamagabe) and Rwamagana stations were used for the period from 1971 to 2005. For evapotranspiration at the level of the selected watershed, it was necessary to precede with the use of results from the climate scenarios of the LMD_98 model in order to have data on evapo-transpiration over the projection years from 2010 to 2100.

As for hydrological data, monthly mean discharges of Nyabarongo at Kigali Station from 1961 to 2005 have been used. The model was also calibrated in function of years with normal, high and low discharges. Thus, the years 1997, 1998 and 2001 were identified as years of high discharges, 1988 and 2002 as years of normal discharges and 1981 and 1984 as years of low discharges. The following graphic shows the years of high, medium and low discharges in the hydrological regime of Nyabarongo, 1971-2013.

Figure 34: Years of high, medium and low discharges for Nyabarongo, 1971-2018

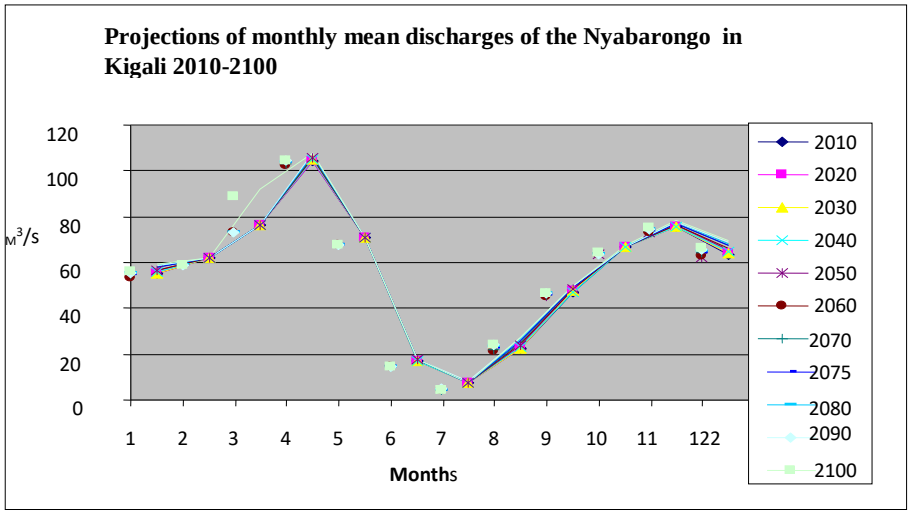


For 1998, the year of high hydrological discharges, high discharges of Nyabarongo begin from January, with a decline in March followed by an increase in Nyabarongo flow in April. Low discharges occur in July and continue up to September during which a new rise in discharges was observed until October. The year 1988, the year of mean discharges is also characterized by a flow with two peaks: a high increase in discharges in May and a low one in November. The year 1984, year of low discharges, presents a low peak in April and another lower peak in November.

✓ **Future projections for Nyabarongo discharges /Kigali, 2010 to 2100**

For these projections from 2010 to 2100, mean discharges of Nyabarongo would be slightly low compared to mean discharges of the baseline year 1988. This implies a decrease in river flows in the years to come. Nevertheless, as shown in the below figure, the differences in flow rates between years remain very low. The graphic below shows the projected monthly mean discharges of Nyabarongo in Kigali from 2010 to 2100(data from Rwanda water Board).

Figure 35: Projections of monthly mean discharges of Nyabarongo in Kigali (2010-2100)



For the period 2010 to 2100, there would be a significant decrease (from 240 m3 / s to 120 m3 / s) in maximum discharges in comparison with the baseline year of 1998 (year of maximum discharges). However, the configuration of discharges in the course of the year would remain the same, with high discharges in March-April and the low water period in June-September.

For the minima, discharges might be also low, not exceeding 90 m^3 / in April, while in 1984, the baseline year with low discharges, they reached 110 m^3 in the same month.

CHAPTER VIII: ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

The present EIA has developed the Environmental Management and Monitoring Plan that is divided into two parts. The first part is the **Environmental Management Plan** and other is the **Environmental Monitoring Plan.** The Environmental Management Plan explain the proposed mitigation measures into actions and provides management measures to be undertaken during the construction and operational phases of the project. The Environmental Monitoring Plan details monitoring activities and measures to be undertaken during construction and operation. The estimated costs for implementation of the mitigation measures are indicative and the appropriate bills of quantities should clearly give actual figures. In any case the consultant used informed judgment to come up with these figures. However it is mandatory that WASAC Ltd designate an environmental and social officer who will make day to day follow up the smooth and proper implementation of proposed mitigation measures during the project implementation The EPC contractor has also mandate to have an Environmental, Social, Health and Safety manager on the implementation team to follow up the implementation this proposed EMP.

8.1. Environmental Management Plan

The EMP is presented in the table below and provides the activity that leads to the adverse impact, the anticipated impact, the proposed mitigation measures, the implementation schedules and the responsibility.

8.1.1. Environmental Management Plan (EMP) for the construction phase

Table 50: Environmental Management Plan for the construction phase

Activity	Adverse Impacts	Proposed Mitigation measures	Responsible	Monitoring	Budget (USD)
Land acquisition	Loss of land, Houses crops and trees	- Valuation and compensation al all assets prior construction	WASAC LTD	WASAC Ltd and district	Expropriation budget
Water abstraction	Water conflicts between water users down the project sites	- WASAC Ltd is required to get the water abstraction permit before project implementation. - Regular monitoring allocated daily water abstraction - Regular monitoring of water level and on Akagera River	WASAC Ltd/ RWB	RWB	2,000
Site installation and Site clearing for WTP and water storage facilities	Soil erosion and water contamination	- All earthworks for site preparation and levelling have to be carried out during the dry season Storm water drainage system has to be installed on sites susceptible to erosion. - Soil erosion barriers have to be installed on site. - Restrict clearing works to only project sites and at the minimum possible - Only use appropriate machinery at each type of activity in order to minimize the risks; - Remove and stockpile topsoil, sub-soils and any parent material separately.	Contractor	WASAC Ltd/ REMA	1,000
	Loss of biodiversity	- Plantation of trees after construction works at the WTP - Stabilize soil with grasses and trees - Stabilize borrow pit with grasses and trees. - In areas of dense vegetation cover, like manmade forestry, the removal of vegetation must be restricted to the minimum necessary width	Contractor	WASAC Ltd/REMA/ Local Authorities/, District	600
	Soil cover loss	- Create contour drains during Construction works - Use of the excavated soil to refill borrow pits - Rehabilitation of the sites and trees planting at the WTP where possible	Contractor	WASAC ltd/ REMA	no cost required
	Conflict on land acquisition and Loss of crops and trees	- Fair compensation of land from owners before project activities Involve and work with district/ Sectors authorities to better solve any conflict that may rise and related to fair compensation - Land should be acquired from only land owners with no intermediaries.	Property valuer WASAC Ltd / District	MINECOFIN WASAC Ltd / District	Expropriation budget
	Loss of bird nesting and loss of biodiversity	- Proper time clearance that does not coincide with nesting period. - Close monitoring of bird population in the project areas especially during exaction period.	WASAC ltd	MoE/ WSAC Ld/ REMA	No cost required
	Changes of landscape - Visual impact	- Rehabilitate working area with trees and grasses	Contractor	WASAC Ltd/REMA	400

Activity	Adverse Impacts	Proposed Mitigation measures	Responsible	Monitoring	Budget (USD)
Construction works of the WTP, pipelines and water reservoirs	Potential soil erosion during construction works	- Only clear areas earmarked for construction works. - Constructions of water ways with check dams as to reduce sediment	Contractor	WASAC Ltd Local authorities	under construction budget
	Water pollution	- Avoid at the maximum the use of polluting machinery. - On site adequate sanitary facilities have to be provided - Staff to be regularly trained and sensitized on appropriate waste management. - All unused materials to be properly handled - Consider measures to prevent pollution of ground water while designing the sludge storage site; - Storage site shall follow the appropriate regulation of Waste Management - Regular monitoring of water pollution sources	Contractor	WASAC ltd/ REMA/ RWB	No cost required
	Disturbance and mortality of terrestrial fauna	- Restrict construction activities do the daylight; - Limit the area earmarked for site clearance - Inspect the area to be cleared for any terrestrial fauna before bush clearing and digging; - Protect any trench left overnight with a net fence to block fauna from being trapped inside; - Capture and release fauna away from the direct influence zone (including species trapped in the trenches);	Contractor	WASAC Ltd/ REMA/ District	No cost required
	Injuries and accidents on site	- Provision of Personnel Protective Equipment to all staff - Sensitization of workers on safety measures - Provide first aid kit on the site - The safety and sanitation plan is formulated and safety trainings are provided for workers - Ensure all employees have health insurance to afford health facilities	Contractor	WASAC Ltd/ Local authorities	3,000
	Air and noise pollution	- Construction activities shall be restricted to normal working hours (7h00-17h00) to prevent noise for neighbours at night especially at water transmission and distribution pipelines - The machinery and automobiles to be used on site should have certification of good working conditions from "National Automobile inspection centre" in order to reduce noise or exhaust fumes emissions. - Ensure routine maintenance, repair of trucks and machines. - Spray water when deemed necessary in order to reduce dust in the ambient environment. - Regularly watering when clearing land to reduce the dust - Construction sites to be fenced by dust barriers and suppressors. - Provision of protective equipment to all workers.	Contractor	WASAC Ltd/ REMA	2,000

Activity	Adverse Impacts	Proposed Mitigation measures	Responsible	Monitoring	Budget (USD)
Purchase of construction materials such as stones, gravel and sand etc	Land degradation	- Purchase of all raw materials and construction materials has to be done from approved quarries and gravel pits. - Backfilling borrow pits after excavation and rehabilitating with vegetation. - Regular inspection of the source of construction materials	Contractor	WASAC Ltd/ local authorities/ REMA	No cost required
Construction of water reservoirs and pipelines	Fugitive dust generated during excavation works	- Wetting the surface when deemed necessary during construction - Top soil to be stored separately from subsoil. - After completion of works, the top soil has to be spread over those areas which can be partially restored in order to facilitate natural regeneration of those areas. - Compaction of soil to be minimized by careful stockpiling and separation of top and sub-soils.	Contractor	WASAC Ltd/ REMA/ Local authorities	Under construction budget
	Nuisance of noise from construction activities	- The Contractor shall restrict any of his operations, which result in undue noise disturbance between 7h00 am and 5h00 pm hour (e.g. blasting activities and operation of heavy machinery and construction traffic) - Restrict construction and operation of heavy machines to daylight; - Ensure noise emissions are kept down and meet the existing noise emission standards depending on sites of works.; - Reduce truck movements by careful planning of needs of delivery of construction materials. - Regular and effective equipment maintenance in order to ensure all machinery is in good working order and use does not generate excess noise.	Contractor	WASAC Ltd/ Local authorities	No cost required
	Disturbance of natural soil structure, mixing of layers	- Top soil to be stored separately from subsoil and be re-used in the future for further project activities. - After completion of works, the top soil has to be spread over those areas which can be partially restored in order to facilitate natural regeneration of those areas. - Compaction of soil to be minimized by careful stockpiling and separation of top and sub-soils.	Contractor	WASAC Ltd/ REMA	no cost required
	Pollution of surface and ground water	- Provide onsite protective equipments - Staff to be regularly trained and sensitized on appropriate waste management. - On site adequate sanitary facilities have to be provided - All unused materials to be properly handled - Regular monitoring by the professional in the domain.	Contractor	WASAC Ltd/ REMA	3,000
	Sediment load	- Proper handling and management of generated of waste on site. - All excavated material to be carefully re-used, replaced and/or planted up with grass and other indigenous seedlings.	Contractor	WASAC Ltd/ RWB/ REMA	no cost required
Levelling of Reservoir Sites and excavation of trenches for water pipelines,	Land degradation	- All earthworks for site preparation and levelling shall be carried out in a proper designated manner and have to be done by the qualified engineers. - Wastes produced have to be disposed of in a designated area.	Contractor	WASAC Ltd Local authorities	500

Activity	Adverse Impacts	Proposed Mitigation measures	Responsible	Monitoring	Budget (USD)
Excavation and alignment of pipes	Disturbance of traffic	- Provide appropriate equipment and manpower in order to complete the work in short time especially for the section that cross the roads - Appoint staff in charge of traffic management - Use of appropriate traffic sign post - Rehabilitation of affected section - Excavation and backfilling of the affected section during evening hours where there is no heavy traffic	Contractor	WASAC Ltd/ Local authorities / Traffic police	Under construction budget
	Accident and injuries	- Provision of Personal Protective Equipment - Provide first aid kit on site - Training of workers on safety measures - Properly avail sign post and traffic management staff at the sites	Contractor	WASAC Ltd/ District	3,000
Overall construction works	Influx of job seekers	- Disclosure the exact number of jobs available for the project; the job application period and the remuneration to be allocated for each type of work before project implementation - Involve local leaders in local employees recruitment process; - Recruitment should consider both male and female. - Local residents and PAPs to be prioritized in the recruitment process.	Contractor	WASAC Ltd/Local authorities	No cost required
	Child labour, forced labour and discrimination	- Protect workers' rights; - Establish, maintain, and improve the employee–employer relationship; - Promote compliance with national legal requirements and provide supplemental due diligence requirements where national laws are silent; - Comply with international Labour Organization, and the UNICEF Convention on the Rights of the Child, where national laws do not provide equivalent protection; - Protect the workforce from inequality, social exclusion, child labour, and forced labour;	Contractor	WASAC Ltd/ MIFOTRA	No cost required
	High expectations of getting great compensation cost in cases of resettlement	- Expropriation and compensation mechanisms should be implemented in all justifiable cases. - Full involve the PAPs in all steps required for the fair compensation as stipulated in the expropriation laws and regulations. Establish and make operational conflicts resolutions committees.	Contractor WASAC Ltd Local Authorities	WASAC Ltd/ Local authorities/ District/ MINECOFIN	No cost required
	Impacts on public utilities such as roads, electrical and water networks etc.	- Rehabilitation of affected structures and infrastructures as soon as possible; - Identification of potential impacts that may occur during construction works and identify mitigation measures prior to the execution works. - Inform local residents ahead of time any expected impact on public utilities (such as power cuts etc)	Contractor	WASAC Ltd/ REG/ RURA/RTDA Local authorities	No cost required

Activity	Adverse Impacts	Proposed Mitigation measures	Responsible	Monitoring	Budget (USD)
	Risk of increase of HIV/AIDS and other Sexually Transmitted Diseases and increasing of COVID- 19 Contamination	- Providing surveillance and active screening and treatment of workers - Regular check up of workers on site - Providing health and hygiene training - Preventing illness among workers in local communities - Providing health services - Use of Personal Protective Equipment - Enforce the health measures established by competent authorities to fight such diseases (wear of protective musk, regular hand washing, keeping distance among workers etc).	Contractor	WASAC Ltd/Local authorities Health Organs	4,000
	Gender based violence and sexual Exploitation and Abuse(GBV/SEA	- Preparation and implementation workers Code of conduct - Conduct GBV/SEA awareness	Contractor	WASAC Ltd/ Districts	1,000
	Disturbance and mortality of terrestrial fauna	- Restrict construction activities do the daylight; - Inspect the area to be cleared for any terrestrial fauna before bush clearing and digging; - Protect any trench left overnight with a net fence to block fauna from being trapped inside; - Capture and release fauna away from the direct influence zone (including species trapped in the trenches);	Contractor	WASAC Ltd/ REMA/ RWB	No cost required
	Overall environmental management	- Avail an Environmental and Social Manager at the site to oversee environmental management, social concerns, environmental training, and the implementation of environmental policies; - Appoint ESHS Manager in EPC contractor team to assist with sampling, monitoring and daily environmental compliance; - Provide environmental training to all employees.	Contractor	WASAC Ltd/	2,000
TOTAL					**22,500**

8.1.2. Environmental Management Plan (EMP) for the Operation Phase

During the operation phase of the present project, it is not expected to have many negative impacts. The table below summarize the Key impact and proposed mitigation measures that were identified.

Table 51: Environmental Management Plan for operational phase

Activity	Adverse Impacts	Proposed Mitigation measures	Responsible	Monitoring	Budget (USD)
Water treatment process	Generation of sludge at WTP	- Conduct the chemical analysis of the produced sludge With the aim of determining the future uses of the produced sludge at the WTP - Dedicated treatment area be provided and regular and be monitored as appropriate - Elaborate sludge management plan at the WTP.	WASAC Ltd	WASAC Ltd/REMA/ RWB/ Local authority	3,000
Chemicals use at the WTP	Environmental pollution resulting from poor handling and management (spillage)	- Provide safe storage facilities according to health and safety regulations. - Waste to be properly stored and properly managed in designated areas as provided by the manufactures. - Liquid fuel storage and dispensing to be done far from water bodies. - All hazardous wastes and material with hazardous wastes shall be stored on site in an approved manner, and be removed at regular intervals to offsite waste disposal facilities designed to handle such hazardous waste as required by law - The use of PPEs should be mandatory during the use of chemicals	WASAC Ltd	WASAC Ltd/REMA/RSB	Under operation budget
Sanitary	Poor management of the project infrastructures	- Proper management of water source, pipes and reservoirs. - Regular maintenance of the infrastructures.	WASAC Ltd	WASAC Ltd/RWB	Maintenance budget
	Contamination of surface and ground water by human waste	- Provide adequate sanitary facilities for workers and plant visitors	WASAC Ltd	WASAC Ltd/health organs/ Local Authorities	No cost required
	Bad smells from backwash effluent	- Proper management of WTP, pipes and reservoirs. - Regular maintenance of the infrastructures.	WASAC Ltd	WASAC Ltd/ RWB/ RURA/ RSB	Maintenance budget
Water abstraction	Sedimentation of river	- Observe 5m from the stream for the excavation activities	WASAC Ltd	REMA/ RWB	No cost required
	Flow regime decrease	- Regular monitoring of the water flow rates at downstream and upstream the project site as well as provide recommendations, - Observation and monitoring of the downstream ecological habitats.	WASAC Ltd	RWB/ REMA/ MoE	No cost required
	Flooding Risk for wells and associated infrastructures	- For protection of wells a concrete room 2.5 m height was considered - Located the water treatment plant at 6.5 m higher than the swamp area level.	WASAC Ltd	RWB/ REMA/ MoE/ District	No cost required
Water supply	Loss of treated water due to break of pipe or , water storages	- Regular monitoring of water infrastructures. - Establish information gathering mechanism from local residents in order to be informed on the break that may occur in the system. - Repair the damages properties as soon as possible.	WASAC Ltd	WASAC Ltd Local residents	No cost required
	Vandalism of equipment	- Provision of guards at sensitive area such as intake and WTP. - Sensitize local population on the importance of public utilities.	WASAC Ltd	WASAC Ltd/ Local authorities	2,000
		-			**5,000**

8.2. Environmental Monitoring

A monitoring plan provided in this section is indicating measurements of parameters, responsibility and cost estimates of outcomes of the proposed mitigation measures. However, a general monitoring plan should be implemented on site. The monitoring plan stands to facilitate and ensure the follow-up of the implementation of the proposed mitigation measures and helps to anticipate possible environmental hazards and/or detect unpredicted impacts over time. The monitoring tools include:

- Visual observations;
- On site measurements
- Selection of environmental parameters/indicators at specific locations; and
- Sampling and testing of the identified and parameters to be monitored.

The Environmental Monitoring Programs for this project should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents and resource use. Monitoring frequency should be sufficient to provide representative data for the parameter being monitored.

Construction and operation phases of this kind of project are often a source of significant surface and groundwater pollution as well as the environmental pollution if not managed and project sited and planned properly. It is no doubt that the implementation of the project would contribute to the project sites pollution through the project activities especially during construction works. Therefore WASAC Ltd together with the competent authorities should undertake monitoring of the environmental aspects prior to project activities and conduct regular monitoring of the site pollution during construction phases in order to avoid any associate impacts. The key parameters to be monitored include flow rate of Akagera river, water and soil pollution, chemical uses during raw water treatment, waste generation and handling ,s oil erosion, fair compensation and community relationship etc. Key parameters to be monitored are provide in the table below only to mention some:

Table 52: Environmental Monitoring Plan

Environmental concern/ impact	Monitoring item/ Indicator	Parameter to be monitored	Location	Frequency	Methods	Responsible	Budget (USD)
Pre-construction and site mobilization phase							
Land and other project affected assets compensation	Compensation for land and other structures	Number/ area of land parcels and assets compensated	Project areas	Once before construction	Compensation report	WASAC Ltd/ MINECOFIN/ District/ Local authorities	Expropriation budget
	Complaints resolutions	Number PAPS with complains	Project area	regural	Log book of the complains	Districts/GRM Committees/ WASAC / MINECOFIN	Expropriation budget
High number of job seekers	Number of job seekers on site	Number of PAPs employed by the project	Project area	Once before project implementation	Employment record	Contractor/ local authorities	No cost required
Air pollution	Status of equipments and machinery used by the project Level of Dust emissions	Quality of air at the project area	Project sites	regular	On filed measurement	Contractor/ WASAC ltd/ REMA	500
Noise and vibrations	Level of Noise and vibrations emitted	Noise and vibrations levels	At project sites	When deemed necessary	On filed measurement	Contractor/ WASAC Ltd	500
Construction phase							
Accident and incident	Complaints (in general such as noise, traffic jam, and accidents)	Records of complaints Number of accidents occurred	Project areas	Daily	Accidents/ incidents report	Contractor/WASAC Ltd/Local authorities	no cost required for verification
Air Pollution	Status of equipments and automobiles at the project site	Level of emissions	Project sites	Regular	Automobile certificate / on site observation	Contractor/ WASAC Ltd	No budget required for monitoring
	Dust emitted and particulate matter atmosphere Level of dust in the ambient air (observation)	Level of dust emitted in the atmosphere Records on water spray during sun seasons.	Project sites	Daily	Records of water spray/ on site dust level measurement	Contractor/ WASAC Ltd/ REMA	1,000
Fire out brakes	Electrical installations, Fire extinguishers, water tanks	Number of fire extinguishers and water tanks Records of inspection	Construction sites	Monthly	On site observation	Contractor/ WASAC Ltd	Under construction budget
Noise and vibrations	Level of noise emitted	Noise and vibration level at the working sites	Construction sites	At the time of earth works or concrete vibrations.	On site measurement	Contractor/ WASAC Ltd/ REMA	Cost of a sound meter level is about 350 US$. Vibration meter 500US$
Soil pollution	Status of liquid storage facilities	Adequate and proper storage of liquid	At the WTP	daily	On site observation	WASAC Ltd/ Contractor/ REMA	Operational Cost
Soil erosion	Presence of measures	Adequate soil erosion	At working	When necessary	On site	Contractor/ WASAC	Operational

Environmental concern/ impact	Monitoring item/ Indicator	Parameter to be monitored	Location	Frequency	Methods	Responsible	Budget (USD)
	established to prevent soil erosion	preventive measures.	areas susceptible to soil erosion		observation	Ltd REMA	Cost
Solid waste generation	Proper management of generated solid waste including excavated soil, concrete debris and others generated solid wastes on site	Established waste management mechanisms	Construction sites	Daily	On site observation	Contractor/ WASAC Ltd/ REMA	Operational Cost
Ecosystem degradation	Reforestation to offset lost grasses and trees	Number of planted trees to restore the tree losses	Construction sites	Every quarter of a year	Trees planting report/ on filed verification	WASAC Ltd / REMALocal Communities/Districts/ Contractor	2,000
Work conditions	Occupational Safety and Health plan	Availability of OHS Plan	Construction sites	Daily	On site verification	Contractor/ WASAC Ltd / Local authorities	500
	Meetings and trainings	Number of meetings and trainings	Project sites	Monthly	Meeting reports	Contractor/ WASAC Ltd	400
	Safety gear for workers	Number of workers with safety gears	Working sites	Daily	On site verification	Contractor/ WASAC Ltd	2,500
	Occurrence of accidents and injuries	Records of accident and injuries	Working sites	Daily	Accidents reports	Contractor/ WASAC Ltd	No cost required
Accident/ Traffic congestions	Traffic management Plan and traffic signage	Availability of traffic Management Plan Number of traffic signage	Project areas	Monthly	On site verification	Contractor/WASAC Ltd/ Traffic Police	Operational Cost
HIV; Covid -19 and other contaminated diseases	Health and sanitation for labour workers	Number of trainings awareness Availability of sanitation facilities and other diseases preventives measures	Project sites	Daily	Induction training report/ on site verification	Contractor/ WASAC Ltd Local authorities/ MINISANTE	5,000
Child and forced labour	Minimum working age and working condition	Employment record by age and working conditions	Project sites	Monthly	Employment records	Contractor/ WASAC Ltd /Local authorities/ MIFOTRA	No budget required
Operation phase							
Water decreases downstream the project site and modification of water flows	Daily water abstraction	Water lever/ discharge downstream the project site	At WTP	Daily	Daily water abstraction records	RWB/ WASAC Ltd	No cost required
Chemical uses/ environmental	Amount of sludge produced and the location of	Chemical parameters of the produced sludge (	At WTP	Weekly	On site verification /	RWB/ WASAC Ltd/ REMA	Under operation

Environmental concern/ impact	Monitoring item/ Indicator	Parameter to be monitored	Location	Frequency	Methods	Responsible	Budget (USD)
pollution	discharge area	No3. Po3, K,p H etc)			Laboratory analysis		budget
Water quality	Drinking water quality	Drinking Water quality parameters such as Physical Parameters: (T^o, pH-, EC, TSS, DO); Organic Parameters: (BOD5 and COD) Nutrient Parameters(TP and TN, Ammonia, NO3 and NO4); Microbiological Parameters (Total and Faecal coliforms).	At WTP and water distribution points	Bi-weekly	Laboratory and on filed analysis	WASAC Ltd/ RSB	Under operation budget
Backwash effluent	Proper drainage and set up of waste water management plan	Degradation of receiving environment	Downstream the WTP	Weekly	On filed verification	WASAC Ltd/ REMA/ RWB	No budget required
Noise emissions	Noise level at the working site.	Permissible noise levels	At the WTP	Monthly	On filed measurement	WASAC Ltd/ REMA	500
Air pollution	Equipment in good conditions	Status of equipments in use	At WTP	Weekly	On filed measurement	WASAC Ltd/ REMA	400
Water losses	Water losses inspection reports	Water leakages	At WTP and distribution pipelines	Regular	On filed observation	WASAC Ltd/ RWB / Local authorities	Under operation budget
Safety for workers	Safety gear for workers	Number workers with safety gear	At the WTP	Daily	On site verification	WASAC Ltd	2,000
Total cost for monitoring							**15,300**

8.3. ESMP implementation arrangements

8.3.1. Overall implementation responsibility

The overall responsibility of implementation of this ESMP is under Contractor and WASAC ltd. WASAC Ltd will designate a staff to act as Environmental and Social Safety Officer for the project implementation. The mandate of the assigned staff would be to follow up on regular basis the environmental and social issues related to the project. He/she will have an oversight of environmental aspects of the construction contracts, including the enforcement of all monitoring provisions, the locations of construction and labour camps, etc. The Contractor also could also have an Environmental Health and Safety Manager (ESHS) and Social Management Officer to oversee the implementation of project during construction phase. The main duties of the designated Environmental officers will include but not limited to:

- Have an insight on the designs and ensure they adhere to the environmental and social specifications and the requirements of the Environmental and Social Management Plan (EMP).
- Co-ordination with government departments on environmental and social issues and obtaining the necessary clearances from the regulatory authorities.
- Collection and dissemination of relevant environmental documents including amendments to environmental protection acts issued by REMA.
- Monitoring the environmental aspects especially during construction phase to ensure that the environmental requirements of the contract and the mitigation measures proposed in the ESMP are implemented.

8.3.2. Environmental and social training

The training program will cover measurement techniques in the field, tools for the prediction of pollutants, conservation of water bodies etc. Rwanda Environmental Management Authority, Rwanda Bureau of Standards and Rwanda Development Board may be consulted for such training. The need for additional and specialised training will be examined and appropriate training will be undertaken as required. Other types of training may be developed by WASAC Ltd and these related to WTP operations and maintenance, chemical uses and waste management etc. Training of personnel to be deployed on the proposed project during construction and operation, with regard to environmental requirements should be the integral part of the planning. In addition all employees will be trained on safety, methods of disaster prevention, action required in case of emergency, fire protection, environmental risk analysis etc. Capacity to quantitatively monitor water sediments or turbidity (by suitable portable test equipment) and noise is always advantageous, but monitoring will primarily involve ensuring that actions taken are in accordance with contract and specification clauses, and specified mitigation measures. Training will be provided to the contractor personnel to ensure the project is implemented in compliance with this EIA/EMP provision.

8.3.3. Monitoring and reporting procedures

The WASAC Ltd designated ESHS officer will visually assess contractor's practices and, if high pollutant levels are suspected instruct the contractor to make corrections. Photographic records will be established to provide useful environmental monitoring tools. A full record will be kept as part of normal contract monitoring. All applicable regulations need to be enforced by the Project Manager and designated ESHS manager. Under the environment law, water quality discharge standards, air pollution emission standards and noise standards have been established. It is a legal obligation of the Contractor that any discharges from the work sites meet these standards. Steps will be taken by the Project Manager and designated ESHS manager to ensure that regular monitoring of water quality parameters such as pH, suspended solids, turbidity, oil and grease be carried out as provided in the contract. Regular monitoring of noise and dust will also be carried out as provided in the environmental monitoring program especially on working sites with machinery uses.

8.3.4. Record keeping

Monitoring forms should be devised for documentation, analysis and record of parameter. The form should focus attention on environmental issues and provide feedback for the future stages of the work. Mitigation and enhancement measures adopted in final design will be explicitly under the Bill of Quantities (BOQ) so that performance and completion is readily documented. Daily project diaries would record environmental problems (injuries, spills, dust, noise, etc.) as well as safety incidents and will be retained as part of accepted modern contract management and summarized in Quarterly Environmental Reports. During the operation phase of the project, daily water abstractions should be recorded and date kept on regular basis for further impacts analysis and prediction downstream the project site.

8.3.5. Implementation schedule

One of the most important aspects of the implementation of the present project is the appointment of the Environmental Social and Safety Officer at WASAC Ltd level and at Contractor level to oversee the implementation of the environmental and social mitigation measures incorporated in the design and contract specifications. Most of the planned mitigation measure will be implemented along with project activities and is provided in Environmental Management Plan and Environmental Monitoring Plan. Land Acquisition and Resettlement Management

8.4 Land acquision and resettlment procedures

At this stage of project preparation, there is no resettlment Plan prepared. However, it was noted the implementation of the project requires land for infrastructure sitting especially the water treatment Plant, and water reservoir and wellfield. Some of the land is government owned land/ public land and others are privately owned. Therefore, a Resettlment Plan including a census survey of all affected land and properties needs to be conducted prior to the project implementation and documented in an Abbreviated Resettlement Action Plan (ARAP). This section describes key requirement and processes for the preparation of the A-RAP.

8.4.1 Objective and purpose

The Resettlment Plan is a prerequisite to determine the level of those who will be ne negatively impacted by the project implementation and resettled to pave the way the project activities. Therefore a cut of date will be determined by WASAC Ltd in collaboration with District and local authorities. This will be done with the aim of areas not to carry out any development activities within the project sites. The residents nearby the project sites are also informed about the cut-off date and commencement of the census survey and that any construction, crops planting or structure expansion or improvement on their assets and people coming into the area after the cut-off date are not eligible for compensation or assistance. This would take emphasis especially at the location of the pipelines considering that there was no household or other structures that was identified to be affected by the project implementation at the WTP except land and trees/ crops.

8.4.2 Eligibility criteria and entitlemnt matrix

This section sets out eligibility criteria, which are necessary to determine who will be eligible for resettlement and benefits, and to discourage inflow of ineligible people.

- ✓ **Principles**

The involuntary taking of land resulting in relocation or loss of shelter; and loss of assets or access to assets or loss of source of income or means of livelihood, whether or not the PAPs must move to another location or not. Meaningful consultations with the affected persons, local authorities and community leaders will therefore allow for establishment of criteria by which displaced persons will be deemed eligible for compensation and other resettlement assistance. Affected people eligible for compensation and resettlement in three groups as shown below.

a) Those who have formal rights to land including customary/communal land, traditional and religious rights recognized under Rwandan Law.
b) Those who do not have formal legal rights to land at the time the census begins but have a claim to such land or assets provided that such claims are recognized under the laws of Rwanda or become recognized through a process identified in the resettlement plan.
c) Those who have no recognizable legal right or claim to the land they are occupying, using or getting their livelihood from before the cut of date.

- ✓ **Entitlement Matrix**

PAPs entitlement matrix is provided in Table 3 below it provides an indication of resettlement and compensation measures to restore livelihoods impacted by the loss of land, crops and other structures. It is important to pay special consideration to vulnerable people, for instance, giving them high priority to be employed as project labors.

Based on the laws of Rwanda, JICA guidelines, and World Bank Safeguards Policies, compensation and assistance by the project, entitlements, and compensation calculation methods are summarized in the matrix below.

Table 53: Compensation entitlement matrix

Type of Loss	Entitled Person	Type of Impact	Compensation/Entitlement/ benefits	Responsible Organization
Land (Agricultural/ residential)	Title holder	**No displacement:** Less than 20% of land holding affected, the remaining land remains	Cash compensation for affected land equivalent to full replacement cost	WASAC Ltd / MINECOFIN

Type of Loss	Entitled Person	Type of Impact	Compensation/Entitlement/ benefits	Responsible Organization
		economically viable		
		Displacement: More than 20% of land holding lost or less than 20% of land holding lost but remaining land not economically viable	Cash compensation for affected land equivalent to full replacement cost	
	Rental/ lease holder	**No displacement:** Land used for residence partially affected, limited loss, and the remaining land remains viable for present use	Cash compensation equivalent to 10% of lease/ rental fee for the remaining period of rental/ lease agreement (written or verbal)	WASAC Ltd /MINEC OFIN
Buildings and other structures	Owner	**Displacement:** Entire structure affected or structure partially affected but the remaining structure is not suitable for continued use	Cash compensation of full replacement cost for entire structure and other fixed assets without depreciation, or alternative structure of equal or better size and quality in an available location which is acceptable to the PAP. Right to salvage materials without deduction from compensation.	WASAC Ltd /MINECOFIN
Standing crops	1. Land owners 2. Crop Owner	Crops affected by land acquisition or temporary acquisition or easement	Cash compensation equivalent to market value/ full replacement cost for the mature and harvested crop. For crop owners with lease title: Cash compensation for the harvest of the affected land equivalent to existing market value (full replacement cost) of the crop for the remaining period of tenancy/ lease agreement, whichever is greater	WASAC Ltd /MINECOFIN
Trees	1. Land owners 2. Tree Owner	Trees lost	Cash compensation based on type, age and productive value of affected trees.	WASAC Ltd /MINECOFIN
Temporary Acquisition	1. Owner 2. Tenant/ occupant	Temporary acquisition	Cash compensation for any assets affected (e.g. boundary wall demolished, trees removed)	WASAC Ltd /MINECOFIN

8.4.3 Cut-off date, assets inventory and valuation methods

a) Cut-off date

Compensation eligibility will be limited by a cut-off date which should be date of commencement of the census survey of PAPs. The precise cut-off date will be publicly announced by the local leaders in advance and the census of PAPs and assets inventory will commence immediately following this announcement.

b) Assets inventory and valuation methods

This section describes the methods to be used in valuing assets that will be eligible for compensation consistent with either Rwandan laws or policies or IFAD. Law No.17/2010 of 2010 establishes and organizes the Real Property Valuation Profession in Rwanda. It provides the registration of land valuers in Rwanda and conditions for registration. The law also allows the Government to conduct valuation when mandated by their government institutions. Articles 27, 29, 30 and 31 of the law deal with valuation methods and stipulate that the price for the real property shall be close or equal to the market value. Land values could also be compared country wide. Where comparable prices are not available to determine the value of improved land, the replacement cost approach shall be used to determine the value of improvements to land by taking real property as a reference. The law also allows the use of international methods not covered by the law after approval of the Institute of Valuers.

c) Valuation methods

Valuation methods recognized under valuation law in Rwanda include:

- **Use of standard valuation tables**

The implementation of the proposed project will be done in all 30 districts and it is anticipated that a relatively large number of small-scale asset valuations will need to be carried out during the course of the project. It would therefore be cumbersome and inefficient to deploy an individual valuation expert in each and every case. Therefore, it is recommended that the independent value is hired to provide the list of properties value and this list will be used by district to calculate the compensation package for affected people when the need arises. The compensation rates / valuation tables would be developed using legally acceptable valuation procedures accepted by both the Government of Rwanda and World Bank for purposes of fairness and consistency. The approach will consider replacement costs and types and levels of compensation under the Rwanda law. Valuation of lost assets will be made at their replacement cost.

- **Comparison of land/property values countrywide**

In case there are no compensation rates, the Valuer shall compare prices by referring to the prices recently assigned to a real property that is similar or comparable to the real property subject to valuation. Where comparable prices are not available for land in a particular area, the Valuer may use comparable prices of similarly classified land from other areas of the country

- **Replacement cost approach**

The replacement cost approach is based on the premise that the costs of replacing productive assets is based on damages caused by project operations. These costs are taken as a minimum estimate of the value of measures that will reduce the damage or improve on on-site management practices and thereby prevent damage. The approach involves direct replacement of expropriated assets and covers an amount that is sufficient for asset replacement, moving expenses and other transaction costs.

- **Gross current replacement cost**

Gross Current Replacement Cost (GCRC) is defined as the estimated cost of erecting a new building having the same gross external area as that of the existing one, with the same site works and services and on a similar piece of land.

- **Other methods**

Rates from Contractors: When rate schedules do not exist or are out of date, recent quotations by contractors for similar types of construction in the vicinity of the project can be used for calculating replacement costs. In projects offering the options of cash compensation or alternative accommodation, the construction cost estimates for alternative accommodation could be used for calculating cash compensation payable.

It is recommended that the replacement Cost is used as valuation methods and results can be used to prepare standardised valuation tables. This is because the Replacement cost valuation methods is recommended by ESS5 and recognised by valuation law in Rwanda. Standardized table will easy the valuation process given that small scare valuation site are scattered in different places.

8.4.4 Calculation of compensation by assets

The following methods of calculation should be adopted for the preparation of the aforementioned standardized asset valuation tables and/or the application of specific case by case valuations in the case of projects that have significant impacts.

(i) Compensation for Land

Compensation for land is aimed at providing a farmer whose land is acquired and used for project purposes, with compensation for land labour and crop loss. For this reason, and for transparency, land is defined as an area or homestead (i) in cultivation, (ii) being prepared for cultivation, or (iii) cultivated during the last agricultural season. This definition recognizes the farmer's labour as the biggest investment he/she makes in producing a crop which is higher than all other inputs such as seed and fertilizer. As a result, compensation relating to land will cover the market price of labour invested as well as the market price of the crop lost.

(ii) Land Measurement

For purposes of measuring land, the unit of measurement would be that which is used and understood by the affected farmers and if a traditional unit of measure exists in the rural areas, that unit should be used. If a traditional unit of measurement does not exist in a particular area, then it is recommended that land should be measured in meters or any other internationally accepted unit of measurement. However, in such an event, the unit that is being used must be explained to the affected farmers/users and must somehow be

related to easily recognizable land features that the communities are familiar with, such as using location of trees, stumps, etc as immovable pegs. The most important concern of this exercise is to ensure that the affected person is able to verify using his/her own standards/units of measurement, the size of land that is being lost. This will ensure transparency in the system and will thus avoid subsequent accusations of wrong measurements or miscalculation of areas. A farmer should know how much land he/she is losing, in terms of size and the replacement land must be at least of that same size and comparable value as land lost.

(iii) Calculation of crops compensation rate

The current prices for cash crops will be determined and all crops will be valued using a single rate considering the crop at mature age. This rate incorporates the value of crops and the value of the labour invested in preparing new land. Determining compensation using a single rate creates transparency because anyone can measure the area of land for which compensation is due and multiply that by a single rate known to all. This approach also allows assignment of values to previous year's land (land in which a farmer has already invested labour) and land that have been planted but crops have not germinated. Further, it avoids contention over crop density and quality of mixed cropping.

The value of the labour invested in preparing agricultural land will be compensated at the average wage in the community for the same period of time. The rate used for land compensation should be updated to reflect values at the time compensation is paid. Table 5 below, derives a total value for a one-hectare land from the value of the crops on the land and the value of labour invested in preparing a replacement land.

Figure 36: Example of method to be used to determine a monetary compensation rate for land*

Item Compensated	Basis of Value	Rwandese Francs/ha
	Average of the highest 2020 official and market survey land prices per ha of staple food crops (maize, rice etc.), plus cash crops (e.g. sugar cane, corn).	
	Labour costs of preparing a replacement land.	
Total	Replacement value of crops plus labour.	

(Rwandan Francs payments will be revised to reflect crop values and labour rates in effect at the time of compensation). This example assumes a one-hectare land. Crop values will be determined on:

- A combination of staple foods and cash crops. The 80/20 ratio of land that a farmer typically has in food crops and cash crops is used to determine the chances s/he would lose food crop rather than a cash crop income.
- The value of stable crops to be taken as the highest market price (over 3 years) reached during the year, in recognition of the following factors:
- Although most farmers grow staple crops mainly for home consumption, they always have the option of selling these crops to take advantage of the market.
- Farmers most often purchase cereals when they have run out, during drought when prices are high. Compensating at a lower value might put the individual or household at risk.
- On average, the highest price of stable food yields a high per hectare value reimburses for the vegetables and other foods that are commonly inter-cropped with staples, but are almost impossible to measure for compensation.
- The labour cost for preparing replacement land is calculated on what it would cost a farmer to create a replacement land. This value is found by adding together the average costs of clearing, ploughing, sowing, weeding twice, and harvesting the crop.

(iv) Compensation for vegetable gardens

Until a replacement garden starts to bear, the family displaced (economically or physically), will have to purchase vegetables in the market for daily use. The replacement costs therefore, will be calculated based on the average amount that an average town dweller spends on buying these items for one year from the local market.

(v) Compensation for horticultural, floricultural and fruit trees

Banana and Mango trees are featured here below as two examples of the set of primary fruit trees that are likely to be found in project targeted area and are estimated to account for a significant amount of all fruit bearing trees. They are primarily important as a source of:

- Subsistence food for families
- Cash produce that contribute to the export economy
- Petty market income in some areas, and

- Shade (in the case of mango trees).

For banana trees, they have a relatively much shorter productive life, normally, than mango trees. For species, banana trees will not bear fruit more than once. Therefore, compensation for banana trees would be compensated at the full market rates for bananas harvested in that year and for another year. The second year payment is for the replacement cost of planting a new tree, looking after it and harvesting it which could all be done in one year. Therefore, the farmer should have restored his pre-project position by the end of the second year. This example of bananas is an example for trees/plants that have a relatively short life.

As defined in this policy, individuals will be compensated for wild trees which are located in their land. Wild productive trees belong to the community when they occur in the bush as opposed to fallow land. These trees will be compensated for under the umbrella of the community compensation.

8.4.5 Asset Inventory , PAPs identification and compensation

(i) Assest inventory and PPAPS

In order to prepare for compensation and other resettlement benefits, it is imperative that a comprehensive asset and affected persons inventory in the designated areas for the different project components is done. The inventory will specify the different assets, properties affected in each plot of land and their owners. The Land Valuation Bureau which is the entity responsible for undertaking valuation of assets will be responsible for the valuation exercise and will therefore provide independent valuation experts. The valuation document will indicate when the affected person will be notified, and that the inventory will not be official until a second signed copy, verified by project supervisory staff, is returned to the affected person. At this time, a copy of the grievance procedure will also be given to the affected person as stated in the grievance redress mechanism. The valuation experts will work hand in hand with the local leaders of the area.

(ii) Forms of Compensation

Individual and household compensation will be made in cash, in kind, and/or through assistance. The type of compensation will be an individual choice although every effort will be made to instil the importance and preference of accepting in kind compensation if the loss amounts to more than 20% of the total loss of subsistence assets. Compensation payments raises issues regarding inflation, security and timing that must be considered. One purpose of providing in-kind compensation is to reduce inflationary pressure on the cost of goods and services. Local inflation may still occur and thus market prices will be monitored within the time period that compensation is being made to allow for adjustments in compensation values. The issue of security, especially for people who will be receiving cash compensation payments should to be addressed by the local administration. The RPF has provided an entitlement matrix that shows type of compensation for each category.

(iii) Procedures for delivery of compensation

It is recommended that compensation be made through reputable local banks. This will ensure security of the PAPs money especially for those receiving large sums. Forms acknowledging receipt of the compensation packages shall be signed by each PAP.

8.4.6 Implemenation and monitoring framework

✓ WASAC LTD

WASAC will be resensible for the prepaaration of abbreviated RAP, its implemenation and monitoring.. The social safeguard Specialists of WASACwill be the focal point RAPs implementation and will liaise with other stakeholders to executive RAP. The Specialist will ensure that the procedures and requirements of the Rwandan laws and doner environmental and Social Polices are complied with. A key role will be to implement the RAP and other resettlement-related activities and to ensure that all procedures have been adhered to and that there is consistency in approach between sub-projects activities. It will also undertake the main monitoring and evaluation role of resettlement activities during and post implementation.

✓ Rwanda Land Use and Management Authority(RLMUA)

RLMUA through its department of Land administration and Mapping is the organ responsible for overall management and coordination of all activities related to land administration, land use planning and management in Rwanda. The role of RLMUA in RAP process will be to advise on matters related to land ownership and expropriation. District land bureau in close collaboration with project staff will check and approve surveys, various maps and approve land surveys carried out during the RAP exercise.

✓ Rwanda Environment mangment Authority(REMA)

REMA was established in 2004 to act as the implementation organ of environment-related policy and laws in Rwanda. REMA is also tasked to coordinate different environmental protection activities undertaken by environmental promotion agencies; to promote the integration of environmental issues in development policies, projects, plans and programmes; to coordinate implementation of Government policies and decisions taken by the Board of Directors and ensure the integration of environmental issues in national plan among concerned departments and institutions within the Government; to advise the Government with regard to the legislation and other measures relating to environmental management or implementation of conventions, treaties and international agreements relevant to the field of environment as and when necessary; to make proposals to the Government in the field of environmental policies and strategies; etc. In Regards to the implementation of this ARAP, REMA will ensure that all policies and regulations related to resettlement are observed and advise on the better way to implement RAPs. This will be done together with environmental monitoring.

✓ Kicukiro District

As indicated in section 3.6, the Land Office is a district based institution authorized by law to manage land. The DLBs will be responsible for ensuring activities undertaken comply with the National and District level Land Use Master Plans. They will assess the validity of land tenure rights of affected persons and eventually provide the land use permit for the new activity proposed by the sub- project. In addition they will be responsible for ensuring effective grievance mechanisms are in place. They will also be used in the design of the RAP as much as possible in order to ensure that community buy in is present at an early stage hence reducing disputed or grievances. Their activities will be monitored by the District authority.

The District Land Offices will play a major role in RAP implementation by:

- Issue construction permits and monitor compliance with construction plans
- Monitor and approve activities pertaining to valuation of land and other immovable property;
- Demarcate and approve land cadastral;
- Establishing project level Resettlement and Compensation Committees at Sector/ Cell level;
- Clarifying the policies and operational guidelines of these Resettlement and Compensation
- Committees;
- Review and approve valuation report done by independent Valuer and ensure that are in compliance with valuation, expropriation and land laws.
- Coordinating and supervising implementation by Resettlement and Compensation Committees

✓ District resettlement committee

The Kicukiro district will work closely with WASAC in the implementation of the A-RAP. A team that includes a civil Engineer, District Land Bureau officer, Social Safeguards specialist(provided by designated SPIU), executive secretaries of Kicukiro sector affected sectors and PAPs representatives will be responsible for resettlement and ensure that the A-RAP is properly applied across all relevant subprojects. Its initial role will be to undertake screening and assessment of potential subprojects. The team will be supported by the project Social Safeguards team based at project headquarters.

✓ Resettlement committees at site level

Based on Rwanda's decentralization governance and project nature, the responsibility for the development and implementation of the RAPs will be at district and site level. Once resettlement requirements, affected assets and affected persons has been identified via the census process, District Land Bureau representatives will be responsible for electing members of a sub-project Resettlement and Compensation Committee. This committee will be constituted for the sole purpose of RAP implementation arrangements, and will operate at District level and site level. It is proposed to be coordinated by the District Land Bureau, due to the executive powers of the DLB.

This committee will plan for, coordinate and monitor resettlement, compensation and relocation activities, as well as supervise compensation payments to the recipient PAPs. A large part of their responsibility will be consultation with potential PAPs.

It is recommended to have site resettlement committee at each block and the Site Resettlement and Compensation Committee would comprise the following:

- Representative from Sectors preferably the land manager
- Representative of four cells that are affected
- Representative from the District Development Committee;
- Representative from any other key sector office involved in the resettlement process;
- Key stakeholder's representative from the implementing organization;
- Two representatives of PAP by cells (equal gender representation); and

The Resettlement and Compensation Committee would have responsibility for:

- Verifying PAPs
- Validate inventories of paps and affected assets;
- Allocate land, where required, to permanently paps;
- Monitor the disbursement of funds;
- Guide and monitor the implementation of relocation;
- Coordinate activities between the various organizations involved in relocation;
- Facilitate conflict resolution and addressing grievances; and
- Provide support and assistance to vulnerable groups including widows, orphans, and the old persons among others).

This committee should meet on a regular basis (as determined by the needs of the project) to ensure that resettlement activities are appropriately designed and executed. It is recommended that a representative be elected to act as the District Project Coordination officer who would act as the key contact with PAPs and therefore facilitate implementation of consultation, public participation and grievance mechanisms.

- ✓ **Mediators/Abunzi**

At the Cell, there are in place mediators (abunzi) whose work is to hear disputes, especially land disputes. The abunzi, or mediation committees, have mandatory jurisdiction over land disputes involving amounts less than three million RwF, which means over most land disputes. The Abunzi also have mandatory jurisdiction over succession and boundary disputes involving less than three million Rwanda Francs. The abunzi will be used in the sub project as the first stop for resolving disputes and grievances following land acquisition. They will be involved in the compensation process from the beginning to the end. They will also be used in the design of the RAPs as much as possible in order to ensure that community buy in is present at an early stage hence reducing disputed or grievances.

- ✓ **Project Affected Persons**

This group of people will also help identify community projects that will lead to the uplifting of the lives as well as share in project . PAPs will also participate in planning and implementing resettlement programs.

Table 54: Summary of Institutional Responsibilities RAP implementation

Institutions	Responsibilities
WASAC LTD	- Collation of information regarding Masaka project , including ARAP documentation. - Review and approval of Resettlement related documentation from all subprojects(screening forms, A-RAP reports etc) to ensure consistency and compliance with regulations; - Overall monitoring and evaluation of resettlement implementation (i.e., annual audits and review of sub-project level monitoring undertaken by District authorities), ensuring that ARAPs are implemented in accordance with regulations - Initiate the resettlement process identify resettlement and compensation requirements - Preparation and signature of Compensation Grant agreement with the District - To establish Resettlement and Compensation Committee in consultation with District Land Bureau - Have a representation in sub-project Resettlement and Compensation Committee - Provision of capacity building and technical support relating to resettlement and compensation activities; - Ensure funds allocated appropriately, according to RAP.
RLMUA	- To advise on matters related to land ownership and expropriation Exercise. - To participate in verification of land ownership and land titles
District	- Verify land owners from records of land register - Issue construction permits and monitor compliance with construction plans - Monitor and approve activities pertaining to valuation of land and other immovable property - Approve land expropriated land surveys - Work in collaboration with the Sub- Project Resettlement and - Compensation Committees to ensure that 'fair and just' compensation is reached in accordance with the law and the requirements of this RAP.

Institutions	Responsibilities
	- To identify resettlement site in any physical resettlement is required - To coordinate the land for land compensation and land redribution
District Resettlement Committee	- Verifying PAPs - Validate inventories of PAPs and affected assets; - Allocate land, where required, to permanently affected households - Facilitate conflict resolution and addressing grievances - Guide and monitor the implementation of relocation
Site resettlement Committee	- Help in creating awareness on expropriation process - Monitor the implementation of community resettlement work closely with environment protection committees to monitor the use of marshlands and reserved areas; - Conflicts resolution - Help in land demarcation confirm holders of land rights during land resettlement process, help in the resettling of the displaced in the community, participate in the identification of community settlement sites, identify and list escheat land, and serve as witnesses in compensation and resettlement
Mediators/ Abunzi	- Resolving disputes - Provide grievances mechanism following land acquisition. - Help in designing resettlement programs at the community level to ensure community buy in.
Project Affected Persons	- Be present when the land survey and inventory is being carried out - Provides all required information in regards to resettlement activities - Participate in compensation and livelihood activities

8.4.7 Grievance Redress Mechanism

The District of Kicukiro is an acknowledged institution for which the PAPs have been made aware of as avenues for expressing discontent and disapproval to the resettlement and compensation process. Article 26 of the Expropriation Law of 2015 provides complaints procedures for individuals dissatisfied with the value of their compensation. The Law stipulates that dissatisfied persons have a period of 30 days after project approval decision has been taken to appeal (Article 19).

Grievance procedures are required to ensure that PAPs are able to lodge complaints or concerns, without cost, and with the assurance of a timely and satisfactory resolution of the issue. The procedures also ensure that the entitlements are effectively transferred to the intended beneficiaries. Stakeholders will be informed of the intention to implement the grievance mechanism, and the procedure will be communicated at the time that the RAPs are finalized. Grievances may arise from members of communities who are dissatisfied with eligibility criteria use, community planning and resettlement measures, actual implementation or compensation.

- ✓ **GRM process**

The overall process of grievance is as follows:

- During the initial stages of the valuation process, the affected persons will be given copies of grievance procedures as a guide on how to handle the grievances.
- The process of grievance redress will start with registration of the grievances to be addressed for reference, and to enable progress updates of the cases.
- The project will use a local mechanism, which includes resettlement committees, peers and local leaders of the affected people. These will ensure equity across cases, eliminate nuisance claims and satisfy legitimate claimants at low cost.
- The response time will depend on the issue to be addressed but it should be addressed with efficiency.
- Compensation will be paid to individual PAPs only after a written consent of the PAPs, including both husband and wife.

- ✓ **GRM procedures**

The aggrieved person should file his/ her grievance, relating to any issue associated with the resettlement process or compensation, in writing to the subproject Resettlement and Compensation Committee. The grievance note should be signed and dated by the aggrieved person.

The WASAC social safeguards officer and the Resettlement and Compensation Committee will consult to determine the validity of claims. If valid, the Committee will notify the complainant and s/he will be assisted. The Resettlement and Compensation Committee will respond within 14 days during which time any meetings and discussions to be held with the aggrieved person will be conducted. If the grievance relates to valuation of assets, a second or even a third valuation will be undertaken, until it is accepted by

both parties. These should be undertaken by separate independent valuers than the person who carried out the initial valuation.

If the aggrieved person does not receive a response or is not satisfied with the outcome within the agreed time, s/he may lodge his/her grievance to the relevant Municipal Administration such as the District Land Bureau, also mandated to help resolve such matters. If requested, or deemed necessary by the subproject Committee, the District Project Coordination officer will assist the aggrieved person in this matter.

The relevant Local Administration will then attempt to resolve the problem (through dialogue and negotiation) within 30 days of the complaint being lodged. If no agreement is reached at this stage, then the complaint is dealt with through the local courts (Abunzi) where possible. Where matters cannot be resolved through local routes, the grievance will be referred to higher authorities at the national level. The Resettlement and Compensation Committee will provide assistance at all stages to the aggrieved person to facilitate resolution of their complaint and ensure that the matter is addressed in the optimal way possible.

If administrative ways of grievance redress is not enough to address the complaint, then the agrieveted person may refer to judicial system. Based on the nature of complaints, the process will start from mediators for asses below 3 millions Rwandan francs and if the value is more than three million, the process will start from intermediate courts , High court and to supreme court.

- ✓ **Grievance Log**

The District land Bureau will ensure that each complaint has an individual reference number, and is appropriately tracked and recorded actions are completed. The log will contain record of the person responsible for an individual complaint, and records dates for the following events:

- Date the complaint was reported;
- Date the Grievance Log was added onto the project database;
- Date information on proposed corrective action sent to complainant (if appropriate);
- The date the complaint was closed out; and
- Date response was sent to complainant.
- The District Project Coordination officer will be responsible for:
- Providing the sub-project Resettlement and Compensation Committee with a weekly report detailing the number and status of complaints;
- Any outstanding issues to be addressed; and
- Monthly reports, including analysis of the type of complaints, levels of complaints, actions to reduce complaints and initiator of such action.

8.4.8 Monitoring

The objective of the monitoring and evaluation process will be to determine whether PAPs have been paid in full and before implementation of the subproject, and people who were affected by the subproject have been affected in such a way that they are now living a higher standard than before, living at the same standard as before, or they are they are actually poorer than before. The arrangements for monitoring the resettlement and compensation activities will fit into the overall monitoring program of the entire project, which will fall under the overall responsibility of WASAC.

- ✓ **Monitoring indicators**

A number of indicators would be used in order to determine the status of affected people (land being used compared to before, standard of house compared to before, level of participation in project activities compared to before, how many kids in school compared to before, health standards, etc). Therefore, the resettlement and compensation plans will set two major socio-economic goals by which to evaluate its success: Affected individuals, households, and communities are able to maintain their pre-project standard of living, and even improve on it; and the local communities remain supportive of the project.

In terms of the resettlement process, the following indicators could be used to understand the success of the measures identified and the working of the relevant parties in implementation the RAP:

- Percentage of individuals selecting cash or a combination of cash and in-kind compensation;
- The number of contentious cases as a percentage of the total cases;
- The number of grievances and time and quality of resolution;
- Number of impacted locals employed by the civil works contractors; and
- General relations between the project and the local communities.

These will be determined through the following activities:

- Questionnaire data will be entered into a database for comparative analysis at all levels of local government;
- Each individual will have a compensation dossier recording his or her initial situation, all subsequent project use of assets/improvements, and compensation agreed upon and received.
- The District authorities will maintain a complete database on every individual impacted by the sub-project land use requirements including relocation/resettlement and compensation, land impacts or damages; and WASAC should prepare Resettlement Completion Reports for each RAP, in addition to other regular monitoring reports.
- Resettlement and Compensation Committee will facilitate coordination of information collation activities (such as surveys, supervising documentation) in accordance with procedures put in place.
- WASC will provide training, technical support and funds to ensure that this happens. In order to assess whether these goals are met, the resettlement and compensation plans will indicate parameters to be monitored, institute monitoring milestones and provide resources necessary to carry out the monitoring activities.

✓ **Monitoring of RAP implementation**

Local Government Authorities from district level will assist in compiling basic information from the project, and convey this information to the SPIU, on a quarterly basis. They will compile the following statistics:-

- Number of households and individuals physically or economically displaced by each sub-project;
- Length of time from sub-project identification to payment of compensation to PAPs;
- Timing of compensation in relation to commencement of physical works;
- Amount of compensation paid to each PAP household (if in cash), or the nature of compensation (if in kind);
- Number of people raising grievances in relation to project; and
- Number of unresolved grievances.

Table 55: Sample format for monitoring

Work	Planned in total	Progress in quantity	Progress in percentage
Announcement to the affected people			
Cost estimation for resettlement			
Consultation meeting			
Revise of the resettlement plan and signing based on the feedback at the consultation meeting			
Compensation in cash			
Compensation by land			
Social supports such as job training			
Number of unresolved grievances.			

WASAC will scrutinize these statistics in order to determine whether the resettlement planning arrangements as set out in this RAP are being adhered to. The project team will alert WASC, if there appears to be any discrepancies. WASC will directly monitor compensation and loss of wages. Financial records will be maintained by the district land bureau to permit calculation of the final cost of resettlement and compensation per individual or household. The indicators that will be used to monitor implementation of the RAP include.

- Outstanding compensation contracts not completed before next agricultural season
- Projects unable to settle compensation after two years
- Grievances recognized as legitimate out of all complaints lodged

Financial records will be maintained by Project team to permit calculation of the final cost of resettlement and compensation per individual or household.

✓ **Storage of PAPS details**

Each PAP household will be provided with a signed report recording his or her initial situation, all subsequent project use of assets and compensation agreed upon and received. At the same time, before compensation all household heads representing the PAPs will be required to provide passport size photographs. The Local Authority and project management team will maintain a complete database on

every individual impacted by the project land use requirements including relocation, resettlement and compensation, land impacts or damages.

Each recipient of compensation will have a record containing individual bio-data, number of household dependents and amount of land available to the individual or household when the report is opened. Additional information to be acquired for individuals eligible for resettlement and/or compensation include the level of income and of production, inventory of material assets and improvements in land and debts. Each time land is used by a sub-project; the report will be updated to determine if the individual or household is being affected to the point of economic non-viability and eligibility for compensation or its alternatives.

- ✓ **Socio-economic monitoring**

The purpose of socio-economic monitoring is to ensure that PAPs are compensated and recovering on time. During implementation of each subproject A-RAP, an assessment will be undertaken on payment of compensation, restoration of income delivery of resettlement objectives. Monitoring of living standards will continue following resettlement.

A number of indicators will be used to determine the status of affected people and appropriate parameters and verifiable indicators will be used to Measure the resettlement and compensation plans performance. For this sub-project with adverse social impacts, a monitoring and evaluation plan of the mitigation measures will be established. As part of the preparation of each RAP, a household survey will be conducted of all PAPs, prior to physical or economic displacement, and this will provide baseline data against which to monitor the performance of the ARAP.

8.4.9 ARAP preparation and implementation schedule and next steps

Responsible organizations and the schedule for the ARAP preparation and implementation are shown in the table below. This schedule is applicable to the PAPs who are eligible for compensation and available and posses all the required documents including land titles.. For those who are absent or not meet the requirements, the processes to be taken are the same but the timing when each process happens may differ, depending on the PAPs.

Table 56: ARAP implementation schedule and and next steps

Process	Responsible Organization	2023						
		Jun	Jul	Aug	Sept	Oct	Nov	Dec
Recruitement of Assests valuer	WASAC Ltd							
ARAP Preparation	WASAC Ltd	X	X	X				
Preparation of compensation forms	WASAC Ltd, Property valuer, Sector/Cell leaders, District One Stop Center			X	X			
Approval of compensation forms	WASAC Ltd Social Safeguard Specialist				X			
Financial arrangement in WASAC ltd	WASAC Ltd Social Safeguard Specialist, Finance Department			X	X	X		
Submission of compensation payment order to MINECOFIN	WASAC Ltd Finance Department					X	X	X
Payment order to the Bank	MINECOFIN					X	X	X
Compensation Payment	Banks of PAPs					X	X	X

CHAPTER IX: CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

The conduct of the study in all steps has identified a number of issues pertaining to the proposed project.. The pertaining impacts have been assessed and described in details to gain an adequate understanding of possible socio and environmental effects of the project in all its implementation phases. The analysis of impacts was done in order to formulate mitigation measures in response to negative aspects which have been raised. The Environmental Management Plan (EMP) provides a way forward for implementation of the identified mitigation measures and should be implemented as a requirement for a positive Record of Decision by appropriate and authorities. .

The estimated costs for implementation of the mitigation measures are indicative and appropriate bills of quantities should clearly give the actual figures. In any case the consultant has used judgment and cost for similar project to come up with these figures. The Environmental Monitoring Plan provides parameters to be monitored and responsibility. While the consultant is aware that each monitoring aspect need to have a separate budget.

Health, Social and Environmental officer should be assigned to the project with the aim of undertaking the monitoring of the mitigation measures for the project through its existence. This will help to achieve sustainable project implementation at reduced cost for undertaking the monitoring despite the facts that regular internal monitoring shall be carried out by the project developer..

The study findings show that most of the potential environmental impacts identified can be mitigated while applying the proposed measures. The proposed environmental management plan and environmental monitoring plan if implemented will protect the integrity of the environment.

Taking into the considerations of the nature and location of this project and its needs, the conclusion is that the potential impacts associated with the proposed project are of a nature and extent that can be refused, reduced, limited and eliminated by the application of appropriate proposed mitigation measures.

9.2 Recommendations

In addition to the Environmental and social Management plan and the proposed mitigation measures the EIA team came up with the following recommendations:

1. The consultant is recommending that the Project Developer/WASAC Ltd collaborate with the city of Kigali to guarantee special construction permit for the WTP as the location is zoned for the residential purpose.
2. WASAC should require the special authorization from The Ministry of Environment as per the article 42 of the Law No 48 /2018 of 13/08/2018 on the environment before of welfiled installation that will be located within the buffer zone of Akagera river.
3. The compensation of land and affected structures should be done before project implementation prior to involvement of land owners during valuation process and an easement agreement should be also negotiated for water supply pipelines prior to the project implementation.
4. Detailed design for the WTP location and access road to wellfield have to take into consideration the proposed railway passing nearby the project location in order to avoid any impacts that may be raised in the future relate d to the cohabitation of both projects.
5. WASAC ltd is required to get the abstraction permit before project implementation and the guaranteed amount of water to be abstracted has to be respected as a prerequisite to avoid any impact that may be raised and related to water abstraction. Budgeting and valuation of affected assets should be conducted prior to the project approval processes.
6. Fair compensation of all assets to be affected by the project should be done prior to the project activities and this with involvement of Local authorities.
7. Affected people and local communities should be given priority when allocating for jobs
8. All on sites works (construction of temporary offices, temporary storages facilities, cement and mortar mixing etc) should be done beyond the buffer zone of the Akagera river to avoid and minimize pollution.
9. Regular monitoring of a joint team made of WASAC, REMA, RWB, Kicukiro District etc should be regularly conducted to assess the implementation of the EMP provided in this report , ;

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Annex 1: List of contacted people

A. Government Institutions

Names	Institution	Contact
Aime Francine MBATEYE	WASAC	0788486203
Vital MUNYANDINDA	RWB	0788225918
Jaques NZITONDA	RURA	
Jacques NSENGIYUMVA	REMA	0786624431
Simeon NTUYE	RDB	0788353048
Marchard BANAMWANA	MoE	0788861374
Jean Nepo NDAYAMBAJE	RTDA	0788703958

B. Local community

No	Owner name	ID	Sector	Cell	Village
1	BIRAHAGWA Janvier	1196180002582182	Masaka	Mbabe	Kamashashi
2	MUKANGAMIJE Marthe	1197370026042033	Masaka	Gako	Kabeza
3	SERUKWAVU John	1197980018641033	Masaka	Mbabe	Ruyaga
4	MPIRWA MIGABO	1197880000323058	Masaka	Cyimo	Kabeza
5	MUKAGASISI Donatha	1196970007349091	Masaka	Ayabaraya	Ayabaraya
6	MUREKATETE Esterie	1197670012124054	Masaka	Gako	Rebero
7	MURINDABIGWI Marcellin	1196880007745098	Masaka	Ayabaraya	Ayabaraya
8	NTAWUBURUMWANZI Thacienne	1195770003293160	Masaka	Cyimo	Cyimo
9	TWAGIRIMANA TWAHA	1197980003734140	Masaka	Cyimo	Kabeza
10	UZABAKIRIHO Donat	1196880005821083	Masaka	Gako	Butare

Annex 2: Land to be affected by Masaka Water Treatment Plant

No	Sector	Cell	Village	UPI	Owner name	ID	Area (sqm)	Ownership
1	Masaka	Mbabe	Kamashashi	1/03/08/05/215	BIRAHAGWA Janvier	1196180002582182	3983	**Private**
2	Masaka	Mbabe	Kamashashi	1/03/08/05/216	BIRAHAGWA Janvier	1196180002582182	4172	Private
3	Masaka	Mbabe	Kamashashi	1/03/08/05/217	BIRAHAGWA Janvier	1196180002582182	2170	Private
4	Masaka	Mbabe	Kamashashi	1/03/08/05/218	BIRAHAGWA Janvier	1196180002582182	1250	Private
5	Masaka	Mbabe	Kamashashi	1/03/08/05/219	BIRAHAGWA Janvier	1196180002582182	1598	Private
6	Masaka	Mbabe	Kamashashi	1/03/08/05/220	BIRAHAGWA Janvier	1196180002582182	2743	Private

Annex 3: Structures to be affected by the transmission pipelines

No	Sector	Cell	Village	UPI	Owner name	ID	Area (sqm)
1	Masaka	Gako	Kabeza	1/03/08/03/5502	MUKANGAMIJE Marthe	1197370026042033	393
2	Masaka	Mbabe	Ruyaga	1/03/08/05/1111	SERUKWAVU John	1197980018641033	2605
3	Masaka	Cyimo	Kabeza	1/03/08/02/1961	MPIRWA MIGABO	1197880000323058	1424
4	Masaka	Ayabaraya	Ayabaraya	1/03/08/01/993	MUKAGASISI Donatha	1196970007349091	1269
5	Masaka	Gako	Rebero	1/03/08/03/5503	MUREKATETE Esterie	1197670012124054	776
6	Masaka	Ayabaraya	Ayabaraya	1/03/08/01/942	MURINDABIGWI Marcellin	1196880007745098	749
7	Masaka	Cyimo	Cyimo	1/03/08/02/603	NTAWUBURUMWANZI Thacienne	1195770003293160	346
8	Masaka	Cyimo	Kabeza	1/03/08/02/4003	TWAGIRIMANA TWAHA	1197980003734140	471
9	Masaka	Gako	Butare	1/03/08/03/2378	UZABAKIRIHO Donat	1196880005821083	429

Annex 4: Checklist of key guiding questions

Checklists of Key questions upon which impacts of the project may be established are in the table below:

		No	Yes
A- Physical and Biological environment:			
a)	Is the ground water dependent on water from the Akagera River or is there an alternative source?		
b)	What kind of soils, vegetation, terrain is in the area? How suitable is it for the proposed irrigation scheme?		
c)	Any likely water sources around? Any likelihood of the project affecting or contaminating them?		
d)	Poor drainage that might eventually influence the risk of water-related diseases such as; malaria or bilharzia?		
e)	Operate within a fragile ecosystem areas (e.g. forests, wetlands) or threatened species?		
f)	Likelihood of soil salinity from Irrigation?		
g)	Any risks leading to increased soil degradation or erosion?		
h)	Impact on the quantity or quality of surface waters (e.g. Lakes, rivers, wetlands), or groundwater (e.g. springs)?		
i)	During construction and implementation any chances of solid or liquid waste production? Proposed disposal or treatment means?		
B- Socio-economic environment/ Impacts			
a)	Influence of the project on public health, proper sanitation and any other health facilities such as; medical insurance "Mituelle"?		
b)	Is its location around an area where there is an important historical, archaeological or cultural heritage site?		
c)	Is its location within or adjacent to any areas that are or may be protected by government (e.g. national park, national reserve, world heritage site) or local tradition, or that might be a natural habitat?		
d)	Depend on water supply from an existing dam, weir, or other water diversion structure?		
f)	Will the project displace homesteads, commercial centres, or individual plantations?- Voluntary and Involuntary resettlement		

Annex 5: Interview guide questionnaires

Interview Guide With Local Population

- ✓Have you ever been told about the water supply project in this area? *Mwigeze mubwirwa ko hari umushinga w'amazi muri aka gace?*
- ✓How do you appreciate this project? *Uyu mushinga murawumva mute?*
- ✓Do you think that some of the population wasdisplaced due to that project? If yes, are they already informed? *Ese mubona hari abaturage bashobora kuzimurwa? Niba bahari barabimenyeshejwe?*
- ✓What are the main activities that enable you to earn money in this area? *Ni iyihe mirimo mufite yinjiza mafaranga muri aka gace?*
- ✓Do you own this land? *Ese ubutaka uhingaho nubwawe, ubufitiye impapuro?*
- ✓Do you think that this project will improve your living conditions? *Mubona uyu mushinga wo kubagezaho amazi meza uzahindura ku mibereho yanyu ya buri munsi?*
- ✓What are the consequences of the displacement of the population due to the project? *Ni izihe ngaruka zaba hari abaturage bimuwe kubera gahunda yo kubagezaho amazi meza?*
- ✓Do you see any consequences on your lives by project? *mubona hari ngaruka mbi uyu mushinga uzagira ku buzima bwanyu?*
    - **a.** What can you suggest that this project may be useful for your families? *Ni iki mwasaba kugira ngo uyu mushinga uzagirire akamaro imiryango yanyu?*

Interview guide with local authorities

- ✓ Are the population aware on the project ? If yes, when? If no, why? *Ese abaturage bagejejweho mbere gahunda y'uyu mushinga? Niba ari yego, ryari? Niba ari oya, kubera iki?*
- ✓ Are there any people who will be displaced due to the project implementation? *If yes are they informed? Ese hari abagomba kwimurwa kubera iyi gahunda? Niba ari yego, Abagomba kwimurwa barabizi?*
- ✓ The labor force who wasused in this project, are they from this area or elsewhere? *Ese abakozi bazakenerwa muri uyu mushinga bava muri aka gace cyangwa ahandi?*
- ✓ Does the project have a time limit? *Gahunda y 'uyu mushinga ese izahoraho ?*
- ✓ How can you assure the population that the project will improve the living conditions of the population? *Ni ikihe cyemezo mwaha abaturiye uyu mushinga ko wazazamura imibereho yabo?*

Guiding questions for policy makers and regulators

- ✓ How do you think your organization mandate is related to water treatment and supply?
- ✓ Which Institutions do you think their attributions are related to water Treatment and supply?
- ✓ Which National policies in place reflecting water treatment and supply?
- ✓ Which National laws in place address Water treatment and suply?
- ✓ Do you know any private company which is dealing with water treatment and supply?
- ✓ Is there any incentives provided for those private companies which are working water supply?
- ✓ How do you rate the involvement of private Sector in water supply project in the city?
- ✓ What do you consider as environmental challenges related to water treatment and supply in Rwanda
- ✓ What are the requirements of establishing a water treatment plant? What about water supply project?
- ✓ Which do you consider as threats of water treatment plant and water supply on the general environment?

RDB | RWANDA DEVELOPMENT BOARD

This is to certify that the Environmental Impact Statement (EIS) was received from

Project title:

Project objective:

The objective of the Project is to enhance stability of water supply and to catch up growth of water demand, for developing and maintaining water supply facilities in Kigali City

Location: District(s) , Sector(s), Cell(s).

The EIS has been submitted in accordance with the Laws and Regulations relating to the requirements & procedures for Environmental Impact Assessment in Rwanda and has been reviewed and found to have sufficient and relevant mitigation measures to the identified likely impacts of the project on the environment.

It was therefore approved subject to fulfilment of the conditions attached to this certificate.

Clare AKAMANZI

Chief Executive Officer

Fred KAREMERA

RWANDA DEVELOPMENT BOARD (RDB) KOSC

Copies to: REMA, MoE, MININFRA,Kicukiro District

RDB | RWANDA DEVELOPMENT BOARD

CONDITIONS OF APPROVAL

In addition to the implementation of mitigation measures outlined in the EIA report, this certificate of approval is granted under condition that the developer shall comply with the conditions given herein:

1. General conditions

a. This certificate of approval is valid for a period of 3 years before the commencement of the project. Application for its renewal shall be examined by RDB. Otherwise, it is valid during the whole lifecycle of this specific project unless henceforth revoked or suspended;
b. Any change in the project designs shall be notified to RDB for further environmental considerations, and adjustment of this certificate of approval;
c. Ensure that the EMP is implemented as prescribed in the EIR and ensure that records are kept for future monitoring or environmental audits;
d. Ensure that any other undesirable environmental impacts arising from implanting this project but no foreseen by the time of undertaking the EIA are mitigated;
e. Obtain all necessary approvals from the local administration as well as other relevant institutions;
f. Ensure that this certificate is clearly displayed and is available at all times at the project site during project development/construction;
g. Fulfill other environmental conditions and requirements as may be prescribed from time to time by the environmental authority or any other lead agency;
h. Carry out regular environmental audits and submit audit reports to the Authority.

2. Specific conditions

- Observe all relevant national, regional and international standards, policies, regulations and legislation that guide this specific project throughout its life cycle ;
- Ensure that Construction works will start if and only if the expropriation and compensation exercises are dully completed;
- Construction works likely to produce excessive vibrations and noise should be carried out during day hours in order to avoid disturbance to the local people ;
- Proper planning, phasing and/or scheduling of activities to avoid/reduce inconvenience and disturbances;
- Workers on site must be provided with protective equipment at all times on duty and medically checked;
- Access to working area shall be restricted to the workers and permitted and guided visitors;
- Avoid emissions of dust emanating from earth works on site and increased traffic movement of vehicles;
- All machinery, trucks and equipment at the construction site should be in good condition so as to reduce the level of noise and exhaust emissions, & risk of accidents;
- Potable water, temporal sanitary toilets should be available on the construction site;

- ☞ Constantly liaise with relevant authorities and consult stakeholders including local communities in case of any new development or changes as regards to implementation of your project plan activities;
- ☞ Abide by all national social and environmental safeguard policies and standards and strive to maintain and constantly improve standards ;
- ☞ Conduct periodic Environmental Audits and facilitate monitoring by relevant authorities;
- ☞ Ensure safe disposal of all types of wastes (solid or liquid) in specified and approved sites after treatment as required;
- ☞ Take measures to ensure that soil and water are not contaminated by fuel and oil spillages/leakages due to the project related activities;
- ☞ The project should have first Aid kits for the first aid assistance in case of accident occurrence;
- ☞ Regular training of the staff on fire extinguishers and other security measures shall be conducted;
- ☞ During construction and operation phase, the project shall have an insurance coverage for all damages and accidents;
- ☞ Liaise with other relevant institutions to make sure that road construction works do not damage or weaken existing structures, infrastructures and facilities like water supply pipes, electrical poles and lines, fiber optic etc.;
- ☞ Be prepared for redesign and incorporation of changes that may be imposed by unpredicted situations;
- ☞ Set up and implement a regular maintenance program to keep the project's infrastructure in good state throughout the operation phase;
- ☞ Set up joint monitoring committee bringing together different stakeholders for regular monitoring of the construction works and solution finding to unforeseen situations;
- ☞ All necessary measures should be takes to ensure quality of work meets or exceeds expectation for the entire project life span design;
- ☞ Campaigns against epidemic and pandemic diseases spread should be regularly conducted during all phases of the project implementation and measures observed;
- ☞ Put in place a mechanism to ensure that any other undesirable environmental impacts that may arise due to implementation of this project but were not contemplated at the time of undertaking the Environmental Impact Assessment are mitigated;

- ➢ The Environmental Impact Report is thus approved subject to the fulfillment of the conditions described above together with all mitigation measures proposed in your Environmental Management and Monitoring Plans.

N.B : Note that in case of non-compliance with the conditions described above, RDB reserves the right to withdraw the certificate.

Signed by

Clare AKAMANZI
Chief Executive Officer
Rwanda Development Board

Gisele UMUHUMUZA
Representative
WASAC

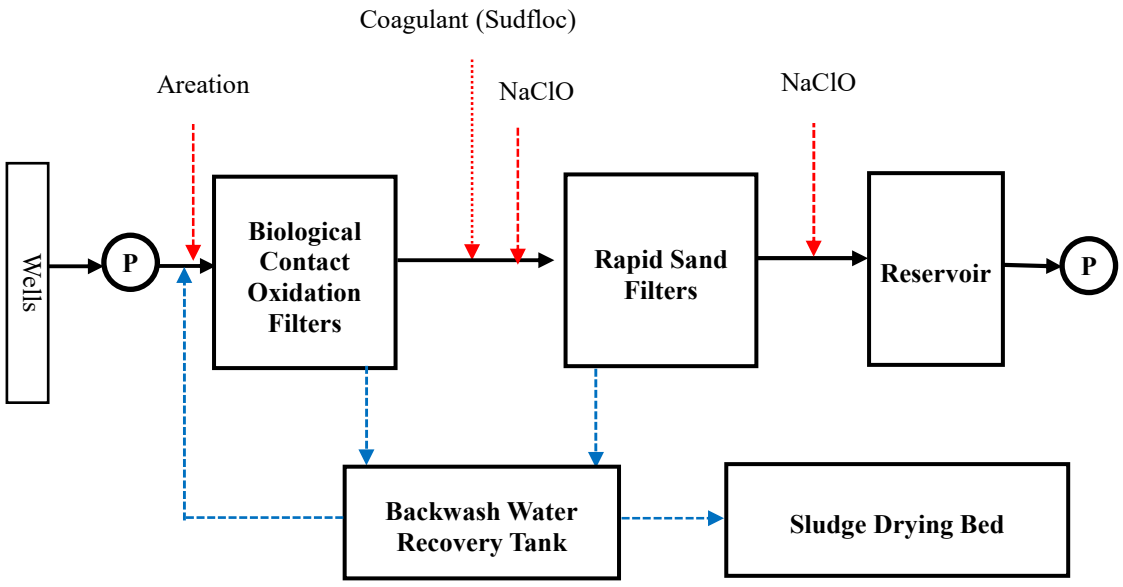
Appendix C: Financial and Economic Evaluation

APPENDIX C FINANCIAL AND ECONOMIC EVALUATION

This Page is closed due to the confidentiality.

APPENDIX D: Hydraulic Calculation

Item	Calculation			
1. Design Parameters				
1-1 Outline of Water Treatment Plant				
(1) Area of the Plant		As specified		
(2) Grand Level of the Plant		As specified		
(3) Water Treatment Process		Wells→Aeration→Bio-Contact Oxidation→Cl_2→Rapid sand Filter→Post-Cl_2		
1-2 Design Flow rate		20,000	m^3/d	
1-3 Raw Water Quality				
(1) pH		7.5		
(2) Turbidity		20	NTU	
(3) Fe		15	mg/l	
(4) Mn		3.0	mg/l	
(5) Ammonia		1.0	mg/l	
(6) DO		4.0	mg/l	
(7) Alkalinity		60	mg/l	(Result of 19/02/2021, Average value of Nzove 1 Raw Water Qulity=30mg/L)
(8) SiO_2		0.0	mg/l	
1-4 Treated Water Quality				
(1) Turbidity	<	1.0	NTU	5 NTU, Rwanda Drinking Water Quality Standards
(2) Fe	<	0.3	mg/l	0.3 mg/L , Rwanda Drinking Water Quality Standards
(3) Mn	<	0.1	mg/l	0.1 mg/L , Rwanda Drinking Water Quality Standards
(4) Ammonia	<	0.5	mg/l	0.5 mg/L , Rwanda Drinking Water Quality Standards
1-5 Return Wastewater (with Raw Water)		1,400	m^3/day	
2. Design Process				



Chemicals and its purpose and application point are summarized below.

Chemical	Purpose	Application Point
Aeration	Ammonia, odor, iron, manganese removal	Biological Contact Oxidation Filters
Sudfloc	Coagulation for removing turbidity	Rapid Sand Filter Inlet Pipe
Intermediated-chlorination	Disinfection, Oxidation and Manganese removal	Rapid Sand Filter Inlet Pipe
Post-chlorination	Disinfection	Clear Water Reservoir

Item	Calculation
1. Aeration	
1.1 Design Condition	
Design Flow Rate	= 20,000 m^3/d = 833 m^3/h = 0.231 m^3/s
1.2 Oxygen Required	
Condition	
Unit Oxygen Need for Fe^{2+} Oxidation	= 0.14 mg/mg
Unit Oxygen Need for Mn^{2+} Oxidation	= 0.29 mg/mg
Unit Oxygen Need for NH_4^+ Oxidation	= 4.57 mg/mg
Safety Factor	= 1.2
Oxygen Concentration of Raw Water	= 4.0 mg/L (Result of 19/02/2021)
[O2] Required	= 2.22 mg/L
1.3 Aeration Method	Spray nozzles
Service Area of Each Nozzle	= 2 m^2/nozzle (1-3 m^3/nozzle)
Installation height	= 1.5 m above the water surface of Contact Oxidation Filter
Total Number of Nozzle	= 50.4 Nozzles
Number of Nozzle in each Filter	= 8.4 → 15 (5 Nozzle/line*3 line/filter)
Output of each Nozzle	= 4.59 L/S
Head Required at Nozzle	= 7 m of water
Nozzle Dia.	= 30 mm
2. Biological Contact Oxidation Filters	
Filter Media	Sand (0.6-1.2 mm)
Washing Type	Surface Washing + Water (Surface washing by inflow nozzle)
Return Backwashing Water Flow Rate	= 1,900 m^3/d
Return Rate of Filtered Water Flow	= 0.5
Design Flow Rate	= 1,369 m^3/h
Frequency of Washing	= 8 hr/cycle/filter
Media Depth	= 3.2 m
Depth of Supernatant	= 1 m
Filtration Rate	= 15 m/hr= 360 m/d
Total Filter Area	= 91 m^2
No. of Filters	= 6 Filters
Sign Filter Area	= 15.2 m^2
Width of Single Filter	= 3.0 m
Length of Single Filter	= 5.1 m → 5.6 m
Total Area	= 101 m^2
Actual Area of Single Filter	= 17 m^2
Unit Backwashing Rate	= 0.5 $m^3/m^2/min$ (8.3 $L/m^2/S$)
Backwashing Duration	= 10 min
Required Water for Backwash Water	= 84 m^3/filter

Item	Calculation
Total Required Water for BW	= 1,512 m^3/day
Number of Backwash Tank	= 2
Total Volume of Backwash Tank	= 168 m^3 (200% of Required Water for Backwash Water)
Major Equipment	
Number of Backwash Water Pump	= 2 (1 unit for stand-by)
Required Capacity per Unit	= 9.24 m^3/min
Level Meter	= 8 unit, Float Type
Flow Meter	= 1 unit, Electromagentic Type
Flow Control Equipment	= 1 unit, Local Control Panel (LCP)
Flow Control Valve of Backwash Water	= 1 unit
3. Rapid Mixing - Flocculator	
Dose of Sudfloc	= 15 mg/L
Dosage of Sudfloc	= 10 L/hr
4. Chlorination Equipment (Sodium Hypochlorite Generator)	
Dose of Intermediate Chlorination	= 2.0 mg/L
Dose of Post-chlorination	= 1.0 mg/L
Effective density of chlorine	= 0.8 %
Dosage of Chlorination	= 313 L/hr
Salt Consumption	= 210 kg Salt (3.5 kg Salt/kg Cl_2)
5. Rapid Sand Filters	
Filter Media	Dual sand/anthracite media (Sand: 0.6-1.2 mm; Anthracite: 0.8-1.6)
Washing Type	Surfacewashing and backwashing
Frequency of Washing	= 24 hr/cycle/filter
Media Depth	= 1 m (Sand: 0.6m; Anthracite: 0.4m)
Depth of Supernatant	= 1 m
Filtration Rate	= 5 m/hr (120 m/d) During Washing = 6 m/hr
Total Filter Area	= 167 m^2
No. of Filters	= 6 (No. of Unit during Washing = 5)
Single Filter Area	= 27.8 m^2
Width of Single Filter	= 4.0 m
Length of Single Filter	= 6.9 m → 7 m
Total Area	= 168 m^2
Actual Area of Single Filter	= 28 m^2
Unit Air Scoring Rate	= 1.0 m^3/m^2/min
Air-scoring Duration	= 5.0 min
Unit Backwashing Rate	= 0.6 m^3/m^2/min (10.0 $L/m^2/S$)
Backwashing Duration	= 10 min
Required Water for BW	= 168 m^3/filter
Total Req. Water for BW	= 1,008 m^3/day
Volume of Backwash Tank	= 336 m^3 *120% 403 (6.8 * 10 * 3 * 2)= 408 m^3
Number of Backwash Tank	= 1 2?

Item	Calculation
Total Volume of Backwash Tank	= 336 m^3 (200% of Required Water for Backwash Water)
Major Equipment	
Number of Backwash Water Pump	= 2 (1 unit for stand-by)
Required Capacity per Unit	= 18.48 m^3/min
Number of Air Scouring Blower	= 2 (1 unit for stand-by)
Required Capacity per Unit	= 30.8 m^3/min
Level Meter	= 8 unit, Float Type
Water Quality Monitoring Equipment	= 1 unit (Temperature, pH, Turbidity (On-line monitoring))
Flow Meter	= 1 unit, Electromagentic Type
Flow Control Equipment	= 1 unit, Local Control Panel (LCP)
Flow Control Valve of Backwash Water	= 1 unit
Air-scoring Equipment	= 6 unit
6. Clear Water Reservoir	
Number of Tank	= 2 Tank
Flow	= 833 m^3/h
Store Rate to Production	= 2 hour
Required Capacity	= 1,667 m^3
Required Capacity per Tank	= 833 m^3/tank
Volume and Dimension	= 850 m^3/tank (10.0 ^{W} x 17.0 ^{L} x 5.0 ^{H})
Unit Area per Tank	= 170 m^2
Total Area of Reservoir	= 340 m^2
Major Equipment	
Level Meter	= 2 unit, Float Type
Water Quality Monitoring Equipment	= 1 unit (pH, Turbidity, Chlorine (On-line monitoring))
7. Backwash Water Recovery Tank and Backwash Water Recycling Pump	
Number of Chamber	= 2 Tank
Required BW Tank Volume	= 151 m^3/Tank
Volume and Dimension	= 192 m^3/Tank (8.0 ^{W} x 8.0 ^{L} x 3.0 ^{H})
Unit Area per Tank	= 64 m^2
Total Area of Reservoir	= 128 m^2
Tank Filling Time	= 23 min
Number of Backwash Water Pump	= 2 (1 unit for stand-by)
Required Capacity per Unit	= 168 m^3
Transmission Period	= 150 min
Required Capacity per Unit	= 1.3 m^3/min → 1.5 m^3/min
8. Sludge Treatment System	
Dry Solid Produced (Turbidity)	= 517 kg/d
Water Treatment Amount	= 20,000 m^3/d
Design Turbidity (Average)	= 20 NTU
Treated Water Turbidity	= 1 NTU

Item	Calculation
Dose of Coagulant	= 15 mg/L
Turbidity - SS Conversion Rate	= 1
Dry Sludge Produced (Fe and Mn)	= 650 kg/d
Unit sludge produced amount	= 1.9 kg/kg Fe^{2+}
	= 1.58 kg/kg Mn^{2+}
Total Dry Sludge Amount	= 1,167 kg/d
Sludge loading of sludge drying bed	= 40 kg/m^2
Average dry time	= 60 days
Area of sludge drying bed	= 1,800 m^2 (25.0 ^{W} x 12.0 ^{L} x 1.0 ^{H} x 6)
9. Wastewater Treatment System	
Treatment Method	Constructed Wetland along Lakeshore of Mugesera Lake
Design Wastewater Flow Rate	= 58 m^3/d Solid Content of Sludge = 2% T_{sd}= 1 ton/m^3
Retention Time	= 48 hr
Total Volume	= 117 m^3
Average Water Depth	= 1 m
Area of the Treatment System	= 117 m^2 → (3.0 ^{W} x 20.0 ^{L} x 2 basins)

APPENDIX E: Distribution Systems Plan

(1) Pipe Profiles

bolckname	area_gis	Area Proportion	Weight	Demand Proportion	2030	2035	2035, rounded	memo		MR	Demand	Existing Customers	Industrial Demand	Expected Customers
MAS0	212635	0.5%		0.0%	0	0	0	1570 > 1540	Gako tophil	CH	0	6		
MAS2	5074395	12.1%	3	10.8%	1,163	2,025	2,100	1560 > 1480	Gako high	CH	2,025	311		4,219
MAS4-1	2312400	5.5%	5	8.2%	883	1,538	1,600	1500 > 1410		CM	1,538	976		3,204
MAS2-2	4511907	10.8%	1	3.2%	345	600	700	1500 > 1410	Mbabe middle	CH	600	24		1,250
MAS3	4825740	11.5%	3	10.3%	1,106	1,926	2,000	1490 .> 1400	Ayabaraya high	CH	1,926	816		4,012
MAS5	4082982	9.7%	3	8.7%	936	1,629	1,700	1430 > 1340	Ayabaraya low	CM	1,629	252		3,394
MAS7	10822641	25.8%	3	23.1%	2,480	4,319	4,400	1430 > 1340	Mbabe low	MB	4,319	571		8,998
MAS6	6709866	16.0%	5	23.8%	2,563	4,463	4,500		Gitaraga	CM	4,463	1587		9,297
MAS1	3329993	8.0%	5	11.8%	1,272	2,215	2,300	1440 > 1350	Gako-Kabuga	CM	2,215	1879		4,614
												6422		**38988**

(2) Total Demand

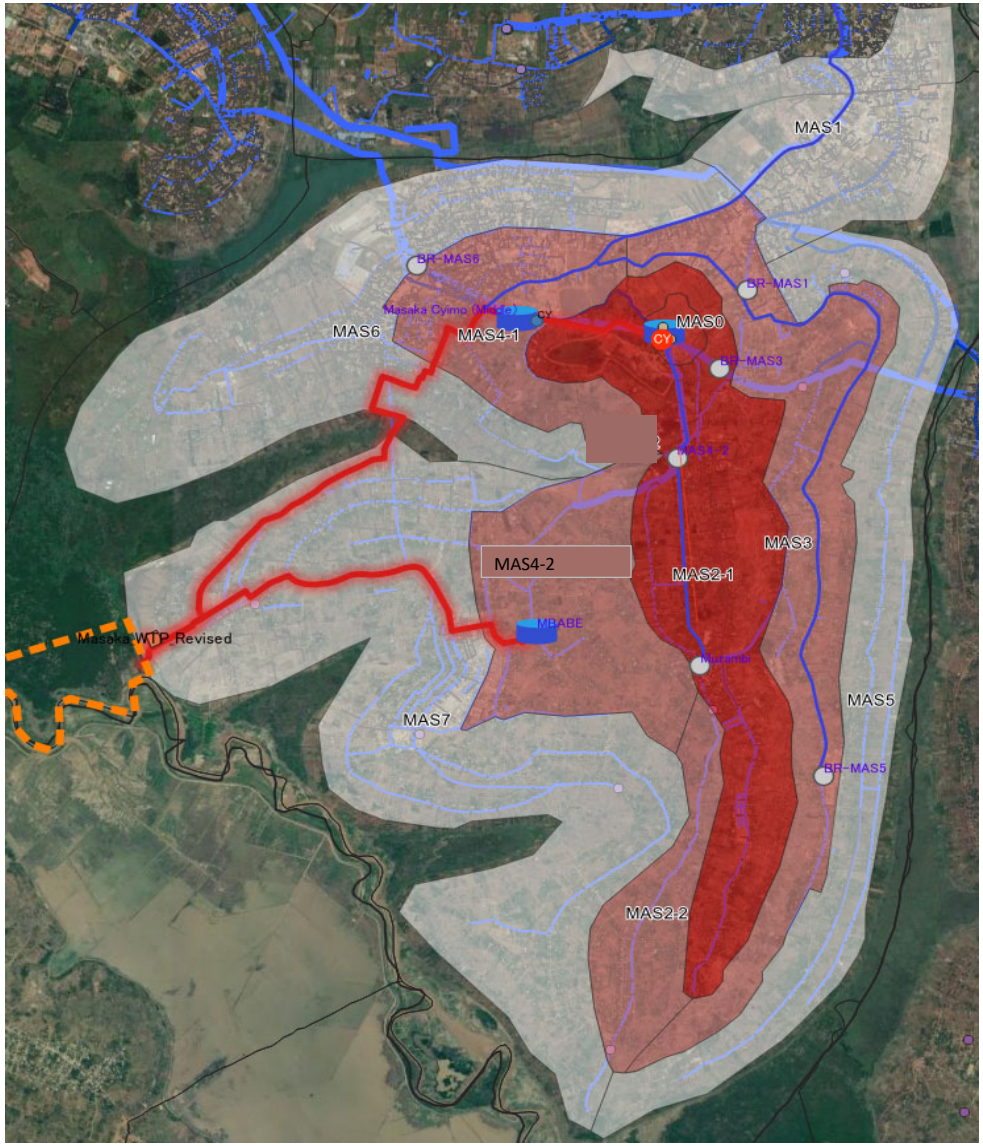
Year	Capacity	Demand inside	Day Max	Transmit Outside
2030	20,000	10,748	13,972	9,252
2035	20,000	18,714	24,329	1,286

(3) Demand Allocation by Blocks

Projection

Block Name	Name	Description	Elevation Range, (EL+)m	Existing Customers, nos.	Demand in 2030, m3/day	Demand in 2035, m3/day	Future Expected Customers in 2035	Demand
MAS0	Gako tophil	Isolated area where it is difficult to supply water from Cyimo (High Reservoir).	1540-1570	6	-	-	-	-
MAS2-1	Gako high	High residential area with the edge of Masaka hill,thie include higher part of newly developing residential area around Cyimo, and pipeline extends to M	1480-1560	311	1,200	2,100	4,219	1,200
MAS4-1	Cyimo-Middle	Middle of existing Masaka city where existing residential and industrial estates are concentrated.	1410-1500	976	900	1,600	3,204	900
MAS4-2	Mbabe middle (1)	Midle elevation part of Mbabe-Masaka where it is to be located in the higher elevation than the future "Mbabe" reservoir.	1410-1500	185	900	1,600	3,204	900
MAS2-2	Mbabe middle (2)	Lower to middle elevation parto of the South-western part of Murambi-Masaka, including Cyeru.	1410-1500	24	300	700	1,250	300
MAS3	Ayabaraya high	Middle elevation zone of Ayabaraya, eastern part of Masaka.	1400-1490	816	1,100	2,000	4,012	1,100
MAS5	Ayabaraya low	Lower elevation residential area at the eastern side of Masaka.	1340-1430	252	900	1,700	3,394	900
MAS7	Mbabe Low	Lower elevation part of the Masaka western hill which includes the existing city site of the veteran residential area	1340-1430	571	2,500	4,400	8,998	2,500
MAS6	Gitaraga	Lower elevation part of the Masaka north area, where the logistics parks and comercial-industrial estates are highly concentrated.	1340-1410	1587	2,600	4,500	9,297	2,600
MAS1	Gako-Kabuga	Residential and commertial area of Masaka near the National Road NR4. The area is continuously stretched to Kabuga-Rusororo.	1350-1440	1879	1,300	2,300	4,614	1,300

(4) Schematic of Blocks



APPENDIX F: Calculation and Unit Rates for Cost Estimate

APPENDIX F Calculation and Unit Rates for Cost Estimate

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APPENDIX G: Comparison of Pipe Materials (DIP and HDPE)

Appendix G. Comparison of Pipe Materials

<table>
<tr><th>Material</th><th>DIP
(Ductile Iron Pipe)</th><th>HDPE
(High Density Polyethylene)</th></tr>
<tr><td>Durability</td><td>− High strength
− High UV resistance</td><td>− High corrosion resistance
− High UV resistance</td></tr>
<tr><td>Workability</td><td>− Good handling and installation for push-on type connection.
− Heavy weight that needs the heavy-duty equipment for installation.</td><td>− Light weight and easy installation. Not necessarily require the heavy-duty equipment for installation for small diameter pipes.</td></tr>
<tr><td>Past application</td><td>Widely used for Transmission Pipelines with high pressures.</td><td>Not used for transmission pipelines.</td></tr>
<tr><td>Maintenance</td><td>Need stocks for the fittings to be prepared the leakage and breakage.</td><td>Less maintenance because the fitting numbers are less (10 to 11 m for 1 straight pipes).</td></tr>
<tr><td>Cost</td><td>USD/m
ND | DIP
100 | 71
150 | 130
200 | 194
250 | 229
300 | 280</td><td>USD/m
ND | HDPE | DIP/HDPE
100 | 20 | 351%
150 | 42 | 307%
200 | 83 | 235%
250 | 128 | 179%
300 | 162 | 173%</td></tr>
<tr><td>Others</td><td>− Flexible within allowable bending angle
− High reliability due to high strength</td><td>− High flexibility
− Joints are fused. Risk of leakage is reduced.</td></tr>
<tr><td>Selection</td><td>Selected for Transmission Pipelines</td><td>Selected for Distribution Pipelines</td></tr>
</table>

Note:

1) ND; Nominal Diameter, HDPE; High Density Polyethylene Pipe, DIP; Ductile Iron Pipe

2) Both assuming PN16. Reference OD for HDPE is 110, 160, 225, 280, 315 respectively.

(Reference) HDPE Price Quotation Summary

Description	Manufacturer	Origin	Quantity	Unit	Unit Price, USD	Discount rate
25MM HDPE PE100 PN16 SDR11 PIPE STANDARD:EN12201-2 ISO4427	AXIS Industry	Turky	50000	m	0.7	0.9
40MM HDPE PE100 PN16 SDR11 PIPE STANDARD:EN12201-2 ISO4427	AXIS Industry	Turky	50000	m	1.3	0.9
63MM HDPE PE100 PN16 SDR11 PIPE STANDARD:EN12201-2 ISO4427	AXIS Industry	Turky	50000	m	2.9	0.9
90MM HDPE PE100 PN16 SDR11 PIPE STANDARD:EN12201-2 ISO4427	AXIS Industry	Turky	50000	m	5.5	0.9
110MM HDPE PE100 PN16 SDR11 PIPE STANDARD:EN12201-2 ISO4427	AXIS Industry	Turky	50000	m	7.9	0.9
160MM HDPE PE100 PN16 SDR11 PIPE STANDARD:EN12201-2 ISO4427	AXIS Industry	Turky	20000	m	16.6	0.9
225MM HDPE PE100 PN16 SDR11 PIPE STANDARD:EN12201-2 ISO4427	AXIS Industry	Turky	20000	m	32.4	0.9
280MM HDPE PE100 PN16 SDR11 PIPE STANDARD:EN12201-2 ISO4427	AXIS Industry	Turky	20000	m	50.1	0.9
315MM HDPE PE100 PN16 SDR11 PIPE STANDARD:EN12201-2 ISO4427	AXIS Industry	Turky	20000	m	63.4	0.9

(Reference) DIP Price Quotation Summary

Cost by Quotation, DIP					USD	
PN10	Straight Pipes	Gaskets	Straight Pipes + Gascket	Discount	Straight Pipes + Gascket	
Ductile iron pipe NATURAL Biozinalium DN100 L=6m C40 Standard	43.00	3.70	46.70	0.8	37.36	
Ductile iron pipe NATURAL Biozinalium DN150 L=6m C40 Standard	64.00	5.40	69.40	0.8	55.52	
Ductile iron pipe NATURAL Biozinalium DN200 L=6m C40 Standard	135.00	7.00	142.00	0.8	113.60	
Ductile iron pipe NATURAL Biozinalium DN250 L=6m C40 Standard	176.00	9.10	185.10	0.8	148.08	
Ductile iron pipe NATURAL Biozinalium DN300 L=6m C40 Standard	225.00	13.10	238.10	0.8	190.48	
Ductile iron pipe NATURAL Biozinalium DN400 L=6m C30 Standard	306.00	19.80	325.80	0.8	260.64	
Ductile iron pipe NATURAL Biozinalium DN450 L=6m C30 Standard	350.00	25.30	375.30	0.8	300.24	
Ductile iron pipe NATURAL Biozinalium DN500 L=6m C30 Standard	421.00	29.30	450.30	0.8	360.24	
Ductile iron pipe NATURAL Biozinalium DN600 L=6m C30 Standard	542.00	39.80	581.80	0.8	465.44	
Ductile iron pipe NATURAL zinalium DN700 L=6.96m C25 Standard	757.00	54.50	811.50	0.8	649.20	
Ductile iron pipe NATURAL zinalium DN800 L=6.95m C25 Standard	912.00	72.50	984.50	0.8	787.60	
Ductile iron pipe NATURAL zinalium DN1000 L=6.96m C25 Standard	1,324.00	111.20	1,435.20	0.8	1,148.16	

PN25	Straight Pipes	Anchor Ring	Gaskets	Straight Pipes + Gascket	Discount	Straight Pipes + Gascket
Ductile iron pipe NATURAL Biozinalium DN100 L=5.97m C100 Universal Standard	58.00	39.80	3.70	61.70	0.8	49.36
Ductile iron pipe NATURAL Biozinalium DN150 L=5.97m C64 Universal Standard	143.00	60.60	5.40	148.40	0.8	118.72
Ductile iron pipe NATURAL Biozinalium DN200 L=5.97m C64 Universal Standard	188.00	130.50	7.00	195.00	0.8	156.00
Ductile iron pipe NATURAL Biozinalium DN250 L=5.97m C50 Universal Standard	230.00	172.20	9.10	239.10	0.8	191.28
Ductile iron pipe NATURAL Biozinalium DN300 L=5.97m C50 Universal Standard	287.00	201.60	13.10	300.10	0.8	240.08
Ductile iron pipe NATURAL Biozinalium DN400 L=5.97m C40 Universal Standard Ve	413.00	103.20	19.90	432.90	0.8	346.32
Ductile iron pipe NATURAL Biozinalium DN450 L=5.97m C40 Universal Standard Ve	483.00	185.40	25.30	508.30	0.8	406.64
Ductile iron pipe NATURAL biozinalium DN500 L=5.97m C40 Universal Standard Ve	564.00	161.30	29.30	593.30	0.8	474.64
Ductile iron pipe NATURAL biozinalium DN600 L=5.97m C40 Universal Standard Ve	738.00	453.30	39.80	777.80	0.8	622.24
Ductile iron pipe NATURAL zinalium Aquacoat DN700 L=6.89m C30 Universal Standard With Weld Bead At The Spigot End	945.00	399.90	54.50	999.50	0.8	799.60
Ductile iron pipe NATURAL zinalium Aquacoat DN800 L=6.89m C30 Universal Standard Ve	1,132.00	336.70	72.50	1,204.50	0.8	963.60
Ductile iron pipe NATURAL zinalium Aquacoat DN1000 L=6.88m C30 Universal Standard With Weld Bead At Spigot End	1,590.00	481.50	111.20	1,701.20	0.8	1,360.96